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Models and Methods for Material and Environmental Sciences

ENVIRONMENTAL INVESTIGATION AIMING TO OUTLINE SITES AND LANDSCAPES POTENTIALLY RECOGNIZABLE AS UNESCO GLOBAL GEOPARKS

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'The proper use of science

is not to conquer nature

but to live in it'

Barry Commoner

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Abstract

During the last 30 years there has been a growing scientific interest in topics related to geoheritage and a large set of related initiatives have emerged all around the world. Despite this increasing attention, only a handful of countries have a national geoheritage inventory and the present knowledge about geological heritage is generally sporadic and incomplete, justifying the establishment of a geoconservation strategy. An important role in this field is played by the UNESCO Global Geoparks, in identifying single areas that comprise sites with international geological significance and establishing for them a holistic management concept of protection, education and sustainable development. This PhD research focuses on the recognition and assessment of sites of geological and geomorphological interest, i.e. geosites, through four main stages, with the outcome of a final list of geosites, in the frame of an expression of interest made by the Ministry of Environment, Sustainable Development and Climate Change of Malta to have the study area recognised as a UNESCO Global Geopark. The assessment methodology applied in this research combines geological heritage with landscape cultural components that are partly determined by the geomorphological context in which they are situated. The evaluation of geological features is essentially based on the scientific value considering different criteria. However other additional values are also considered such as the links between geological heritage and all other aspects of the area's natural, cultural and intangible heritage, as required by the UNESCO guidelines for a UNESCO Geopark status recognition. Furthermore, this thesis presents an innovative quantitative methodology to assess the risk of degradation of geosites, the latter fundamental to understand the threats

affecting them and to schedule a relevant monitoring and management plan to conserve their geoheritage relevance. The methodology is based on three main criteria (i) natural vulnerability, (ii) anthropogenic vulnerability and (iii) public use. The proposed risk-based approach is also important to tackle the effects of climate change and to assess their future impact on the potential geosites. The assessment and recognition of geosites and the application of the new degradation risk methodology have been conducted on the Maltese Islands, located in the centre of the Mediterranean Sea. The archipelago, despite having a steadily increasing growth in population and tourism, still conserves geological and geomorphological features of great relevance and interest both for their contribution to the understanding of the geological processes acting through time on landscapes and for their aesthetic importance. Coastal cliffs, bays, sandy beaches, sinkholes and caves are some of the most outstanding geological and geomorphological features of the Maltese Islands, creating a stunning landscape and serving as an attraction to a high number of visitors each year. These are mostly concentrated in coastal areas, where the main economic activity is tourism. Human activities and natural processes may cause direct negative impacts on specific sites of particular value or large areas of the territory. Malta was considered the most suitable location to conduct the research due to the fact that, despite the rich geological heritage, the country to date still lacks a complete national inventory of geosites. This research provides insights to potential strategies which may address both the conservation of geoheritage elements and also the development of a sustainable and responsible tourism. The latter, can enhance the rich geological heritage of these areas by encouraging the knowledge and understanding of the landscape and its evolution. Such measures are of current relevance, due to the fact that the Maltese Islands have the highest population density in Europe and annually receive a considerable tourist influx,

which result in a high degree of human pressure. In addition, the research has contributed to proposal about the management of the studied area, also in the view of a UNESCO Geopark nomination.

Key words (5): geoheritage, UNESCO Global Geopark, geosite assessment, degradation risk, Malta

CHAPTER 1. Introduction

1.1 Foreword

Since the beginning of the 1990s, there has been a growing interest in themes related to geoheritage. Geoheritage is a rapidly emerging domain of geosciences, with the mission to recognise, select and assess sites with geological and geomorphological interest, referred to as geosites, and thus to ensure proper conservation of the abiotic natural heritage. Using an interdisciplinary approach, geoheritage studies comprise not only geology and geography disciplines, but also other fields such as ecology, biology, human culture, natural hazards, climate change and education. Geosites can be assessed for their main scientific interest, but other additional values can be considered such as ecological, aesthetical, cultural, historical and educational interests, in order to enhance the link between abiotic and biotic part of nature and cultural heritage. Despite the increasing interest and recognition, geoheritage is still not considered at the same level as biodiversity or climate change issues.

Recently, amongst the agenda of works of IUCN (International Union of Conservation of Nature), IUGS (International Union of Geological Sciences) and UNESCO, there have been several advancements in the realms of geoheritage suggesting a promising future for the field as an integral part of the natural heritage. IUCN was the first to recognise the importance of geological features as part of nature and in 2014 it established a Geoheritage Specialist Group, within the World Commission of Protected Areas (Reynard and Brilha, 2018). In 1996, IUGS launched the Global Geosites Project in order to carry out an inventory of international geological heritage. An important role was also played by UNESCO in 2015, who ratified the creation of a new label, the UNESCO Global Geoparks, single unified geographical areas where sites and landscapes of international geological significance are managed with a holistic concept of protection, education and sustainable development.

Geoheritage has also obtained increasing attention mainly from the scientific community. Recognition and assessment methods of geosites as well as classification and conservation strategies have been developed to safeguard the geological heritage for present and future generations (Brilha, 2016; Reynard and Brilha, 2018). Despite the growing worldwide interest in the field, in many countries, mostly outside Europe, there is a lack of an exhaustive knowledge of national geological heritage. Most of the times, nations without a systematic inventory of their geological sites are not aware or underestimate the importance and richness of those sites as component of natural heritage. Therefore, there are improper interpretations and wrong conservation actions undertaken by national competent authorities on the implementations of nature conservation policies, or in the worst-case scenario, no strategies at all (Dingwall et al., 2005; Brilha, 2002). The non-existence of a systematic inventory of the geological heritage and its adequate management may lead to the degradation and eventual destruction of geosites with scientific relevance. Thus, the first step in any geoheritage recognition and geoconservation strategy is the development of a geosites inventory.

The Maltese Islands, located in the centre of the Mediterranean Sea, are rich in natural and cultural heritage, and also experiencing a steady increase in population and tourism. The present landscapes of the islands are the result of processes that began at the time with the emergence of the archipelago, mainly during the last glacial cycle, when global sea level was substantially lower than at present, and continued through time in climatic conditions different from the present one (Prampolini, 2016). The study of geoheritage helps to recognise and select the sites of geological and geomorphological interest that need to be preserved for the future generations to better understand the evolution of past and present landforms. On the Maltese Islands, there are several protected areas, such as Special Areas of Conservation (SACs) for ecological importance, UNESCO World Heritages Sites and other sites of historical, cultural and natural relevance (Spiteri and Stevens, 2019). However, there is not an inventory of the geological heritage. In literature, few studies dealing with geoheritage recognition and geosites inventory have been carried out in the northwestern coast of Malta, especially on the area of Il-Majjistral Nature and History Park and environs (Coratza et al. 2011; Cappadonia et al. 2018; Selmi

et al., 2019). Other research on geoheritage assessment were conducted in the island of Gozo (Coratza et al. 2016; Calleja and Tonelli, 2019), in particular on the Dwejra area that comprises outstanding sinkholes having highly scientific, ecological, aesthetic, cultural and use values, assessed as geomorphosites. In addition, an important book on Maltese landscapes and landforms was recently published, illustrating the rich diversity of the Maltese physical landscapes under the World Geomorphological Landscapes series (Springer) (Gauci and Schembri, 2019). The volume comprises works on geoheritage and its relationship with cultural heritage, particularly to illustrate the significance of Maltese coastal landforms for societal well-being (Satariano and Gauci, 2019; Gauci and Inkpen, 2019). Such a recent research on geoheritage highlighted the presence of a rich heritage transcending the island's geographic scale, but which however remains somehow absent within the local perception and not directly considered worth of recognition and protection.

In 2017, scientific research on the international geological significance of the Maltese landscapes have suggested to the Maltese government, in particular the Ministry of Environment, Sustainable Development and Climate Change of Malta, to establish the Malta Geopark Commission in order to apply for possible inclusion of the Maltese Islands in the UNESCO Global Geoparks Network and to submit the relevant application in the near future. Due to limitations of size of the archipelago, the geological, historical and cultural properties tend to be very concentrated and intense thus rendering history disproportionate to size. In addition, there is a wide variety and high density of meaningful geological and geomorphological features, characterised by easy accessibility and great readability to non-specialists, making the area an excellent candidate for a geopark designation. Notwithstanding the initial interest shown by the Ministry of Environment, Sustainable Development and Climate Change of Malta and the high geological and geomorphological richness, the Geopark project has not registered any progress in the last two years.

Within this context, this research aims to present the first inventory of geological and geomorphological sites of interest in the Maltese archipelago, in particular for a designed study area in view of the country's application for status recognition of UNESCO Global

Geopark in the near future. The broad geosites survey is part of a strategy that targets notably the identification of geosites in northern Malta (Selmi et al., 2019) and geomorphosites recognition on the Majjistral Nature and History Park, and Gozo island (Coratza et al., 2011, 2012). A new methodology for the degradation risk assessment of geosites was developed and applied on the study area, in order to investigate the natural and anthropogenic factors affecting the geosites and to identify the best possible conservation strategies.

1.2 Aim and Objectives

The main aim of this doctoral thesis is to recognise and assess the geoheritage of the Maltese Islands in order to carry out effective conservation strategies which may help to prepare the study area to fulfil all the requirements for the nomination as UNESCO Global Geopark, such as a new national sustainable development plan with the inclusion of geoscience in tourism and educational activities.

The doctorate project is outlined by the flowchart in Figure 1.1 and the objectives are as follows:

1- Identification of preliminary geopark boundaries, using UNESCO rules and guidelines, geoparks' application dossiers, Maltese legal instruments related to natural landscape management and protection, combined with the analysis of landscape features of the Maltese archipelago.
2- Recognition and selection of sites of geological and geomorphological interest, by means of bibliographic research, satellite images analysis, interviews and field surveys conducted seasonally on the study area.
3- Characterisation of the sites selected, thanks to the combination of the data collected in point 1 and 2, in particular bibliographic research and field surveys. Descriptive cards of each site have been produced and organised in a database format.

4- Preliminary selection of potential geosites through (i) the subdivision of the sites classified as categories based on the main scientific interest as geomorphology, structural geology, stratigraphy, palaeontology, and human activity; (ii) selection of potential geosites for each category due to qualitative evaluation that consider two main criteria: geodiversity – spatial criterion - and geohistory - temporal criterion. Potential geosites are active both for their inherited features, unique or rare landforms as well as for more common and abundant features that are useful to provide an overview of the landforms visible in the area and are representative of the regional geo(morpho)diversity.
5- Assessment of potential geosites, by using two quantitative methodologies internationally used, proposed by Reynard et al. (2007) and Brilha (2016), partially modified and adapted for the study area. The methodologies assess the scientific value and the additional value (aesthetic, educational, touristic etc.) of the potential geosites.
6- Analyses of the results obtained from the application of the two methodologies. Sites with high score (more than 60/100) in scientific value in both methodologies were selected as geosites.
7- Identification of geosites degree of interest as international, national and local. The presence of at least one geosite with international relevance is required from the UNESCO guideline to apply as UNESCO Global Geopark.
8- Analysis of scientific papers on the degradation risk and the development of a methodology to assess the degradation risk level for each geosite. A new methodology has been developed considering natural and anthropogenic factors that can be grouped following three main criteria: natural vulnerability, anthropogenic vulnerability and public use.
9- Degradation risk assessment of geosites through the application of the methodology developed in output 8.

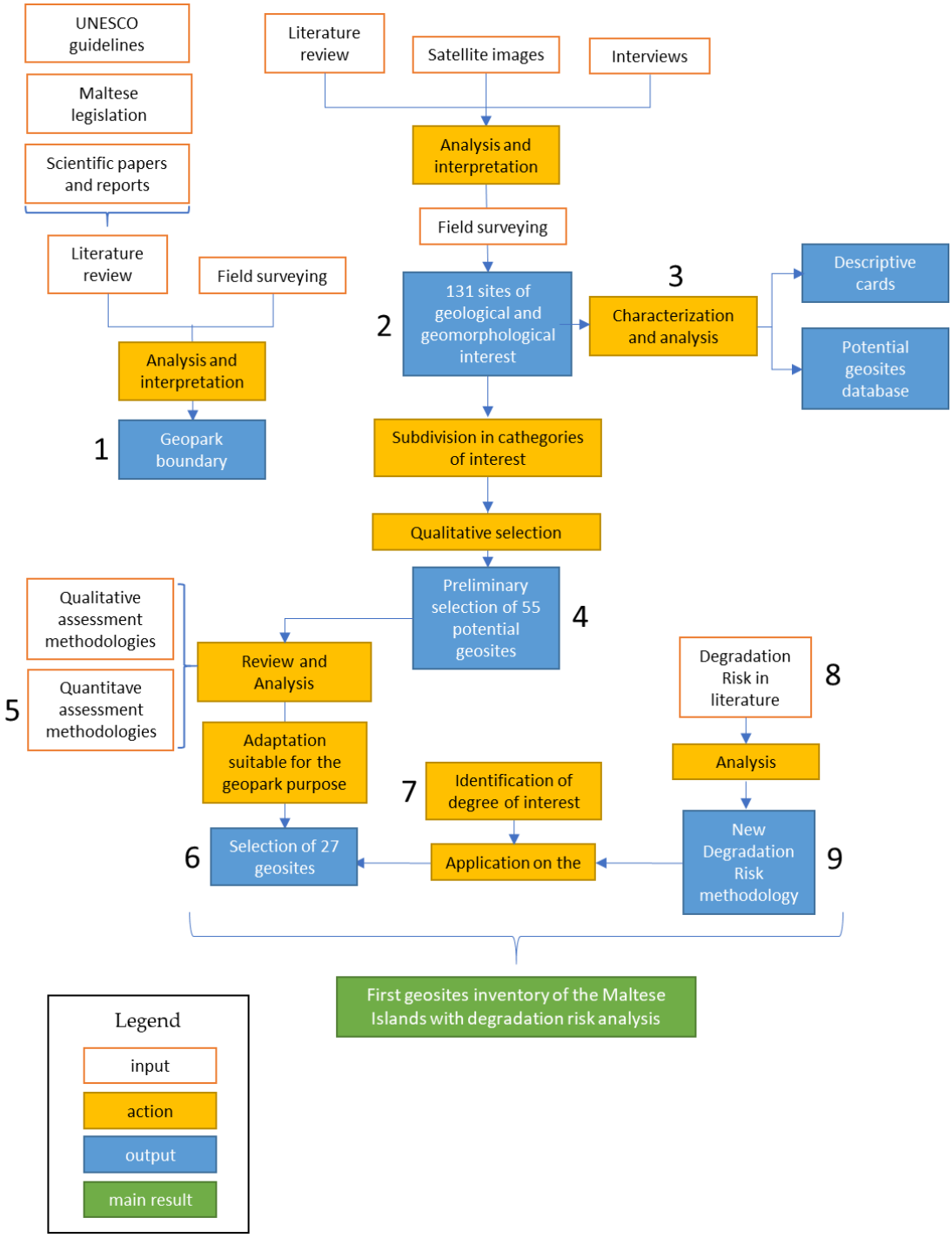


Figure 1.1: Organization of the PhD research.

1.3 Outline

The thesis is organized into seven chapters, including the introduction (**Chapter 1**), in which an outline of the doctorate project is presented.

Chapter 2 gives a condensed, but comprehensive literature review of geoheritage. In this chapter, the recent domain of geoheritage is summarized briefly in five parts. Paragraph 2.2 gives a brief description of the geoheritage history and underlines the main initiatives and actions that led to its recognition by the international scientific community. A selected glossary of the most important terms of this field is also presented. Paragraph 2.3 deals with geoconservation and the UNESCO initiatives currently taken at international level for the conservation of geological heritage: World Heritage Sites and UNESCO Global Geoparks. Paragraph 2.4 is about geoparks; it gives a short historical lookback on geoparks, explains their connection with UNESCO and defines the main pillars that characterize each UNESCO Global Geopark. Paragraph 2.5 refers to the definition of the term geosite and its values.

In **Chapter 3**, the regional setting of the Maltese archipelago is described, including geographical, vegetational and climatic setting, geological and structural setting. The context of the study area is also given with an introduction dealing with the ongoing geomorphological processes acting on the islands and the resultant typical, inherited and active landscapes.

Chapter 4 provides a discussion of the local legislations and acts (some based on European Union directives) issued for the protection of the natural heritage in the Maltese Islands, with an analysis on the current focus and protection rules related to geoheritage.

Chapter 5 presents all the material and methods used in order to achieve the different objectives, summarized on paragraph 1.2. This chapter contains a review and an analysis on qualitative and quantitative methodologies for the assessment of geosites (paragraph 5.5). The two geosites assessment methodologies applied in the study area are described in detail. Finally, a new quantitative methodology to evaluate the geosites degradation risk is proposed.

Chapter 6 contains all the results obtained for each objective. A detailed geological description of the 27 assessed geosites is presented, followed by an analysis and discussion of the main natural and anthropogenic factors that may cause their degradation.

Finally, in **Chapter 7**, the conclusion and remarks on the research results are reported. Issues such as challenges and possible future recommendations are covered in this part.

Chapters 4 and 5 are partially based on a published paper (Selmi et al., 2019) and in particular, paragraph 5.8 and 6.8 are based on a manuscript in preparation for publication.

CHAPTER 2. Geoheritage: definitions and terms

This chapter is to be considered as an introduction on geoheritage and its domain, where it is described in detail its connection with geology, geodiversity, geoconservation and geoparks.

Geoheritage is a concept developed in the last 30 years that is related to a wide range of sectors. The first direct connection is inevitably with geology. In fact, the geoheritage concept was born from many studies on geology that led to the dissemination of a more enthusiastic approach to the information on geological processes that can be deduced from outcrops and landscapes (Reynard and Brilha, 2018; Bentivenga, 2019). Geology is the subject that par excellence investigates rocks and landforms of the Earth and the study of geoheritage could be identified as one of its topics. As part of earth sciences, geoheritage is a scientific discipline that led to the recognition and evaluation of geosites. The geosites are assessed for their main scientific importance through scientific research and production of inventories. The geosites inventories are important tools that highlight the geological heritage of a specific study area and plan the best strategies of geoconservation and management.

Geoconservation is particularly fundamental and is connected both with scientific importance endowed by the sites and also with education and sustainable tourism. In fact, the conservation of geosites is possible through scientific research and legal instruments to protect the area, but also through educational activities and sustainable tourism aimed at sharing geoheritage knowledge and awareness with locals and tourists. Geosites can recognised as UNESCO Global Geoparks, on the basis of which they can protected and managed to promote their geological interest through education, sustainable tourism and geoconservation. Lastly, the close connection between geoheritage and geodiversity is important. These two terms were used often interchangeably but as clarified by Brilha (2016), geodiversity is the equivalent of biodiversity and can be described as the variety of elements of geology - rocks, minerals,

fossils and soils — natural landforms and processes that shape them throughout geological time (Gray, 2004). Geoheritage comprises exceptional geodiversity elements, landforms and processes with scientific importance. All the mentioned concepts are under the geoheritage umbrella, a quite new scientific subject, constantly evolving. Figure 2.1 schematises the main connections with geoheritage. The 4 main oval-shaped sets referring to geology, geopark, geoconservation and geodiversity overlap in different parts, as consequence of the close link between the various terms and concepts that all contribute to geoheritage.

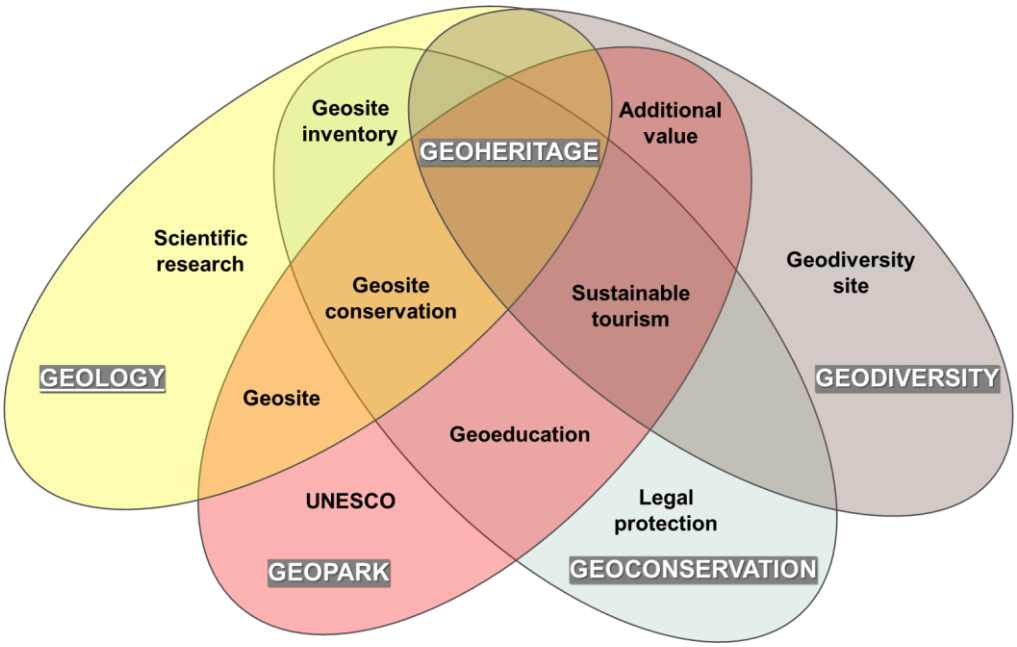


Figure 2.1: Butterfly graph that shows the connection between geoheritage and other keywords (modified by Williams et al., 2020).

2.1 Geology as a basis for geoheritage

The Earth is often described as the third rock from the Sun, underlining the fact that it is basically a physical entity. The Earth has developed an extremely complex geology, as a consequence of its 4.6-billion-year history involving moving plates, catastrophic events, big and small extinctions and changing climates (Gray, 2019).

Geology is one of the fundamental subjects of the Earth Sciences, that encompasses several subdisciplines including the study of geoheritage and what may be comprised under its umbrella and thus, geoconservation. Geology and its related subdisciplines overlap with other disciplines such as chemistry and biology. Some of the subdisciplines of geology are shared by other science, but all of them are oriented in their endeavour to the study of the Earth, including all topics studied in Earth Science, as mountains and cliffs, rocks, hydrological systems and their products such as precipitates and karst. Most of the geology subdisciplines are considered on geoheritage studies in order to identify which geological elements have heritage value and why they need protection and conservation. Table 2.1 presents the range of main subdisciplines and specialised subdisciplines within geology that should be considered in geoheritage studies (Brocx and Semeniuk, 2007).

Table 2.1: The range of main subdisciplines and specialised subdisciplines within geology considered in geoheritage studies (modified by Brocx and Semeniuk, 2007).

Main subdisciplines	**Selected list of associated specialised subdisciplines**
Sedimentology	Mineralogy, stratigraphy, geochronology, petrology
Marine geology	Marine geomorphology, stratigraphy, sedimentology, geochronology
Stratigraphy	Geochronology
Palaeoclimatology	Stratigraphy, biostratigraphy, geochronology
Hydrology	Stratigraphy, hydrodynamics, hydrogeology
Palaeontology	Palaeobiology, palaeoecology, evolutionary biology, geochronology, biostratigraphy
Geomorphology	Marine geomorphology, coastal geomorphology, aeolian geomorphology, fluvial geomorphology, karst geomorphology
Surface processes	Geomorphic processes, weathering, erosion, transport

2.2 Geoheritage

The term **geoheritage** derives from two conjoined terms: 'geo', as the abbreviation of 'geological', and 'heritage'. Geological, in this case the prefix 'geo', refers to the word geology and hence it is synonymous to something that is part of the abiotic nature. Heritage is defined as a valuable asset that has been transmitted from the past and expresses the idea that its value lies in its natural, historic or cultural characteristics that is worth to preserve and pass to the future generations (Sharples, 2002; Brocx, 2016).

The natural heritage has always received a large attention in the history of humankind. Despite this consideration, the protection of the natural heritage has always been more correlated with the biological features such as animals and plants and with less relevance for the abiotic part of nature. Compared with the recognized interest of the biotic nature, the recognition of the importance of the abiotic nature is quite a new concept. In fact, its recognition emerged in line with the worldwide trend to tackle a series of environmental problems, which were especially accentuated in the 1990s.

The concept of geoheritage has long established roots that can be traced back to the Industrial Revolution. In fact, according to Busby et al. (2001), it was in that period that geoheritage appeared as a concept, when the knowledge was being gained from the geological discoveries. In United Kingdom many sites assumed significance with scientific interest thanks to geologists such as Lyell, Smith, Murchison, and Sedgwick who put in place the foundations for the science of geology l.s., built on its understanding both in the field, and on site-specific locations (Hallam 1989). This was based upon a valorisation of the elements of the abiotic nature and the natural landscapes as a basis to reconstruct the Earth's history and evolution. These geological elements and landscapes were called sites of Earth Heritage and protected as sites of special scientific importance. Nevertheless, the effective protection of these sites came at a later stage, with legal provisions set up independently by nations and collectively through international initiatives.

It is from 1991, with the Declaration of the Rights of the Memory of the Earth held in Digne (France), that progress was made towards the recognition of 'geological heritage'

as an integral part of the natural heritage. The term geoheritage first appeared in literature in the beginning of the 1900's and between 1991 and 2006, with a multitude of definitions and notions of geoheritage and related terms appearing in the literature (Brocx & Semeniuk, 2007). In 1995, Sharples widened the original idea of geological heritage to include also dynamic geological processes and products, for the recognition and protection of their inherent or intrinsic values. According to the author geoconservation strategies, based on scientific, aesthetic and cultural criteria, need to be developed, in order to preserve the geoheritage that is fundamental for the human life. Dixon (1996), in contrast, raises the question of the ethics and rejects to consider the natural environment depending only on human use. He claims the right to protect geoheritage as part of natural heritage, independently by its connection with human exploitation (Brocx, 2016).

Continuous research and publications conducted in the last 25 years led to the formalisation of the term geoheritage and in 2008 to the launch of the journal 'Geoheritage' by the publishing house Elsevier.

Another term related to geoheritage had taken hold in the beginning of the 1990's: the term geodiversity. The word **geodiversity** was introduced for the first time in 1993, following the Convention on Biological Diversity established at the Rio Earth Summit in 1992 (Murray, 2018). It is currently used to indicate the natural range (diversity) of geological (rocks, minerals, fossils), geomorphological (landforms, processes) and soil features, as well as their assemblages, relationships, properties, interpretations and systems (Gray, 2013). Some authors define geodiversity as analogous of the term biodiversity (Kiernan, 1990; Eberhard, 1997) and the introduction of this new term helped to focus the attention on the conservation of the geological systems, as the term biodiversity is the base for conservation of the biosphere (Brocx, 2007).

Geodiversity is made up of a variety of geological environments and active processes that give rise to landscapes, rocks, minerals, fossils, soils and other deposits, and which result from the slow evolution of the Earth. All these elements of geodiversity are an important support for life and biotic nature, and therefore have a level of importance equivalent to that of biodiversity (Santos, 2014).

Figure 2.2 diagrammatically illustrated the relation between geoheritage and geodiversity by the McKevely Box, modified for the specific topic by Gray (2018). The original box from McKelvey was elaborated in order to have a way of visually representing the total presence of mineral resources on the planet, whether identified or not. The box adapted by Gray represents the relationship between geodiversity and geoheritage. The total resource is the geodiversity of our planet, where geodiversity refers to the natural range of geological (rocks, minerals, fossils), geomorphological (landforms, topography, physical processes), soil and hydrological features, according to the definition proposed by Gray (2013). It includes their assemblages, structures, system and contribution to landscapes (Gray, 2013). The base of the McKelvey box proposed is left open due to the fact that the geodiversity on our planet is constantly increasing and that geodiversity has been increasing since the Earth was formed, although at different rates over the time (Gray, 2013; 2018). In addition, in the box it presents the concept of 'hypothetical geodiversity', that refers to the geodiversity that has not yet been discovered or described. In fact, current research and exploration regularly lead to the discovery of new fossils, landform types, minerals, etc. Looking to the diagram, geodiversity defines the abiotic equivalent of biodiversity and is considered a value-neutral term describing all abiotic phenomena on the planet. Geodiversity is divided into identified geodiversity and undiscovered geodiversity. Geoheritage is the part of the identified geodiversity that has importance value and for this is worthy of conservation. In fact, the term geoheritage is used to identify those specific elements and landforms of geodiversity that are selected for geoconservation (Brilha, 2018). In the diagram the base of the geoheritage is left open in order to allow the inclusion of more elements and landforms worthy of conservation. The sub-box as part of the identified geodiversity refers to a second possibility in which geoheritage can be increased by restoration of processes and forms. In this way, elements in the conditional geoheritage box can be included as geoheritage, conditional on geoconservation decisions or the implementation of restoration schemes (Gray, 2018), such as by remaindering of rivers, integrating old quarries back into the landscape or removal of coastal protection (Gray, 2013; Prosser et al., 2006). It is important to note that the size of the geoheritage sub-box

depends on the conservation threats, values and decisions, due to the fact that geoheritage can also be lost, destroyed, damaged or polluted by anthropogenic activities.

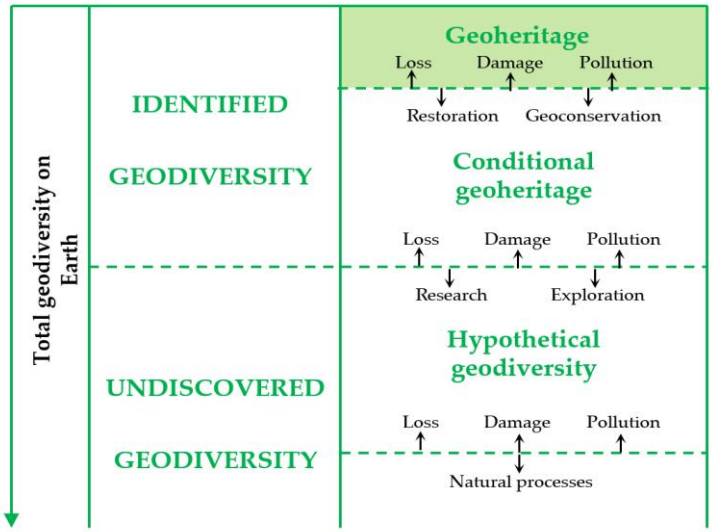


Figure 2.2: A McKelvey Box showing the relation between geodiversity and geoheritage (modified by Gray, 2018).

However, historically, actions for the protection and conservation of biodiversity have always been a priority with respect to the protection and conservation of geodiversity, as pointed out by Ferreira (2016). The same author stresses that the biotic and abiotic elements of nature are interrelated and must, likewise, be protected. Hjort et al. (2015) argue that geodiversity must be preserved not only for representing life support, but also for the values that are recognized.

From 1990s, several scientific research have been conducted in parallel worldwide in different context and the resultant literature reveals a multitude of concepts and definitions concerning geological heritage. Sometimes, these different terms have been coined to define the same concepts, but other times different terms are wrongly used as synonymous or used interchangeably. This led to conflicting thoughts between various authors. In view of the existence of multitude of concepts, the present thesis adopts the definitions proposed by Brilha (2016) who proposed for the definition of the following terms: geodiversity, geoheritage, geosite and geodiversity site (Figure 2.3):

- **Geodiversity**: generic term used to describe the abiotic elements that together with the biotic elements - biodiversity – compose the natural diversity.
- **Geoheritage**: refers to exceptional elements of geodiversity, in situ or ex situ, with international or national scientific value. In addition to the scientific value, the geoheritage may have other types of values.
- **Geosite**: a geosite is a site with geological significance, important for the scientific community do to its primary scientific value. A geosite is defined as a geoheritage element (Brilha, 2016) and this term refers to sites in different sizes, ranging from minerals or fossils, group of rocks, to ground formations or geological structures resulting from an event during the creation or evolution of the earth (Wimbledon, 1996). In addition to scientific value, it may also have educational, aesthetic, and cultural value. It may be used by society for educational and touristic activities. These locations may have local, national or international relevance.
- **Geodiversity site**: refers to abiotic elements that are important resources for education, tourism and cultural activities, but without exceptional scientific value. The geodiversity site is important for the society which uses the site for teaching, learning, tourism or leisure. These locations may have local, national or international relevance.

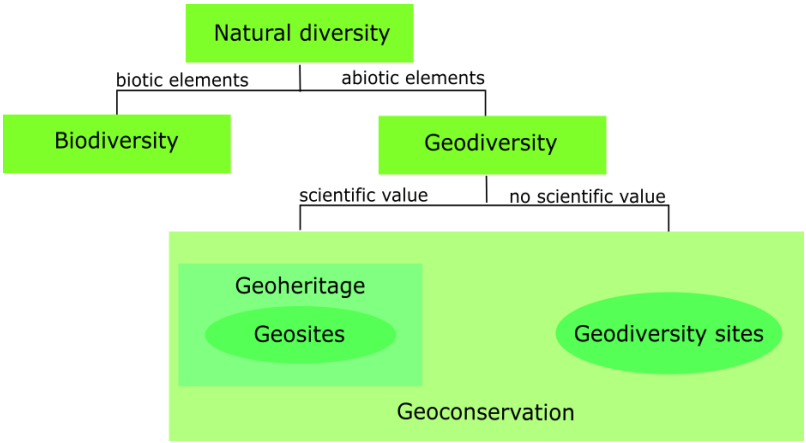


Figure 2.3: Conceptual framework of natural diversity with focus on geodiversity. Geoheritage is part of the geodiversity with a scientific relevance. Geoconservation encompasses both geosites and geodiversity sites (modified by Brilha, 2016).

2.3 Geoconservation

In the last thirty years issues related to the conservation of geodiversity have been gaining visibility. Recently, several authors (such as Kozlowski, 2004; Brilha, 2005; Serrano and Ruiz Flaño, 2007; Brilha, 2016) developed works in order to systematize, discuss and propose measures for the protection and sustainable management of geodiversity i.e. geoconservation. It has established itself as a new branch of geosciences (Henriques et al., 2011). Geoconservation refers to 'the forgotten half' of nature as defined by Sharples (2002) and aims to preserve the natural diversity of significant geological elements, landforms and soil features and processes (Sharples, 2002). This term was introduced and used in the 1990s (Sharples 1995). Geoconservation, as mentioned in the introduction of this chapter, is related to scientific research, sustainable tourism and education, but it is also involved with matters of environmental management, geohazards, sustainability, natural and historical-cultural heritage as it relates to maintaining habitats, biodiversity, and ecosystems in general (Brocx, 2016).

In the last two decades, global organizations, scientific associations and national geological surveys have conducted research and projects to promote the geodiversity at different scales and its protection (Fassoulas et al., 2012).

The conservation of geoheritage sites can be compared with the conservation of natural, historic or archaeological sites, with the difference that rather than conserving the testimony for reconstructing human history, it refers to the history and evolution of our planet. The reconstruction of the Earth history comprises also the evolution of the life on the planet and allows also to understand the place of humankind. In fact, since humans have evolved by natural selection from ancestor species during geological times, it therefore follows that human history is an integral part of Earth history. In this view, the conservation of geological heritage allows to understand the history of the earth and the place of humans in it.

Geodiversity sites and geosites have been and are being damaged or destroyed in particular in the developing countries. They are subject to a set of threats which most often results from anthropogenic activities and from a lack of knowledge about

geodiversity and geoheritage (Gray, 2019). Therefore, the most relevant elements of geodiversity must be the target for the implementation of geoconservation measures and for new conservationist policies and actions. Further important reasons for protecting geodiversity and geoheritage elements are to retain these for the training of future scientists as geologists and biologist, and for future educational field surveys (Gray, 2019).

2.3.1 International framework on geoconservation

In recognition of the importance of geodiversity and the conservation of its exceptional elements, important international initiatives related to geoconservation have been established in recent years (Brilha and Reynard, 2018). At international level, geoconservation is currently represented by two UNESCO site networks (Gray, 2018):

- World Heritage Sites. World Heritage is an official Convention of UNESCO adopted in 1972 and aimed at the protection of most valuable objects, sites and landscapes across the globe. In 1994 UNESCO launched a global strategy to ensure that the World Heritage List of sites is 'representative, balanced and credible' of global natural and cultural heritage, and this includes geoheritage. The motivation behind this strategy stems from an unbalanced situation in which there were (and still are) around five times more recognized cultural than natural sites. In addition, a major study was carried out for the IUCN by Dingwall et al. (2005) to determine whether the World Heritage List adequately represented global geology and geomorphology. This latter study revealed the discrepancy between the number of geological sites around the world and their recognition as World Heritage Sites. Nowadays, UNESCO and IUCN are working towards a World Heritage List that is more representative of geodiversity in chronostratigraphic, spatial and thematic terms. Geodiversity is the backbone of this part of this major global heritage conservation site network (Gray, 2018).

- UNESCO Global Geopark. Geopark is a striking concept that in less than 20 years has gained a worldwide recognition and has taken geoheritage outside the limited and small world of geoscientists. It refers to a territory with a particular geological heritage and a sustainable territorial development strategy (EGN, 2000; Brilha, 2018). Since the UNESCO Global Geopark is relevant to the present thesis, this concept is described in more detail in the following section.

It is important to note that neither World Heritage Site nor UNESCO Global Geopark status gives legal protection to geosites. It is therefore the country in which they lie that has the responsibility to make laws and regulations in order to protect them. Sometimes also regional or local regulations are issued for geoconservation. However, on the application process to obtain the World Heritage Sites status, it is necessary to indicate what legal protection exist or will be provided to help preserve the sites. Similarly, new applicants as UNESCO Global Geoparks are expected to indicate the current status in terms of protection of geological heritage within the proposed area. All UNESCO Global Geoparks and a fair number of World Heritage Sites go to significant efforts to attract visitors and provide geological explanation (Gray, 2019), and are always related with information about the natural context and the possible links with historical-cultural heritage. This enhances the concept that all the elements of natural and cultural value need all specific attention and protection, as part of the heritage. The link between natural and historical-cultural heritage is explained in Figure 2.4. The educational purpose related with this two UNESCO site networks is important for geoconservation and it is done mainly through interpretative centres and museums, by visitor panels, displays and thematic activities, by books, leaflets and other publications, through websites and apps, and by guided tours (Gray, 2019). All these activities indicate a strong desire to involve and immerse locals and tourists in geosciences and heritage in general, by promoting awareness on the topic and contributing on geoconservation.

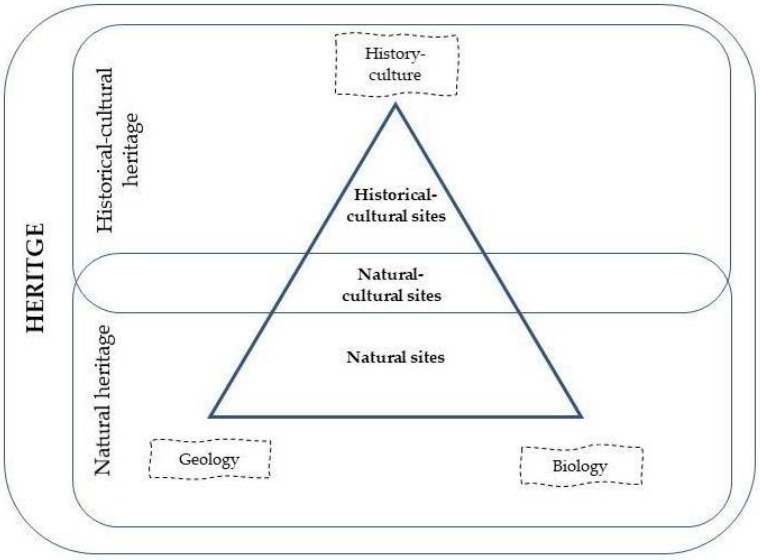


Figure 2.4: Relationship between geological, biological and historical-cultural components as part of the heritage (modified by Carreras at al., 2000; Coratza and Hobléa, 2018).

2.4 Geoparks

2.4.1 Brief history

In the early 1970s the world began to be concerned about the protection of the natural and cultural assets, as demonstrated by the Man and the Biosphere Programme approved by UNESCO in 1971 (Brilha, 2018). However, as mentioned above, only the biotic part of nature was considered worthy of international recognition and the geodiversity was under-represented.

In the 1990s the geoscientific community proposed two concrete global actions to make up for the shortfall of recognition and protection on geodiversity: the *Global Geosites Project* and the *UNESCO Geoparks Programme* (Figure 2.5).

The *Global Geosites Project* was launched in 1996 by the International Union of Geological Sciences (IUGS) in order to carry out an inventory of international geological heritage and to integrate geological sites on the UNESCO World Heritage List. This project was carried out in Europe through ProGEO (the European Association for the Conservation

of Geological Heritage) with the aim of promoting actions throughout the European territory for the protection of geological heritage, and through geoconservation strategies (Santos 2014, Ferreira, 2016; Brilha, 2018). The Global Geosites project ended in 2003 and, subsequently, other working groups were created at IUGS to address issues related to geological heritage (Brilha and Reynard, 2018).

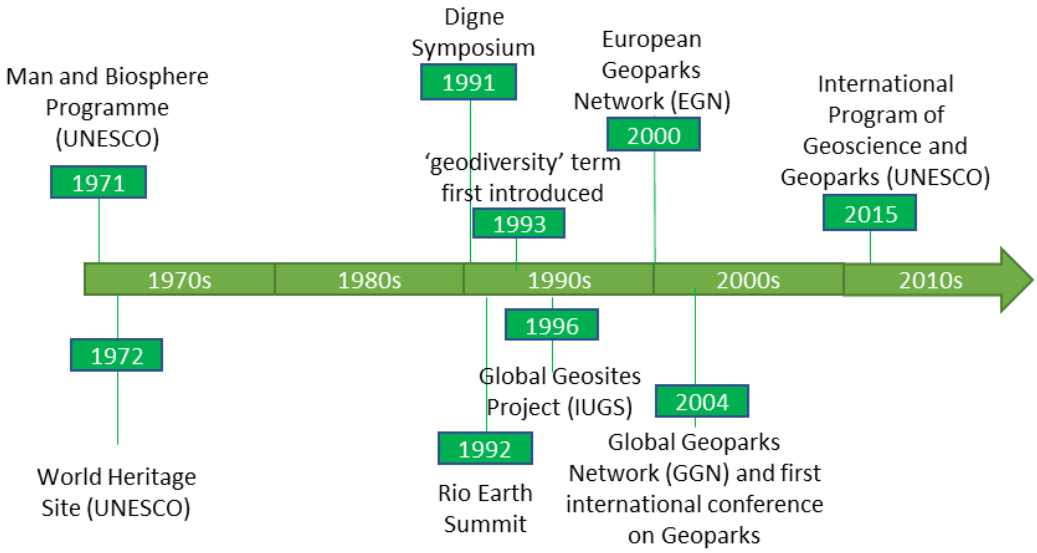


Figure 2.5: Timeline with some of the major events concerning the global stage for the development of the geoparks concept and its evolution and dispersion around the world (modified from Brilha, 2018).

The *UNESCO Geoparks Programme* intended to promote a global network of geoparks safeguarding and developing selected areas having significant geological features (Patzak and Eder, 1998; UNESCO, 1999) and also to support national initiatives for the preservation of important geological sites, in line with sustainable development (Erdelen, 2006).

In 2000, the European Geoparks Network (EGN) was created. The founding countries - Germany, France, Greece and Spain - highlighted as the main objectives of their joint cooperation being the actions of geoconservation and sustainable development and contributing to studies and development of technical information (Brilha et al., 2018).

In 2004, in a meeting in Paris, a group of researchers from the scientific community of three international institutions (International Geoscience Program [IGCP], International Geographical Union [IGU] and the International Union of Geological Sciences [IUGS])

discussed the creation of the Global Network of Geoparks of the UNESCO and its operational guidelines. During the meeting it was decided to integrate the existing European geoparks and the Chinese geoparks in the Global Geoparks Network (Brilha 2018b). In June 2004, the First International Conference on Geopark was held in Beijing, China, with the aim of promoting the establishment of a worldwide network of national Geoparks, with the support of the international governmental and non-governmental community (Brilha, 2018b; GGN, 2020). In 2014, the Geoheritage Specialist Group (GSG) was created by the World Commission on Protected Areas (WCPA - IUCN). The GSG is a group of experts to advise on issues related to geodiversity (including karst and caves) related to protected areas and its management. Currently, geodiversity and geoconservation integrate priorities in strategic policies (such as: climate change, ecosystem management, environmental law, protected areas, water science and knowledge and World Heritage), as defined by the IUCN 2017-2020 Program (IUCN, 2016). In November 2015, in global recognition of the importance of geological heritage, the International Program for Geoscience and Geoparks was created by UNESCO, which establishes the designation "UNESCO Global Geopark" (Brilha and Reynard, 2018). By definition, a UNESCO Global Geopark, constitutes a geographic area specifically delimited and legitimized by the local government, where there is geological heritage of international relevance, which must be managed with a holistic concept of protection, education and sustainable development (UNESCO, 2015). The areas that comprise the geological heritage must involve actions for conservation combined with sustainable development, and at the same time involve the local communities, in order to promote the geodiversity of the region, which may include ecological, archaeological, historical and cultural aspects.

Nowadays, as at July 2020, the number of geoparks in the Global UNESCO Geoparks Network is 161 in 44 Member States worldwide (Figure 2.6), and 20 areas that have applied to enter in the network will be evaluated within the next year. Three are the already existent UNESCO Geoparks (one from Czech Republic, two from Germany) that requested the extension of their boundaries.

These geoparks, combined with other strategies, represent an important tool for the conservation and promotion of geological heritage.

Figure 2.6: Map showing the location of UNESCO Global Geoparks around the world, dated on June 2019 (source: UNESCO website, the most update map available).

2.4.2 *Global UNESCO Geoparks: characteristics*

The completed definition of a UNESCO Global Geopark, available in the official UNESCO website, is as follows:

> *'a single, unified geographical area where sites and landscapes of international geological significance are managed with a holistic concept of protection, education and sustainable development A UNESCO Global Geopark uses its geological heritage, in connection with all other aspects of the area's natural and cultural heritage, to enhance awareness and understanding of key issues facing society, such as using our earth's resources sustainably, mitigating the effects of climate change and reducing natural disasters-related risks'.*

Every geopark is based on three fundamental pillars that are **geoconservation**, **education** and **geotourism**.

Geoconservation is required because once the geological heritage has been recognized and assessed, its preservation is also necessary in order to pass it on to future generations

as testimony of the Earth's natural history. In some cases, the geological heritage is under high risk of degradation with a possible loss of value. A UNESCO Geopark does not provide any specific restrictions on any economic activity in a geopark site and the label "UNESCO Global Geopark" is not a legislative designation. It is up to the country to protect their own geoheritage sites through local, regional or national legislation.

Education addresses the promotion of geosciences for researchers, locals, students and general public. A geopark must provide for education on the environment, training and development of scientific research in the various disciplines of Earth Sciences, enhancement of the natural environment and sustainable development policies. In this way, also the local community is aware of the richness of its territory and is encouraged to re-evaluate its heritage and play an active role in the protection of its geological heritage (Eder and Patzak, 2004; Fassoulas et al., 2012).

Geotourism incorporates sustainable tourism principles and uses geology to promote sustainable economic development. Geotourism brings an economic revitalisation through activities focused on preserving geological heritage, and other environmentally friendly activities engaged with the general public (James and Hose, 2008). The geotourism concept stimulates also the creation of innovative local enterprises, small businesses, new jobs, generate new sources of revenue for the local population (for example production and sale of geoproducts) (Eder and Patzak, 2004).

2.5 Geosites

Since the beginning of the studies on geoheritage, scientists have called the direct physical representations of geoheritage with different names: geological sites, geosites, geotopes, site of geoheritage significance, etc. (Wimbledon et al., 1995; Reynard et al., 2004, Fassoulas et al., 2012; Brilha, 2016 and reference therein). The most accredited term is 'geosite'. Geosites are basic units and direct physical representations of geoheritage that are being subjected to geoconservation initiatives and could be used for geoeducation and geotourism purposes (Reynard et al., 2004). A geosite refers to localities essential for demonstrating key stages and features in the geological

development of the Earth, including the evolution of climates and life (Reynard, 2009; Brilha, 2016). Geosites are often identified in connection to geoconservation frameworks, such as inventories of geoparks, World Heritage Sites and national protection designations. The geosites could be used for further purposes as well, such as tourism and education, due to their frequent association with elements of culture and biodiversity as well. The several different concepts can be grouped into the categories of restricted and broad definitions (Reynard, 2009).

Sensu stricto, geosites are only those representation of geoheritage that have scientific importance for understanding the Earth's History (Panizza and Piacente, 1993; Grandgirard, 1999; Reynard, 2009). Thus, the scientific value is the key value to consider a site as a geosite. A geosite is important for the scientific community, regardless of the possible additional values. It may have geohistorical importance and could be a stratotype section or an outcrop that helps to understand past processes related to the former Earth and to reconstruct the Earth history (Reynard, 2009; Brocx, 2016). *Sensu lato*, the term geosite is used to identify all kinds of sites with geological interest, even if there is no any scientific relevance, but that presents a certain value due to human perception. In addition to the scientific value, the geosites may have additional values that come from many interests (Figure 2.7).

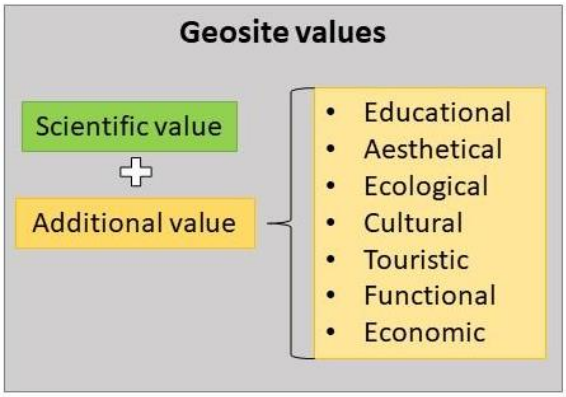


Figure 2.7: Geosite values: central and additional values of geosites.

The most widely values attributed to geosites are as follows:

- Scientific value: it is considered as a key value for choosing geosites. Brilha (2016) proposed only to name geosites as such with a high scientific value, regardless

the outstanding nature of associated values. Considerations such as its representation in scientific literature, or proposal as a key site for geosciences by its geohistorical importance, or as a stratotype sections are assessed under scientific values.

- Educational value: a geosite with an educational value has the potential or is used for educational and training activities due to its interpretative potential of geological phenomena for students at different school levels (from primary school to university). It provides reference, teaching localities, and standards for future students and research. For example, the educational value can be attributed to a geosite that provides the full lithostratigraphic section of a study area. Furthermore, a geosite made up by two different formations in juxtaposition due to the activity of a fault system, can have educational value because it explains past and present tectonic movements.

- Aesthetical/Scenic value: the aesthetical value is considered as one of the main factors by the tourists that are more focused on the spectacular nature of a site than its geological meaning. The aesthetic value considers the difference in shape, colour and morphology between the geosite and its background. In detail, it considers the quality of the surrounding landscape and nature, the panoramic view quality, the level of contrast of colours to the nature, appearance and difference in shapes. Geosites with aesthetical value may have also a societal aspect and be considered an iconic or scenic feature or valuated by the community.

- Ecological value: the geosite hosts endemic plants or animals or is the habitat of protected species and thus covers an important ecological role. This value refers to the indissoluble connection between abiotic heritage and biotic heritage, as part of nature.

- Cultural/sacred value: as part of intangible heritage, the geosite with cultural value has a connection to cultural landmark or heritage. The adjective 'cultural'

relates to religious, historical, customs, symbolic and social behaviour of a society.

- Touristic/recreational: a geosite has touristic value when it has possible connection with geotourism potential. The geosite has easy accessibility, good level of interpretation by guides, panels, interpretation centres, museums or other structures to accommodate tourists. Touristic value refers to the annual number of visitors, the level of additional infrastructures for tourism as pedestrian pathways, garbage cans, hotels and restaurants close the geosite, other public services, etc. The geosites can be frequented for recreational use, not directly related to its geological value (example: an important lithological formation along the coast can be frequented by a large number of tourists for seaside tourism).
- Functional: it is the potential usage of the geological phenomena as local resources such as habits, water sources, etc. (Vereb et al., 2020).
- Economic: a geosites of economic value offers economic revenues to locals. The economic value partially overlaps with touristic and functional value. A geosite can have economic value for example when the geological elements that form the geosite are exploited for economic interest (e.g. mining activities, quarries, but also potential revenues from geotourism activities)

The term geodiversity site is used to identify elements of geodiversity that do not have a particular scientific value, but which have educational, touristic or cultural relevance and are thus used as important resources for communities.

CHAPTER 3. Study area: the Maltese Islands

3.1 Geographic context

The Maltese Islands lie in the centre of the Mediterranean over a surface area of 316 km², around 90 km south of Sicily and 290 km east of Africa (Tunisia) (Figure 3.1). The archipelago consists of three main islands – Malta, Gozo and Comino - and a group of minor inhabited islets. The main island is Malta (246 km²), where the capital Valletta is situated, followed by Gozo (67 km²) located to the North, and Comino (3.5 km²), located in between the two larger islands (Tonelli, 2014; Gauci and Schembri, 2019). The archipelago rests on the submerged Malta–Hyblean platform, with the latter occupying the zone of convergence of the African and Eurasian plates. This platform is considered a wide undersea shelf bridge that connects the Ragusa platform (southern Sicily) with the Tripolitana platform (northern Libya) (Said and Schembri, 2010).

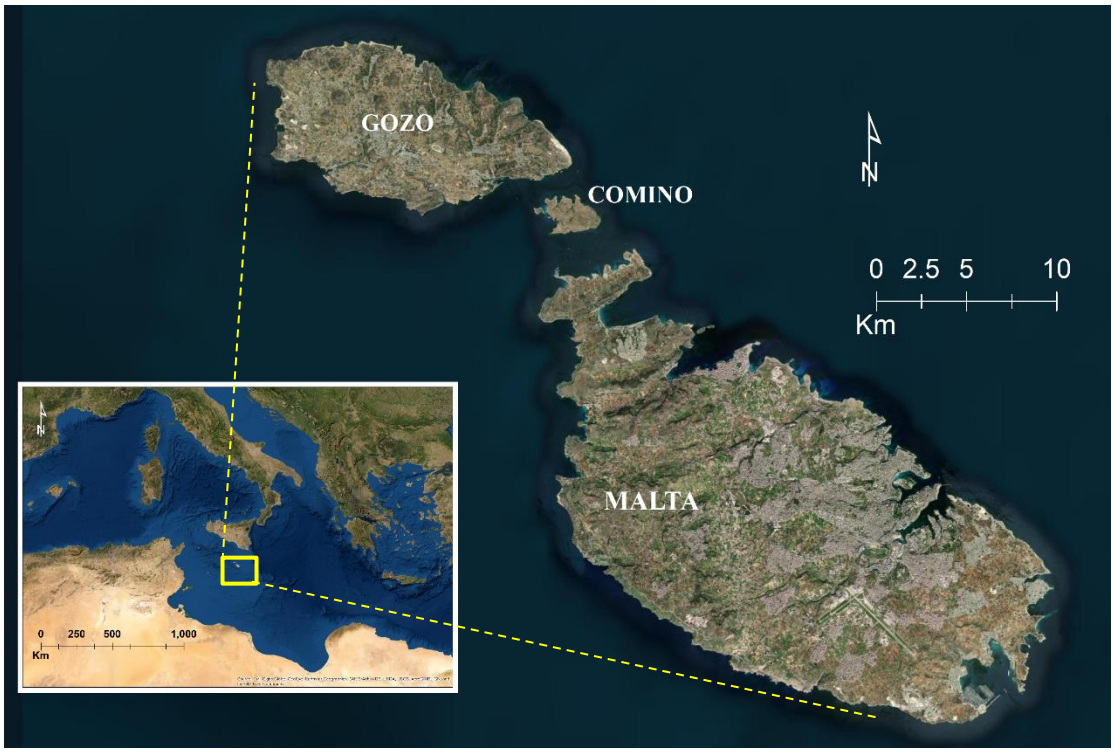


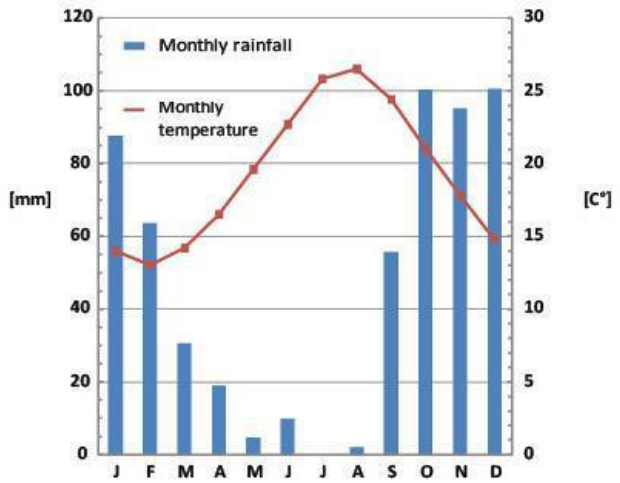
Figure 3.1: Location of the Maltese Islands in the Mediterranean (source: ESRI; Google Earth).

The number of inhabitants stood at 493,559 at the beginning of the 2019, with 460,171 of those living in the main island (Regional statistic Malta, 2019). During the last 10 years, the population of the Maltese islands increased steadily with an overall growth of more than 18.2% that corresponds to 76,127 persons (Regional statistic Malta, 2019; Costa, 2019). Malta counts over 1300 persons per km² and it is considered the country with the highest population density in Europe and one of the highest in the world (Schembri, 2019).

3.1.1 Climatic setting

Due to its central Mediterranean location, the archipelago is influenced by different air masses that condition the climate: two principal air masses from the southern warm areas, that ensure the warm temperatures experienced on the islands, and two principal air masses from the cold northern areas responsible for cooling the temperature during winter and early spring. The air masses from the warm areas are: i) the continental Tropical Air Mass from Africa, associated with a dry, warm atmosphere, that with its passage from the Sahara desert over the Mediterranean waters results in increased humidity levels on the islands and produces the typical hot and humid summer environment, with long- term stability and calm waters; ii) the Maritime Tropical Air Mass, from the mid-Atlantic Ocean, that is associated with warm temperatures and a substantial amount of humidity. On the other cold northern side, the dry Continental Polar Air Mass from mainland Asia and the Maritime Polar Air Mass from the North Atlantic are responsible for cooling the temperature for a few months of the year. Thus, the climate of the Maltese islands is Mediterranean, characterised by hot and dry summers, relatively wet autumns and springs and short and mild winters. The highest temperatures are measured in summer (highest maximum temperature of 43.8°C in August), and conversely in winter they reach the minimum levels (lowest minimum temperature 1.4°C in January) (MEPA, 2004). The archipelago receives on average 550 mm of precipitation annually, but rainfall pattern varies during the year. Indeed, the confluence of the warm and cold air masses along the Mediterranean Front contributes

to erratic heavy rainfall in early autumn and spring that may cause flash floods, encourage soil erosion and gullying (Schembri, 2019). The rainfall pattern has also varied significantly during the years (Figure 3.2), as shown from the longest rainfall dataset provided by the Malta Meteorological Office since 1929 (Mantovani et al., 2013).



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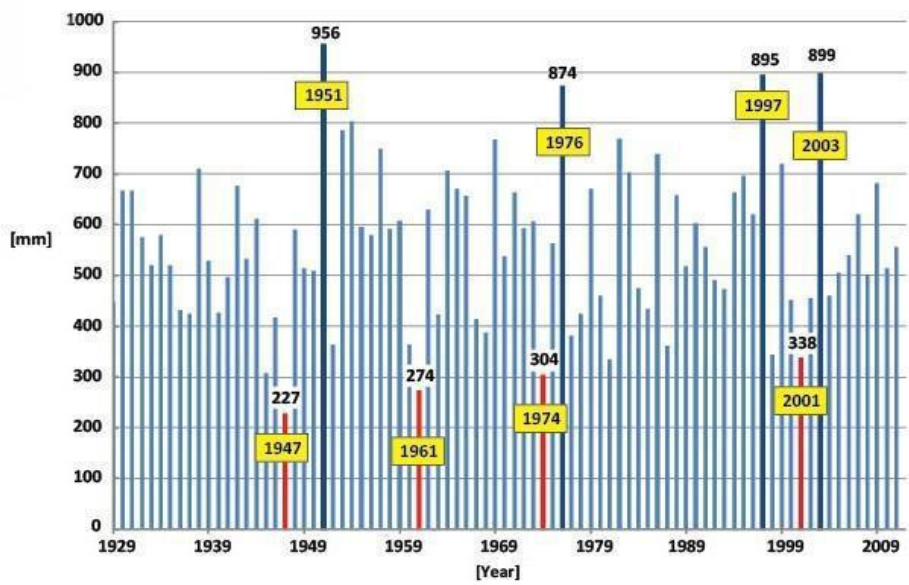

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Figure 3.2: Rainfall and temperature distribution in the Island of Malta: a) climatograph of the Mellieha meteorological station, northern Malta (modified from Devoto, 2013); b) Historic record of annual rainfall at Luqa weather station from 1929 to 2015. 338 mm of precipitations were registered in 2001, while 899 mm were recorded in 2003.

Throughout most of the year the archipelago is windy, with less than 10% of the days of the year being calm. The predominant wind is the Majjistral, a cool northweast wind which blows on 19% of the windy days. Other winds are all nearly equally represented as the Grecale, a dry wind that blow from northeast and the Scirocco, that typically blow in late summer - early autumn from the south (Schembri, 1997).

3.1.2 Vegetation

The vegetation of the archipelago is typical of the Mediterranean biome, due to its position and climate. The vegetation can be divided in three categories according to Schembri (1997):

- major communities, as woodland, maquis, garigue and steppes. This category consists mainly on sclerophyllous scrub, the highest type of vegetation that can exist in equilibrium with the climate. It comprises characteristic seral communities with a very rich assortment of evergreen trees and shrubs, lianas, herbaceous perennials and annuals. The evergreen woods have been almost destroyed by humans, but nowadays several replanting have taken place (Magri et al., 2008). The maquis vegetation is considered of secondary origin, but is widespread especially on correspondence of dry valleys (widien in maltese). Garrigue and steppes are the most typical and widespread of the Maltese vegetation communities that colonized the karstic rocky regions and clay slopes (Lanfranco, 1992).
- minor communities, which occupy specific habitats, perhaps rare habitats of the islands. One example are the coastal communities as the saline marshlands that form an interface between the marine and terrestrial environments.
- vegetational assemblages as rupestral and freshwater assemblage. This category comprises plants that occupy land subject to periodic disturbance, usually related to anthropogenic activities. Due to the high level of human impact, this category has become the most widespread habitat over the urbanized areas.

The vegetation growth is limited by factor such as water supply, strong winds and high ground temperature during dry periods. Lastly, it's important to clarify that many of the species of the archipelago are alien-plants which have become naturalised over the years (Lanfranco, 1992).

3.2 Geological setting

The Maltese Islands lie at the northern margin of the Pelagian Platform and in part owe their importance to the fact that they form emergent land in the central Mediterranean (Galea, 2019).

The geology of the archipelago was first described in the 19th century by a number of British geologists such as Spratt (1843, 1852), Hutton (1866) and Adams (1870) (Gauci and Schembri, 2019).

The islands are composed of a marine sedimentary rock sequence ranging in age from Upper Oligocene to Upper Miocene, with additional Pleistocene deposits (Figure 3.3).

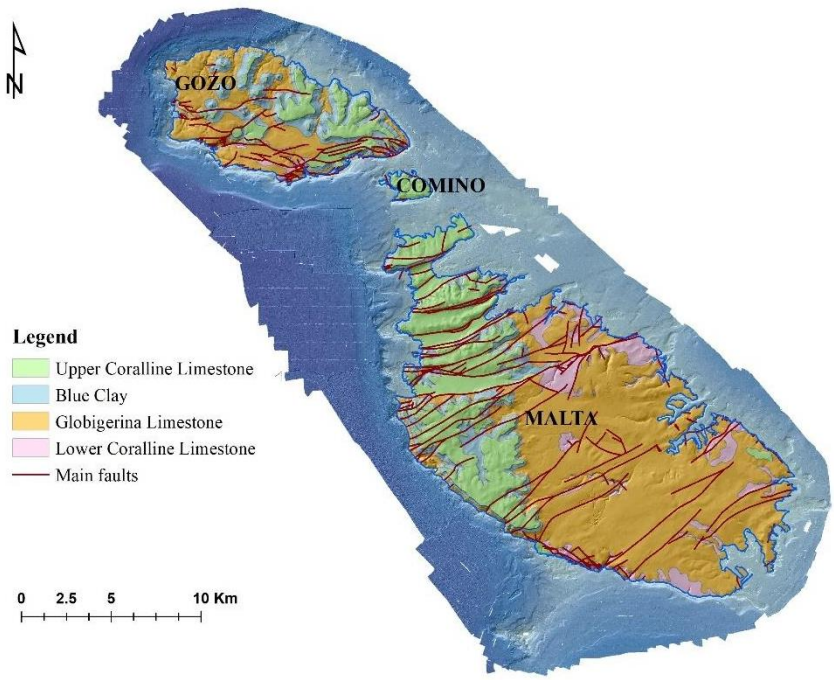


Figure 3.3: Simplified geological map of the Maltese Islands (modified by Oil Exploration Directorate, 1993).

It consists of limestones, marls and clays, which are ca. 250 m thick (Pedley et al. 1976; Pedley 2011) (Table 3.1).

The more detailed and comprehensive description was produced by Pedley (2002) that looked in detail at the full stratigraphy sequence of the islands and subdivided into five formations still currently in use. From the oldest to the youngest the formations are as follows: Lower Coralline Limestone Fm., Globigerina Limestone Fm., Blue Clay Fm., Greensand Fm. and Upper Coralline Limestone Fm. In addition, a discontinuous layer of quaternary deposits is found on the archipelago (Pedley, 2011; Scerri, 2019).

Table 3.1 Stratigraphic sequence of Maltese sedimentary rock units from the oldest formation to the youngest (modified by Scerri, 2019).

Epoch	Stage	Formation	Member
Pleistocene	Calabrian	**Quaternary deposits**	
Miocene	Messinian	**Upper Coralline Limestone**	Ġebel Imbark
	Tortonian/Messinian		Tal-Pitkal
	Tortonian Lhangian/Tortonian		Mtarfa
			Għain Melel
		Greensand	
		Blue Clay	
	Burdigalian/Lhangian	**Globigerina Limestone**	Upper Globigerina Limestone
	Aquitanian/Burdigalian		Middle Globigerina Limestone
	Aquitanian		Lower Globigerina Limestone
Oligocene	Chattian	**Lower Coralline Limestone**	Il-Mara
			Xlendi
			Attard
			Wied Magħlaq

Lower Coralline Limestone Fm.

The Lower Coralline Limestone Fm. is composed of pale grey, hard, shallow biomicrites and biospartites with abundant fossil corals and marine calcareous algae (Pedley and Waugh, 1976; Pedley et al., 2002). The formation can reach 140 m in thickness and outcrops in the cliffs of the western Malta and Gozo and in the eastern sector of Malta. This formation forms the steep spectacular sea cliffs along the southwest coast of Malta from Bengħisa to Fomm ir-Riħ, but it exhibits its maximum thickness in sea cliff sections at Ta' Ċenċ, in Gozo (140 m thick) and at Għar Bittija on Malta (120 m thick, Figure 3.4) (Gauci and Scerri, 2019). Exposures are generally limited on the northern-eastern coastline, where only two of the youngest strata of the formation are almost uninterruptedly exposed. Inland exposures are restricted to locally deeply incised valleys and faulted inliers (Scerri, 2019).

According to Pedley (1978), this formation can be divided into four members:

- the lowest Magħlaq Member (base unexposed) is mainly composed of medium to fine grained calcarenite, with mudstones and wackestone, cream or chalky white in colour, often soft and highly porous. This member is generally poor in fossil content, that is mainly represented by echinoids and marine bivalve molluscs (Scerri, 2019). The sparse fauna and the abundance of micritic sediment suggests a lagoonal or back reef environment, with deposition taking place in channels between beds of sea grasses (Felix, 1973).
- Attard Member, first described from a quarry section from Pedley (1978) as pale grey 'biosparites' associated with abundant algal rhodoliths. This member is mainly represented by white limestone composed of detrital coralline algae with scattered, variably developed algal rhodoliths. It is composed by a series of sub-facies which are indicative of widely varying sedimentary conditions that ranged from calm lagoonal to high energy environments where coral patch reefs developed (Scerri, 2019).
- Xlendi Member, a coarse-grained limestone with abundant pale grey biocalcarenites and biocalcirudites. It is characterized by a large-scale cross- stratification and its

thickness is highly variable ranging from 10 to 15 m (Scerri, 2019). Frequent is the presence of fragments of the echinoid *Scutella*, that, when rich in concentration forms the particular *Scutella* breccias.

- Il-Mara Member is composed of yellow to pale yellow, or brown beds of biocalcarenites which are rich in giant Lepidocyclina, Bryozoans and echinoid spines and plates (Scerri, 2019). At the top of this member, a 1 m-thick layer rich in Scutella marks the passage to the next formation.

Figure 3.4: Lower Coralline Limestone outcrop in the south of Malta, in proximity of Blue Grotto (from Devoto, 2013).

Globigerina Limestone Fm.

The Globigerina Limestone Fm. consists of a soft, but lightly cemented, yellowish biocalcarenite, deposited in deep marine environment. This biocalcarenite is characterized by bioturbation that, where intense, made the rock to be more resistant to erosion (Scerri, 2019). The formation was named on account of the high percentage of planktonic foraminifera Globigerina. A smaller number of fossils as bivalves and echinoids occurs also in this unit. This formation has been subdivided into three

members (Figure 3.5a) based on the occurrence of laterally extensive phosphorite conglomerate beds (Pedley and Bennet, 1985):

- Lower Globigerina Limestone, a pale cream to yellow planktonic foraminiferal packstones to wackestones. Common is the presence of glauconite and frequent pectinid bivalves and echinoids (Figure 3.5b, 3.5c). This member represents the most frequent outcrop across the low-lying plains of central and eastern Malta and southern Malta (Scerri, 2019). This limestone unit received the status of Global Heritage Stone Resource (GHSR) by the International Union of Geological Sciences in 2019 due to historical and cultural value in its fundamental use over the centuries for heritage buildings. This member is separated from the following by a Lower Phosphorite Conglomerate Bed (C1) (Pedley and Bennet, 1985).

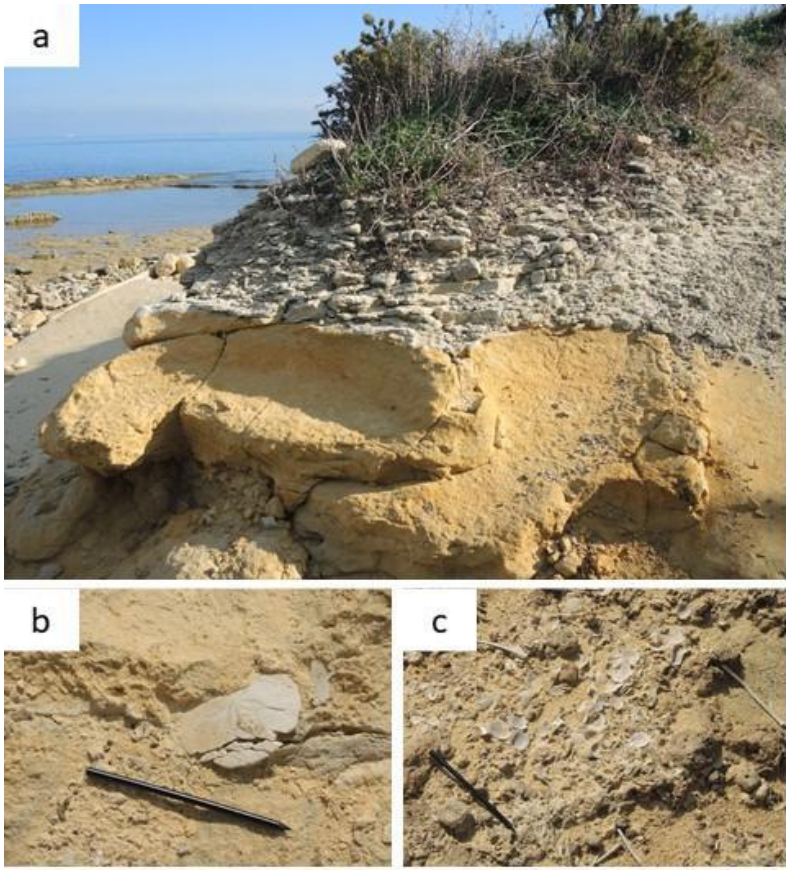


Figure 3.5: a) Globigerina members with different colours, b) fossil of echinoid, c) fossil of bivalves.

- Middle Globigerina Limestone, a white-grey soft carbonate mudstone composed mainly by planktonic foraminiferal, frequently disturbed by burrowing. Minor

phosphorite beds indicate breaks of deposition. An Upper Phosphorite Conglomerate Bed (C2) occurs at the top of the present member.

- Upper Globigerina Limestone a lower cream to pale grey, fine-grained, planktonic foraminiferal wackestones. It outcrops mainly above hardground and erosion surface in western areas (Tonelli, 2014). Its thickness may vary from 8 m to 18 m. At the top of the member, there is a rapid transition (over about 1 m) to the following formation, characterised by increase in clay content of the bed (Scerri, 2019).

Blue Clay Fm.

The unit is made up of fine-grained sediment abundant in organic component from planktonic foraminifera. The carbonate content in the Blue Clay is less than 25% and the formation represents the only terrigenous sediment of the Maltese rock succession. It is composed of bluish grey coloured banded kaolinitic marls and clays, or olive-green marls and clays (Scerri, 2019). The Blue Clay occurs throughout eastern Gozo and western Malta and exhibits considerable thickness variation, from 20 to 70 m. It outcrops mainly in the northern sector of Malta and in Gozo forming gentle sloping landscape that shows a sequence of alternating dark and light grey layers (Figure 3.6). This formation is often covered by soil and exploited for agricultural activities (Prampolini, 2017). On the NW coast of Malta, a specific outcrop of Blue Clay located at Ras Il Pellegrin has been selected as the Global Stratotype Section and Point (GSPP) of the Serravallian stage (Hilgen et al., 2009).

The name for the Blue Clay is 'tafal' in maltese language, and since prehistoric times, the pure clay layers have been used as raw material for the manufacture of local pottery and sculpture models (Scerri, 2019).

Figure 3.6: Sequence of alternating dark and light grey Blue Clay layers, south Gozo.

Greensand Fm.

The uppermost part of the Blue Clay Fm. registers an increase in grain size and green grains glauconite content, together with abundant fossil fragments (bivalves, echinoids and macroforaminifera), often separated by an erosional surface. This particular layer is named Greensand and shows the passage on a shallow water environment, that characterise also the last following Fm. This formation poorly outcrops in the archipelago: on the island of Malta is absents or presents less than 0.5 m in thickness; only Gozo exhibits its maximum thickness of 11 m (Scerri, 2019).

Upper Coralline Limestone Fm.

The upper part of the lithological sequence is made up by a hard, pale grey limestone unit very similar in colour and coralline algal content to the oldest formation (Pedley et al., 1976). Its origin is related with shallow water deposition. As the Lower Coralline Limestone Fm, this formation has been subdivided in members by Pedley (1978) as follows:

- Għajn Melel Member, a massive, bedded, pale brown foraminiferal packstones containing glauconite. It is mainly composed of Heterostegina foraminifera bioclasts,

but it can contain sand large echinoids and pectinid bivalves. It is mostly resistant to weathering and shows its maximum thickness in Gozo (13 m).

- Mtarfa Member, a massive carbonate mudstone characterised by light yellow cream or white limestones and marls with beds of algal nodules and rhodoliths. On this member the presence of bivalves, echinoids, microfauna and rhodolitic coralline algae, is abundant.
- Tal-Pitkal Member is considered a pure limestone member, often highly indurated, resistant to weathering and coarse in texture. It consists of a pale grey coarse grained wackestones and packstones with coralline algal, mollusc and echinoid bioclasts. (Scerri, 2019).
- Gebel Imbark Member, is a hard, pale grey carbonates. This member outcrops as a thin unit sequence, usually restricted to erosional outliers such as in western Malta (Tonelli, 2014). The formation of this member is related to a shallow water or intertidal deposit, with subaerial events being represented by white terrigenous clay beds (Scerri, 2019). The Upper Coralline Limestone is well exposed on the three main islands of the archipelago and form the island of Comino *in toto*. It often supports karst topography and makes up plateaus and steep cliffs affected by weathering and mass movements (Scerri, 2019) (Figure 3.7).

Figure 3.7: Upper Coralline Limestone Cliff at Rdum-Ahmar, northern Malta; on the right corner a sea cave.

Frequent is the presence of a dense network of tectonic discontinuities which provide the rock masses with a brittle behaviour (Devoto et al., 2013a, Prampolini et al., 2018).

Quaternary deposits

The quaternary deposits consist of soil and materials carried mainly by wind and water in torrents and rivers. This layer is characterised by brick-red coloured deposits, mostly of continental origin, that contain fossil mammalian fauna. Its presence is intermittent and covers pre-existing landforms. These deposits lie unconformably over older marine strata of Oligo-Miocene age and occur in caves, as fractures filling and subtle coverage of the most recent formation (Scerri, 2019). The most ancient deposits, two million years old, are characterised by vertebrates' bones Pleistocene in age: a well preserved sequence was found in Għar Dalam cave (south Malta), where the deposits are rich in hippopotamus, dwarf elephants and swans remains, species of dormice, bats and birds, deer and horses remains. Cranes and reptiles were also found (Pedley et al., 2002). The most recent quaternary deposits are calcareous conglomerates, alluvial fans and *terra rossa* soils, occurring mainly in the valleys.

The stratigraphic sequence described lie almost horizontally across the archipelago, although it has been intensely faulted, tilted, weathered and sculpted over the times (Galea, 2019).

3.3 Structural setting

The structural setting of the archipelago is strictly related to the tectonic movements of the central Mediterranean, mostly occurred within the past million years and still active today. The Maltese archipelago is located on the northernmost part of the African plate, known as the Pelagian platform, and its tectonic evolution is given by the Pantelleria Rift and Sicily Rift Zone (Patacca et al., 1979) (Figure 3.8).

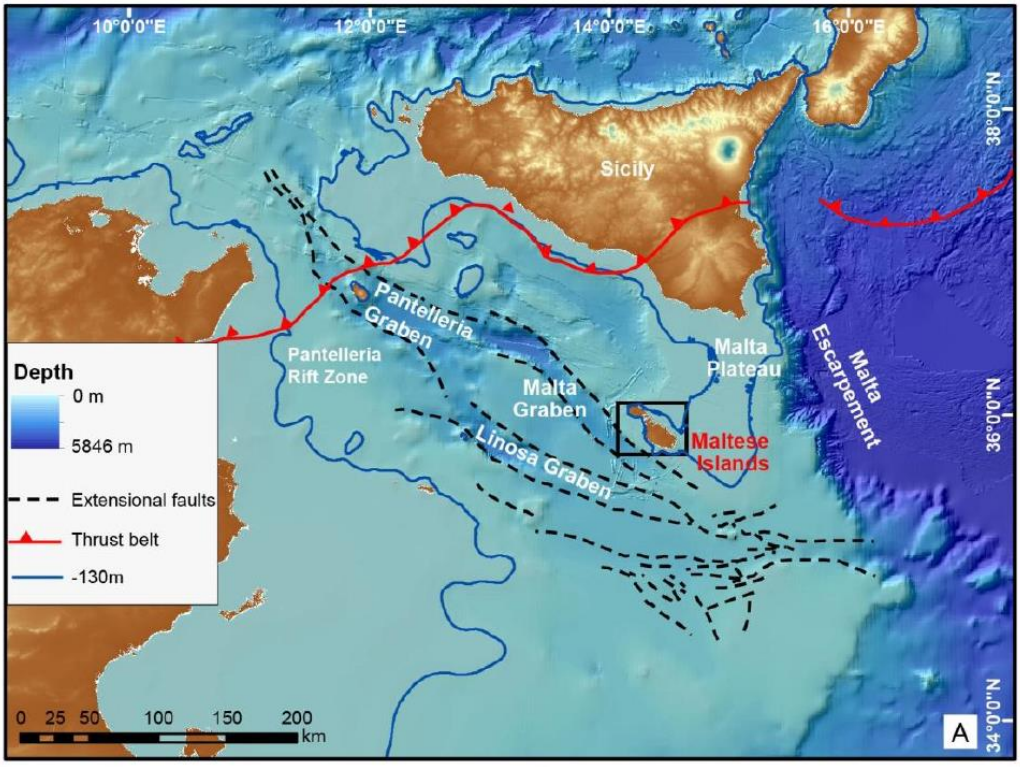


Figure 3.8: Location of the Maltese archipelago and geodynamic setting of the Sicily Channel (from Prampolini, 2016).

This shelf is separated eastwards by a Mesozoic sediment-undersupplied passive margin known as the Malta Escarpment, that is separating the continental domain from the oceanic Ionian basin and affected by a number of large submarine landslides (Micallef et al., 2013b).

The Maltese archipelago is part of a wide shelf bridge that connects the Tripolian platform of northern Libya and the Ragusa platform of southern Sicily (Illies, 1981).

During the Neogene-Quaternary, the Sicily channel has been interested on a continental rift, that has led to the following geological characteristics: the Malta, Pantelleria and Linosa Grabens, controlled by a NW-SE-oriented normal fault system; the volcanic islands of Pantelleria and Linosa and a series of submarine volcanic events; a thinning of the crust in correspondence of the grabens; Bouguer's positive anomalies (circa from +40 to +80 mGal). This event has been analysed by several authors that has led to three main different interpretations:

- Some authors (Finetti, 1984; Jogsma et al., 1985; Reuther and Eisbacher, 1985; Boccaletti, 1987; Cello et al., 1987) consider the rift system of Sicilian channel as a dextral strike-slip movement along the fault system oriented NW-SE or W-E, while the Pantelleria, Malta and Linosa Grabens are considered as pull-apart basins.
- According to Illies (1981), two phases are identified to explain the mechanism of intraplate rifting: a Miocene WSW-ENE graben system and a cross-cut by the NW-SE Pantelleria Rift system in post-Miocene times. Winnock (1981) claims that the deformation was active in Plio-Pleistocene times and the rifting confined to the Quaternary period.
- Argnani (1990) proposed that the rift origin was connected to the opening of the Tyrrhenian Sea back-arc basin on the Messinian-Early Pliocene.

The Maltese archipelago is dominated by two rift systems with different orientation intersecting each other at an angle of 30-60°. This brings the intersection of two trends of faults, different in age. The most ancient fault system started its activity on Early Miocene (Serravallian-Tortonian, according to Pedley, 2011) and is WSW-ENE oriented. It has given rise to a 'basin-and-range' topography on a zone 15-16 km wide. This characteristic topography is found both at a small and a large scale and at least five horsts separated by valleys have been identified, two of which are submerged (North and South Comino Channels). This characteristic structure is clearly visible on North Gozo Graben (located on the north-western of the island), Gozo Horst (on which Gozo is set), North Malta Graben (situated in the northern area of Malta) and Malta Horst (southern part of Malta). The Great Fault (also known as Victoria Lines) divides the island of Malta on two different parts, the North Malta Graben and the South Malta Horst, and it is considered the principal lineament of this system, with a vertical displacement of 195 m. The North Malta Graben is distinguished by typical ridge-trough morphology, bounded by the Great Fault at the south and by parallel ENE trending normal faults. It also included the islands of Comino and shows the highest topographic contrast in relief and landforms of the island, comprising largest flat basins and steepest slopes in the main island (Gauci and Schembri, 2019; Selmi et al., 2019). Regarding the island of Gozo, there is a

system of oblique-slip normal faults with a dominant E-W orientation. Some of these faults offset vertically and laterally several dissolution collapse structures that may be used as a market to identify neotectonics deformations (Illies, 1980; Oil Exploration Directorate, 1993; Tonelli, 2014). The fault system considered is related to the development of the adjacent North Gozo Graben since the late Pliocene, which shows evidence of recent faulting consistent with a right-lateral transtensional regime (Gardiner et al., 1995).

The second fault system started in the Late Miocene- Early Pliocene and is still active. It is NW-SE oriented, being parallel to the Pantelleria Rift trend. Its major lineament is the Magħlaq Fault, located along the south coast of Malta. Trecham (1938) claims that the Magħlaq Fault was active during the Quaternary; conversely Pedley (1975) demonstrated that the subsidence structure of the islands was active in different moment during the Miocene.

The presence of these two divergent systems is debated. Two are the hypothesis proposed by different authors:

1. Illies (1981) and Reuther and Eisbacher (1985) subdivided the mechanism of intraplate rifting into three phases. The first phase involves the development of the WSW-ENE-oriented faults. Subsequently, the development of the faults NW-SE-oriented, associated to the Pantelleria Rift. The last phase combines the reactivation of the WSW-ENE-oriented system with a dextral strike-slip movement (Prampolini, 2016).

2. Dart et al. (1983) suggested a single phase of extension (N-S-oriented) forming both the fault systems. The present interpretation is based on three main evidences: the simultaneity of the activating phase based on the study of filling sediments; the extension direction, calculated through the faults orientation and the kinematic indicators on them; the lack of proof of a reactivation with a strike-slip movement.

3.4 Geomorphological landscapes of the Maltese Islands

The Maltese Islands, despite their small size, presents a distinctive topography. The close link between geological formations and geomorphological processes has led to the creation of a rich variety of contrasting landscapes (Gauci and Scerri, 2019).

The geomorphology of the archipelago has been investigated by several authors (Pedley and Waugh, 1976; Illies, 1981; Alexander, 1988; Schembri, 1993, 1997; Hughes, 1999; Pedley et al., 2002; Magri et al., 2008; Barbieri et al., 2010; Coratza et al., 2011; Mantovani et al., 2016; Prampolini et al., 2017, 2018; Soldati et al., 2018, 2019). Some researchers are focused on specific portion of the islands, as coastal areas (Paskoff and Sanlaville, 1978; Said and Schembri, 2010; Biolchi et al., 2016), or on specific topics as dissolution processes and landslides (Coratza et al., 2012; Devoto et al., 2012; Mantovani et al., 2013; Soldati et al., 2013; Galve et al., 2015a).

The geological formations and their different geomechanical properties and resistance to erosion, contribute to an important control on the landscape. Both Upper and Lower Coralline Limestone formations are the most resistant layers and form the plateaus of the northern area of Malta and the mesas of the north-western region of Gozo. These formations constitute the vertical cliffs that outcrop on the coast and inland as edge of plateaus, in all the archipelago, with a height of 180 to 250 m (Magri, 2006). The Globigerina Limestone Formation is associated to a landscape characterised by gentle reliefs. The three soft members of Globigerina Limestone are easily eroded and weathered. On the contrary, the hardgrounds and conglomerates present within these members are much more resistant to the erosion and locally could form a step-like features. The Blue Clay Formation generates a landscape characterized by gentle slopes, easily eroded by rainfall and sea water when outcropping along the coasts. The Blue Clay slopes are playing an important role in the development of the landslides affecting the archipelago. (Prampolini, 2016).

The main geomorphological features of the Maltese Islands are described above according to their genesis.

3.4.1 Structural landforms

The Maltese landscape is largely controlled by structural factors: tectonics and lithology (Alexander, 1988). The tectonic control is exerted both by the WSW-ENE-oriented fault system that is responsible for a horst and graben structure at a large scale. In addition, in Quaternary times, the lithological succession experienced a 4° tilting towards northeast. This tilting in combination with the hydrographic network developed in wetter climatic conditions, generated a monocline with a SW-NE trend (Alexander, 1988; Anderson, 1997; Schembri et al., 1997). The watercourses, named 'wied' in maltese language, cut valleys that now are dry since the islands have a semi-arid climate, and the occasional water streams are related to intense precipitation events (Prampolini, 2016).

The fault system also contributed to the landscape evolution allowing the juxtaposition of lithological strata with different physical and mechanical properties. As a result, erosion has been locally enhanced.

In terms of structural geology, the whole archipelago can be divided into four main structural regions (House et al. 1961; Pedley et al. 1976, 1978). These four regions are as follows (Gauci and Scerri, 2019) (Figure 3.9):

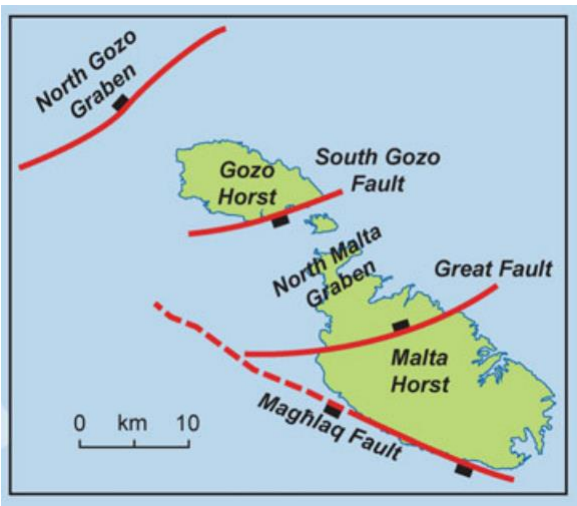


Figure3.9: Main structural regions of the Maltese Islands (from Gauci and Scerri, 2019).

- *The North Malta Graben*, that comprises the portion of Malta at the north of the Great Fault and the island of Comino. This region is characterised by a distinctive

sequence of ridge-trough morphology, north of the Great Fault and bounded by parallel ENE trending normal faults. The greatest topographic contrast in relief and landforms of the island is shown at the north of the Great Fault, containing both the steepest slopes and largest flat basins in Malta. The western zone of the region is characterised by Upper Coralline Limestone cap rock almost intact, which on the contrary, has been entirely removed in the eastern zone. These two sectors are in fact separated by a major subdivision that occurs along an irregular line running from St. Paul's Bay to Mosta. This region is composed by several divisions, the most relevant are: Marfa Ridge Peninsula, the Mellieħa valley, the Mellieħa ridge and the Bingemma valley.

- *The Malta Horst*, that comprises all the landforms at the south of the Great Fault. The region is characterised by the presence of plateaux and hills in proximity to the Great Fault. The remaining part of the horst is characterised by less structural deformations and faulting is generally much less pronounced (Gauci and Scerri, 2019). On the northeast sector, valleys converge into the low-lying shores. Globigerina Limestone is the dominant exposed rock formation of this region, except along the lower sections of the valleys and closer to sea level where Lower Coralline Limestone is exposed.
- *The Gozo Horst* that comprises the whole island of Gozo. It is characterised by a gentle regional depression to the north. This dip led to the develop of vertical cliffs in Lower Coralline Limestone up to 120 m high along the south-west coast, in contraposition to lower cliff up to 20 m on the northern coast between Marsalforn and San Blas Bay (Pedley et al. 1976, 1978). Gozo is cropped by several faults, mostly concentrated in the south. The most relevant are the the Sannat Faults and Qala Faults, both located close to Mġarr ix-Xini in southern Gozo, that separate south-eastern Gozo from the rest of the island (House et al. 1961). Three main features dominate the gozitan landscape (Gauci and Scerri, 2019): fragmented mesas of Upper Coralline Limestone; low-lying plains and hills on Globigerina Limestone; low-lying flat-topped hills where the Upper Globigerina Limestone member is exposed.

- *The North Gozo Graben*, an entirely submerged region, located at the north of the island of Gozo.

3.4.2 Gravity induced slope landforms

Gravity-induced slope landforms and processes are widespread over the Maltese Islands, especially along the north-western coast of Malta and eastern Gozo, at the edge of the Upper Coralline Limestone karst plateaus. The mass movements are mainly connected with the dissimilar mechanical behaviour of two different lithologies: Blue Clay and Upper Coralline Limestone. The limestone plateaus, hard and fragile, undergo tensile stresses by the underlying ductile blue clays, causing the development of trenches, fissures and persistent fractures. This favours rock spread (Figure 3.10d) phenomena that usually evolve into block slides when the detached and displaced limestone blocks tilt and move above the clays. Block slide deposits (Figure 3.10c) extend hundreds of metres below sea level reaching a depth of ca. 40 m (Prampolini et al., 2019). The accumulations of the displaced rock masses are called in Maltese language *rdum* and with the term *ras* is indicated the head, the edge of the of the plateau. These rock masses, when occurring along the coasts, protect the seashore and the clayey slopes from wave action. These types of mass movements are found mainly the northern coasts of Malta. The most important are: Rdum il-Qammieħ, where rock falls (Figure 3.10a) and rock topples (Figure 3.10b) occurs at the edges of the plateau at Ras il-Qammieħ and are favoured by rock spreading (Pasuto and Soldati, 2013).

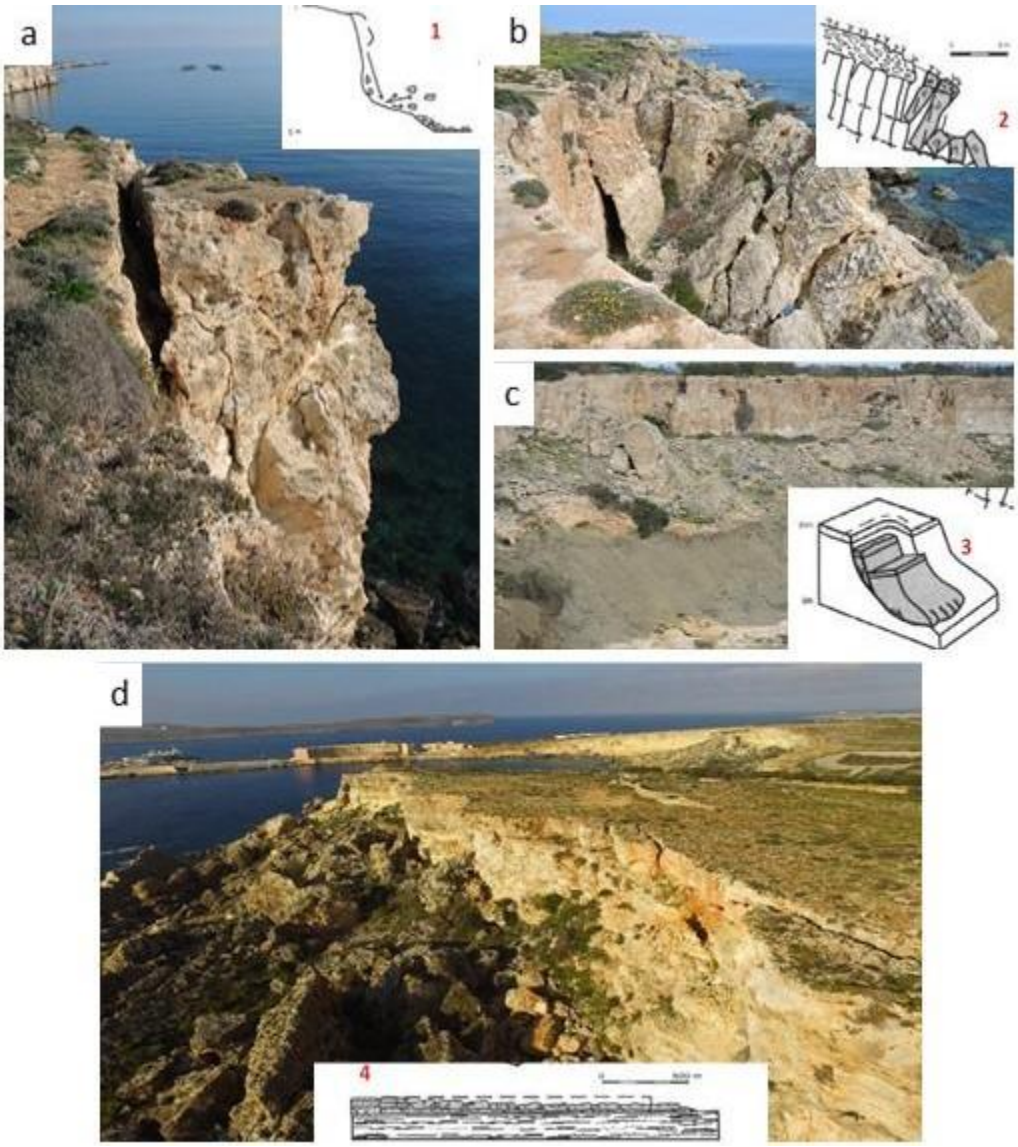


Figure 3.10: Landslides features of the Maltese Islands: a) rock fall, b) rock topple, c) rock slide, d) rock spreading. Landslides sketches from Cruden e Varnes (1996).

On the south-western side of the plateau, mainly earth flows affect the clayey slope, while the eastern part is characterised by slope instability phenomena that are spatially more limited than the western part. Ras il-Waħx promontory, along the northwestern coast of Malta, reaches on its western sector an altitude of 100 m. It is affected by rock spreading phenomena extending 70 m from the cliff edge. The promontory is surrounded by block slide accumulations that comprises highly fractured blocks with relevant volume. The blocks are often sunk in the clayey terrains and tilted backward (Prampolini, 2016). Some important plateaus are also located inland, as the Citadel of

Victoria and Tas-Salvatur mesas in Gozo. Il-Qarraba peninsula, connected to inland through a narrow isthmus in Blue Clay, is made up by a densely fractured limestone slab that is bounded by 10 m high cliffs. Rock spreading affects the western and northern parts of the limestone plateau isolating huge blocks often interested by block sliding (Magri et al., 2008; Devoto et al., 2013). The southern side of the limestone peninsula is mainly characterised by rock fall deposits composed by small blocks that rolled over the clayey terrains and accumulated on the shore and under the sea level.

Other types of mass movements are frequent on the islands: rock falls and earth flows (Devoto, 2013; Devoto et al., 2013; Mantovani et al., 2013, Soldati et al., 2018; 2019). Rock falls are caused by the presence of a dense network of discontinuities on limestone plateaus and are often associated with rock topples. Evidence of rock fall deposits at the base of the limestone cliffs is clear at several locations in northern Malta across all the Marfa Ridge Penisula or in the weastern coast (Magri et al. 2008; Devoto et al. 2012, 2013). Rock falls also occurs on the Lower Coralline Limestone sheer cliffs of southwestern Malta, western Gozo (Tonelli, 2014) and along the northeastern coast of Comino, where huge blocks lay accumulate along the shoreline.

Earth flows are typical of the Blue Clay slopes. They are usually related to extremely rapid event triggered by intense rain events that lead the clayey slopes to saturation and resultant instability, favoured also by groundwater springs. These processes are favoured by the presence of mud cracks in Blue Clay terrains that help the rainwater infiltration. An example of active earth flow was reported by Devoto (2013) in Ghajn Tuffieha Bay, where the flow was triggered by the intense precipitations occurred at the beginning of May 2012.

3.4.3 Karst landforms

Karst processes play a significant role in the Maltese archipelago due to the extensive presence of limestones. This has favoured the development of an interesting karstic system on the islands: karstic features are well developed on the surface topography of plateaus, characterised by highly irregular and rugged surface morphology, resulting

from solution processes. Two cavern system were recognised on the archipelago (Pedley et al. 2002; Tonelli, 2014): one developed in the Miocene and the other in recent times. The ancient one is associated to the Lower Coralline Limestone Fm. and gave rise to a series of sea floor collapses forming several sinkholes. The latter cave system developed within the Upper Coralline Limestone Fm. and comprises at least three levels of sea caves and associated sinkholes. Solution subsidence structures and sinkholes are the most spectacular landforms of karst landscapes on the archipelago, which generally developed as a result of mechanisms of subsidence, collapse and dissolution of the limestone. Sinkholes are also considered one of the most representative landforms of the Maltese Islands: over 50 structures have been recorded throughout the territory (Figure 3.11) (Calleja, 2010; Calleja and Tonelli, 2019). Therefore, the considerable number of circular or elliptic sinkhole of different size that can be found all around the archipelago are usually caused by the collapse of cave roofs: the most spectacular are Il-Maqluba (Malta) and Dwejra (Gozo).

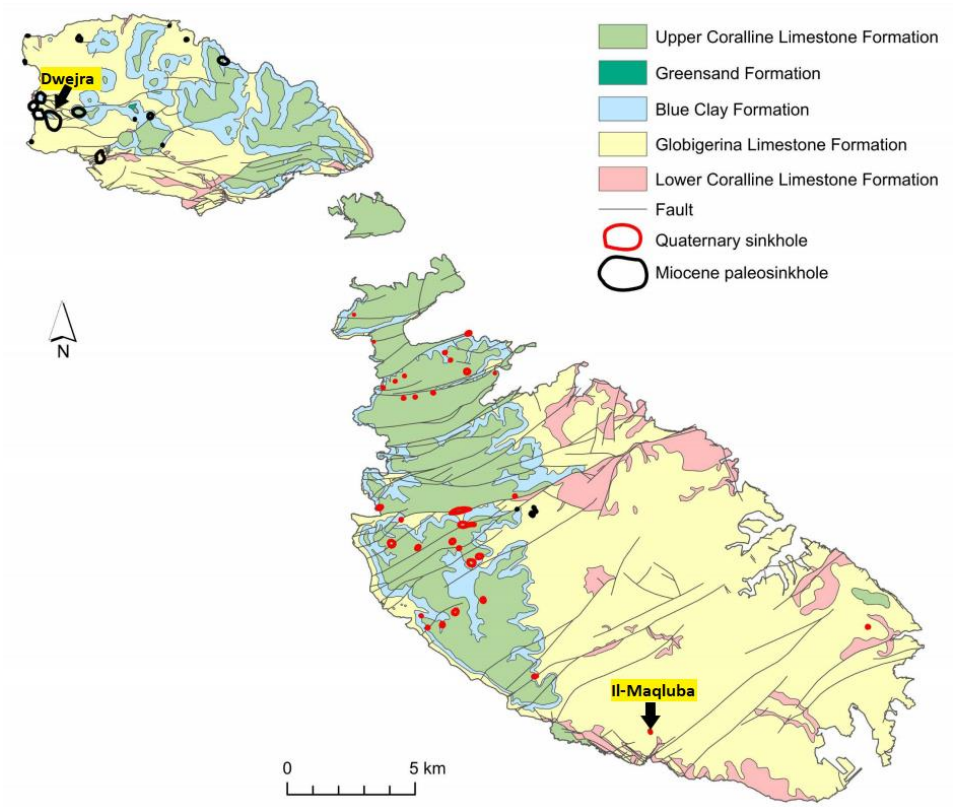


Figure 3.11: Geological sketch map of the Maltese archipelago and location of Miocene and Quaternary sinkholes, with location of Il-Maqluba and Dwejra sinkholes (modified from Calleja and Tonelli, 2019).

Submarine sinkholes have recently been recognised offshore the eastern coast of Malta (Angeletti et al., 2012; Micallef et al., 2013; Prampolini, 2017). Karst pavements, solution holes, solution pans, sea caves and arch are also common in the islands.

3.4.4 Coastal landforms

The archipelago exhibits a rich and complex coastline that displays a myriad of different landforms (Gauci and Scerri, 2019). The Maltese coastlines have changed through time, the last large exposure being during the Last Glacial Maximum, when the coastline was around 130 m below the present sea level (Caruso et al., 2011; Lambeck et al., 2011; Furlani et al., 2013; Micallef et al., 2013). Thus, past sea-level changes have significantly modified the palaeogeography of the islands (Tonelli, 2014). The coastal landform is mainly determined by tectonics, lithology of the outcropping units and sea level change. Bays of the northern sector of Malta are controlled by faults, as Mellieħa Bay, St. Paul's Bay, Salina Bay and Fomm ir-Riħ Bay. High cliffs prevail along the southwestern coasts, whereas low rocky coasts, gently dipping towards the sea, characterize the northeast, due to the NE tilting of the archipelago mentioned in the previous paragraph (*3.4.1*) (Paskoff and Sanlaville, 1978). The tectonics, in particular the NW-SE trending faults related to the Pantelleria Rift, are also responsible for the formation of vertical and subvertical rectilinear high cliffs, mostly formed in Lower Coralline Limestone. Outcrops of Blue Clay Fm. and Globigerina Limestone Fm. usually occur at the sea level as inlets and bays with small pocket beaches (Figure 3.12a). Where cliffs are cut in the Globigerina Limestone, shore platforms have developed as a result of differential erosion at the contact between different members, especially due to the presence of resistant conglomerate beds and hardgrounds. Examples of shore platforms can be found in Malta at Qammieħ Point (shore platform in LGLM) and Selmun (in UGLM); in Gozo at Għar Qawqla (in UGLM) (Figure 3.12b) (Gauci and Inkpen, 2019; Selmi et al., 2019).

The western coasts of the Maltese islands are generally high and characterised by plunging cliffs in Upper Coralline Limestone (Figure 3.12c), at times shaped in sea caves and sea arches (Figure 3.12d). Rock falls and topples are also common along the Upper Coralline Limestone coastline. In particular, evidence of rock spreading and block sliding phenomena characterize the stretch of coast at Rdum il- Qammieħ and Rdum il-Qawwi, in the Marfa Ridge Peninsula (Northern Malta) and at Rdum il-Majjiesa, located inside the Il-Majjistral Park boundaries. The lateral extension of rock mass frequently evolves into block sliding which, gently slide on the Blue Clay slopes toward the sea and protect the shoreline from marine erosion (Selmi et al., 2019). The eastern coast of the islands are mainly characterized by low-lying coasts constituted by shore platforms in Globigerina Limestone or by sloping coasts in Coralline Limestone. Examples are the Xwejni Bay in Gozo, and the Selmun area in northeastern Malta.

Also subcircular bays are frequently found along the coastline, created by the differential erosion provoked by the geological structure. Two examples are the rounded bays located near Marsaxlokk, south-eastern coast of Malta (Soldati et al., 2013; Prampolini, 2016).

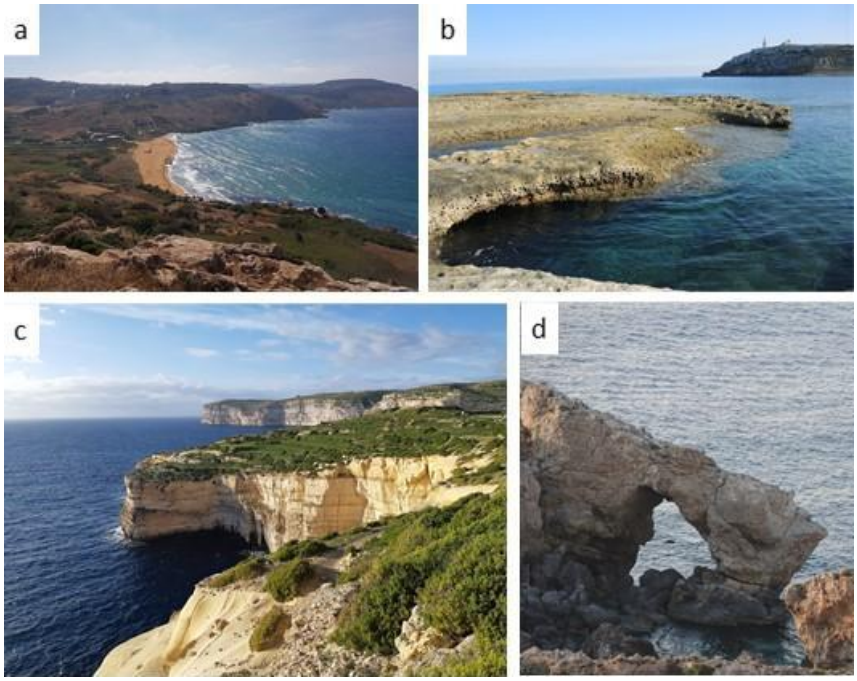


Figure 3.12: Diverse coastal landforms and features on the Maltese Islands: a) sandy beach at Ramla Bay in Gozo, b) shore platform in Selmun, c) plunging cliff, south Gozo, d) sea arch in Upper Coralline Limestone, Rdum il-Qawwi, northern Malta.

3.4.5 *Fluvial landforms*

Several fluvial valleys, *widien* in Maltese language, characterised the Maltese landscape (Figure 3.13a). They are carved within calcareous rocks and often controlled by faults. Nowadays the running water is scarce in Malta, but the fluvial valleys were developed in different climatic conditions (Devoto et al., 2012). Lower Coralline Limestone drainage has produced deep entrenched meanders and gorges as the case of Xlendi Valley. Complex systems of interconnected valleys formed by long and slightly sloping rivers characterise the area of Valletta (Paskoff and Sanlaville, 1978). Suspended valleys are shown along the cliffs of the archipelago (e.g. Hofra Il-Kbira Bay, east of Marsaxlokk Bay). Fluvial deposits (Figure 3.13b) are rare and most underlie flat terrace surfaces at the side of valleys and are often interbedded with palaeosoils (Hunt and Schembri, 1999; Tonelli, 2014).

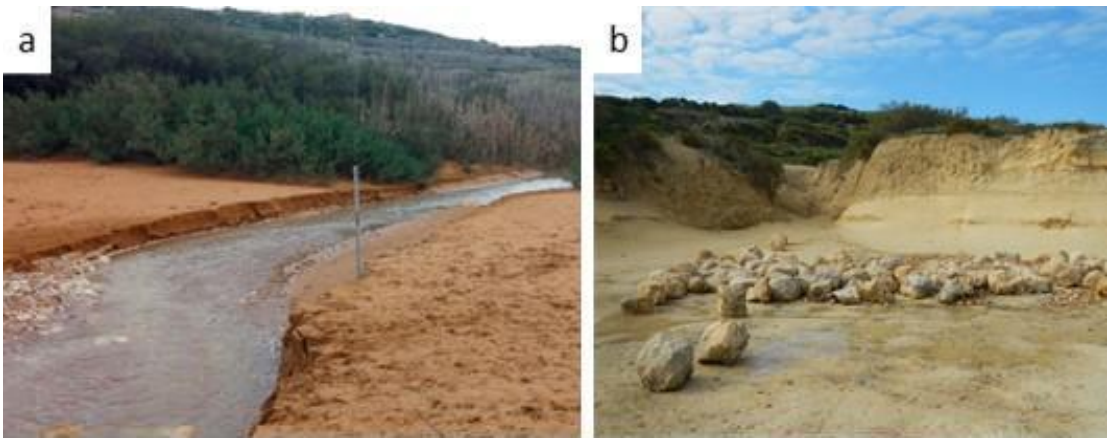


Figure 3.13: Fluvial landforms on the Maltese Islands: a) Ramla wied in Ramla Bay, Gozo, b) fluvial deposits at Selmun.

3.4.6 *Man-made landforms*

There is a deep relationship between geomorphology and human activities. All the archipelago has been significantly influenced over time by human activity, especially in recent years due to its high population density. The central and southern part of the island of Malta have been heavily urbanized, hiding the real natural landforms. Touristic development and the enhancing of coastal areas with shoreline modifications

to accommodate beach facilities can be found in St. Paul's Bay, Mellieħa, and the Sliema to St. Julian's areas. Gentle slopes have been remodeled into terraced fields retained by dry stone walls for agricultural purpose (Cyffka and Bock, 2008; Micallef 2019). The terraced fields and agricultural land are usually installed on V-shaped dry valleys, relict of former pluvial conditions and extensive groundwater sapping (Selmi et al., 2019).

Another notable human impact are the numerous quarries carved in the Globigerina Limestone. Presence of archaeological features can also be encountered. Abandoned British military architecture can be found along the coastline or on the top of strategic plateaus. Examples of historical heritage related to military defence are the The Mistra Coastal Military Battery and the Għajn Ħadid tower, erected in 1658 as part of the thirteen coastal military towers around the island used for strategic defence. Frequent are also small pill boxes used as sentinel posts (Selmi et al., 2019; Sammut et al., 2019).

Figure 3.14: a) Mistra Coastal Military Battery; b) example of pill box along the coast (Selmun).

CHAPTER 4. Maltese Context

4.1 Natural heritage protection in the Maltese archipelago

Landscape is one of the primary natural resources of a nation: its quality and uniqueness positively contributes to give a sense of place and identity, promotes employment - especially in tourism related activities that usually depend on the landscape quality. The connection between landscape and human activities is also considered an experience with recreational, inspirational and educational potential (MEPA, 2004).

The Maltese landscape has been modified over millenia by both natural processes and anthropological activities. Humans have inhabited the islands for at least 7000 years: from the first evidence of the Neolithic period until today, human activities have influenced all the territory, with various degrees of impact, in some cases changing the landscape entirely (MEPA, 2004; Spiteri and Stevens, 2019). Nowadays, the archipelago, especially the main island, comprises heavily urbanized areas fragmented by rural territories. The most industrialized areas are the districts of Northern Harbour and Southern Harbour, which register the highest number of population and also the highest population rate (Regional Statistics Malta, 2019).

For this reason, the landscape is a precious resource that needs legal recognition and protection, also to be enjoyed both by the present and future generations (Spiteri and Stevens, 2019).

The safeguarding of natural landscape is considered a recent aspect of the environmental management of the archipelago that has developed mainly in the last three decades. The Environmental Protection Act (EPA) is the main act in governing environmental regulations and was adopted in 1991. Before the EPA came into force, it is possible to identify some fragmented legal instrument that protected specific part of natural heritage, mainly concerning the vegetation systems but no other aspects of the biotic and abiotic nature (Selmi et al., 2019; Spiteri and Stevens, 2019) as follows:

- Government Notice 85 of 1932, published via the Malta (Temporary Government) Order of 1930, which provides legal protection to the Mediterranean Thyme (*Thymbra capitata*, Sagħtar in maltese).
- Government Notice 269 of 1933, published under the provisions of the Antiquities (Preservation) Act (Act XI of 1925, as amended). This protects all trees older than 200 years and declares them as of "antiquarian importance" (GN 269, 1933). This Notice is now replaced by the Cultural Heritage Act (Cap. 445 of the Laws of Malta).
- The Conifer (Preservation) Regulations (Government Notice 328 of 1949) issued under the provisions of the Code of Police Laws (Cap. 13) which fully protects all pines and the Italian Cypress.

In 1991, with the adoption of the EPA, the protection of natural heritage of the Maltese islands became more concrete and complete.

Furthermore, with the accession of the country as a member state of the European Union in 2004, Malta has the obligation to protect habitat and species of importance at a national and international level. These new obligations concern also the designation of protected areas and their management, to ensure a more efficient nature conservation. It has therefore adopted two important European environmental directives on the conservation of natural habitats and of wild fauna and flora: the Habitat Directive (Council Directive 92/43/EEC), aims to promote the maintenance of biodiversity and the Birds Directive (Directive 2009/147/EC), aims to protect all of the 500 wild bird species naturally occurring in the European Union. The adoption of these two important directives contributed towards a good consolidated compilation of the sporadic rules on nature conservation which existed at that time (Spiteri and Stevens, 2019).

Malta signed also the European Landscape Convention decreed from the council of Europe on 20th October 2000. In order to respond to the convention, a review of the structural plan of the Maltese Islands has been made in 2004 by MEPA. The revision produced The Landscape Assessment Study of the Maltese Islands (LAS). The LAS subdivided Malta into 96 different landscape character areas and mapped the country in terms of landscape sensitivity: areas of high and very high sensitivity were identified and recommended for statutory protection, through scheduling of Areas of High

Landscape Value (AHLVs). The aim of AHLVs is to ensure controls on developments that may compromise landscape characteristics (Conrad, 2019).

In 2006, the proportion of legally protected landscapes in the Maltese Islands has grown over 33% of total land area, three times more than in 2000, due to the adoption of five local plans and the recognition of 42km² as new AHLVs (MEPA, 2004). A number of islets around the Maltese Islands, such as Filfla and St Paul's Islands have been legally established as nature reserves and restricted human access only for scientific purposes. Under the Development Planning Act (last revision 2016), other strategies and plans were established in order to set a framework to base decisions on land use and development, by providing a land use strategy that balances environmental, economic and social issues:

- The National Biodiversity Strategy and Action Plan (NBSAP)
- The Water Catchment Management Plan
- The National Environment Policy (NEP)
- The Strategic Plan for the Environment and Development (SPED)

To sum up, all the amount of main legislative acts and subsidiary legislations enacted after the EPA are reported in Table 4.1 (Selmi et al., 2019).

Table 4.1: Maltese legal instruments related to the natural landscape management and protection.

Type of Legal Instruments	
Acts	**Subsidiary Legislations**
Environment Protection Act (Chapter 549) Development Planning Act (Chapter 552) Cultural Heritage Act (Chapter 445) Fertile Soil (Preservation) Act (Chapter 236) Filfla Nature Reserve Act (Chapter 323)	Flora, Fauna and Natural Habitats Protection Regulations (SL 549.44) Trees and Woodland Protection Regulations (SL 549.64) Selmunett Islands (St. Paul Islands) Nature Reserve Regulations (SL 549.03) Fungus Rock (il-Ġebla tal-Ġeneral) Nature Reserve Regulations (SL 549.01) Motor Vehicles Off-roading Regulations (SL 552.01) Rubble Walls and Rural Structures (Conservation and Maintenance) Regulations (SL 552.02).

	Conservation of Wild Birds Regulations (SL 549.42) Establishment of the Majjistral, Nature and History Park Regulations (SL 549.48) Establishment of the Park Nazzjonali tal-Inwadar Regulations (SL 549.109) Protected Beaches (SL 549.42) Tree Protection Areas (SL 549.123)

All the legal instruments cited are regularly updated in order to transpose European and international laws, mainly from the United Nations (including the Mediterranean Action Plan), the Council of Europe and the European Union (Spiteri and Stevens, 2019, Selmi et al., 2019).

Furthermore, several sites protected by more than one designation enrich the legal framework of natural heritage protection of the Maltese Islands. The rich mosaic of protected site is summarized in Figure 4.1.

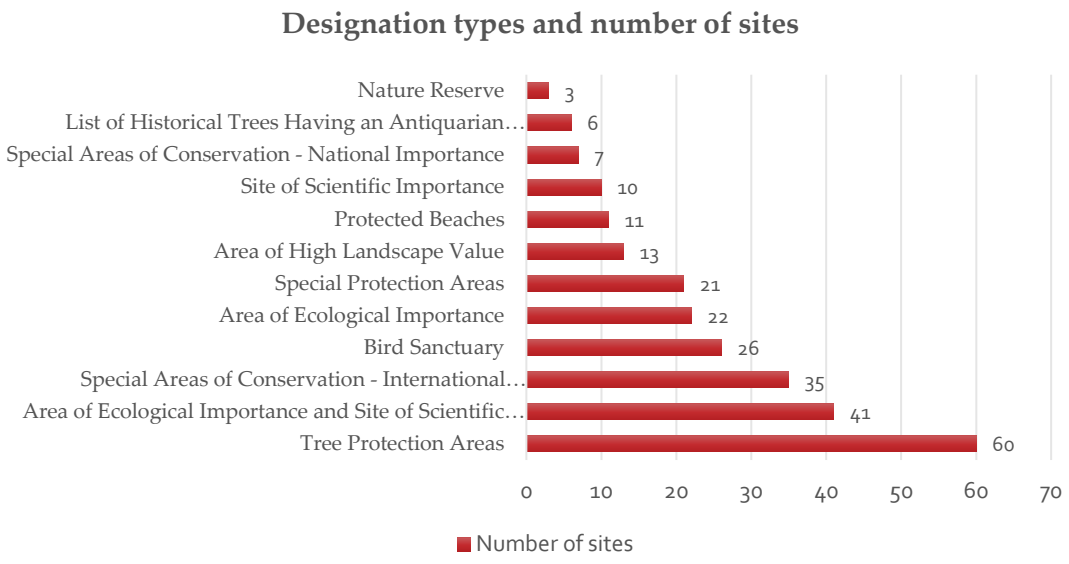


Figure 4.1: Number of protected sites according to designation type (Souce: Compiled from ERA, Selmi et al., 2019).

Besides these sites, government has also designated a large tract of country in the northwestern of the mainland as the Majjistral Nature and History Park through the Establishment of the Majjistral, Nature and History Park Regulations (SL 549.48) (Rolé,

2019). Other Parks have also been designated recently, as the Park Nazzjonali tal-Inwadar Regulations (SL 549.109), issued in October 2016 (Spiteri and Stevens, 2019).
Important is the role of NGOs (or eNGOs) that carry out activities related to the protection and conservation of the territory. These NGOs are very active in environmental education through various means, as they consider education as the best tool to create awareness on nature conservation. The principal NGOs present on the archipelago dealing with the protection of the natural environment are: The Gaia Foundation, Birdlife Malta and Nature Trust Malta. On the territory are present other NGOs that carry out activities related to the protection of the urban and historical heritage and that indirectly contribute to the natural environment conservation.

4.2 Protection of geoheritage in Malta

The previous section shows how detailed and rich is the protection of the natural heritage on the Maltese Islands. But what about the protection of the geological heritage? Despite the high number in legislations and acts on natural heritage, there is still no legislation created *ad hoc* to protect exclusively the geological heritage. This lack may be explained by the following reason: the protection of geological heritage, as mentioned in the second chapter of this thesis, has been developed in the last 25 years. Worldwide the recognition and protection of geological heritage has been achieved by nations that have already a solid base in environmental protection. The recognition and protection of the abiotic nature is often mistakenly considered of secondary importance with respect to the biotic nature. As mentioned in the previous paragraph, the safeguarding of natural landscape in the Maltese Islands is considered as a relatively recent development, and still in progress.
The review of Maltese legislations mentioned in the previous paragraph shows that there is minor indirect literature on geological heritage. This is the case of the natural landscape features classified as Areas of High Landscape Value (AHLV) under the Development and Planning Act. The AHLVs comprise coastal cliffs, valley systems, karstic plateaus, escarpments and other geomorphologic features as coastal caves, shore

platforms and low cliffs (Sammut, 2019). These natural features intrinsically incorporate geological and geomorphological properties; however, their value is primarily recognised for its support function to bio-diversity and ecological systems, rather than specifically (or exclusively) for their geological properties in their own right (Selmi et al., 2019).

Similarly, in the Cultural Heritage Act, natural features are classified under the term 'cultural heritage' movable or immovable objects, comprising also 'geological sites and deposits' and 'landscapes', but also in this case the act has no specific provisions related to their geoheritage value (Selmi et al., 2019). This act is specifically dedicated to the protection of cultural heritage, but it is the only one that recognizes abiotic elements as worth of protection. The Cultural Heritage Act includes as cultural heritage also archaeological and paleontological sites, human remains, scientific collections and "Underwater Cultural Heritage". The latter includes underwater and seascapes such as traces of human existence having a cultural, historical or archaeological character (e.g. ancient cart ruts, Bronze age platform silos, Roman Age tanks) which have been partially or totally submerged (Furlani et al. 2012). Its main function is to promote the integration of conservation and management practices with respect to cultural heritage at all levels of government, local government, the private and voluntary sector (Cap 445 of the Laws of Malta). The terms of reference also include advices and coordination with the Planning Authority on actions to safeguard cultural heritage when considering development applications for planning permission which may affect objects, sites, buildings or landscapes which form part of the cultural heritage (Spiteri and Stevens, 2019).

Another legal instrument linked indirectly with geoheritage protection is the Motor Vehicles Offroading Regulations (SL 552.01): it is directed to control activities affecting Maltese landscape or features important for landscape conservation. This is because such activity adversely affects landscape, causes soil erosion and land degradation (Micallef, 2019, Spiteri and Stevens, 2019).

On a legal framework, the importance of geoheritage protection and conservation remains however diluted, when compared with other aspects of natural heritage such as ecology and biodiversity.

On the contrary, the scientific community interest in geoheritage is increasing and with several studies conducted in recent years. In April 2007 the International Workshop on the 'Integration of the geomorphological environment and cultural heritage for tourism promotion and hazard prevention' was held in Malta and the importance of developing studies to investigate the linkage between environment and cultural heritage and the relationship between geoheritage and tourism was initially explored (Soldati et al. 2008a, 2008b).

Specific studies on geoheritage recognition and geosites inventory have been carried out in the north-west coast of Malta, especially on the area of Il-Majjistral Nature and History Park and environs (Coratza et al., 2011; Selmi dissertation, 2017, Cappadonia et al., 2018; Selmi et al., 2019). Other studies on geoheritage assessment were conducted on the island of Gozo (Coratza et al. 2016; Calleja and Tonelli, 2019), in particular on the Dwejra area that comprises outstanding sinkholes having highly scientific, ecological, aesthetic, cultural and use values as geomorphosites.

In addition, a first geomorphology monograph about Maltese landforms and landscapes was recently published in 2019. The book collects several contributions edited by Gauci and Schembri (2019) and illustrate the rich diversity of the Maltese physical landscapes under the World Geomorphological Landscapes series (Springer) (Selmi et al., 2019). The volume comprises works on geoheritage and its relation with human culture. The significance of Maltese coastal landforms for societal well-being was investigated by Satariano and Gauci (2019) who examined the intense reactions experienced by both the Maltese and international community following the sudden loss of an iconic sea arch at Dwejra (Gozo) in March 2017. Another work, by Gauci and Inkpen (2019), highlighted the geoheritage value of shore platforms in Malta by examining the close relationship between the physical landscape of the foreshore and human cultural development (Selmi, 2019).

All these recent studies on geoheritage highlight the presence of a rich heritage, but it still remains something far from local perception and not directly considered for legislation as heritage. The present legislation already meets specific needs that were not considered in the past. Laws, policies and plans were designed to guarantee the natural protection, but despite this increasing awareness, anthropogenic pressure risks are also increasing on the small archipelago. The Maltese archipelago, with its just 316 km², needs to find the best solution to balance the protection of the natural and cultural heritage and urban development that brings substantial changes and loss in natural landscapes (Spiteri and Stevens, 2019). This could be met with a revision of the Structural Plan that brings to consider also the geological heritage as fundamental part of the natural heritage. In addition, as identified by Gill (2017) and by Brilha et al. (2018), the protection of geological heritage is consistent with sustainable development. Geomorphological and geoscience research may contribute to achieving the Sustainable Development Goals approved by United Nations in September 2015 (Attard, 2019). Once again, there is still little recognition of the influence of landscapes and landforms in the documentation and policy surrounding the discourse on sustainable development. This also leads to a lack of public understanding on the importance of natural heritage, in particular geological heritage, in everyday life (Brilha et al. 2018; Attard, 2019). It is important to integrate the cultural heritage and environmental heritage with geoheritage aspects, in order to bring geology at the same level of biotic elements, considering also the landscape itself as worth of protection. This holistic view of natural heritage will make all the archipelago a destination of remarkable value to be promoted for a more sustainable and responsible tourism.

CHAPTER 5. Methods

A variety of methods were used in this study (Figure 5.1). These are described below as follows:

1. Literature review of UNESCO guideline for UNESCO Global Geoparks.
2. Landscape character analysis in Maps of Malta and Gozo and Natura 2000 Map.
3. Insular UNESCO Global Geoparks review and analysis.
4. Literature review of Maltese geology, geomorphology and geoheritage.
5. Literature review of international and national natural heritage and geoheritage policies.
6. Geological and geomorphological map analysis.
7. Thematic maps, satellite imagery and aerial photograph analysis.
8. Interview to experts and field studies to selected areas of the Maltese Islands.
9. Literature review geoheritage assessment methodologies.
10. Literature review of degradation risk analysis.
11. The development of new degradation risk methodology on geosites.

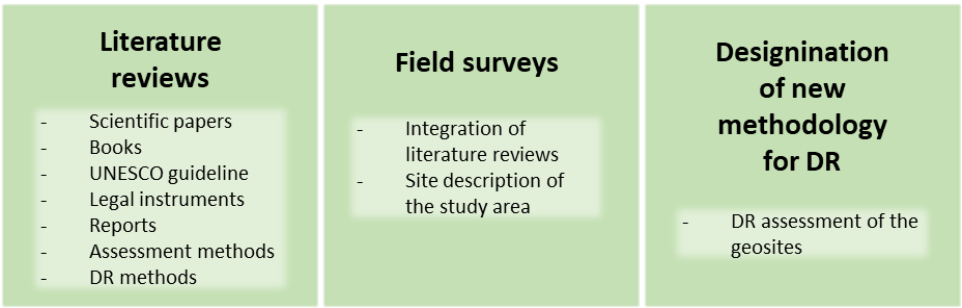


Figure 5.1: Methods used in this research.

The methodologies outlined in this chapter fall into three broad categories, namely: (i) literatures reviews (e.g. scientific papers, books, UNESCO guidelines, Maltese legal instruments related to the natural landscape management and protection, internet searches) of the geological and geomorphological characteristics of the Maltese Islands and of the geoheritage assessment methods; (ii) field surveys and site descriptions of the

study area; and (iii) designing a new methodology for the degradation risk assessment of geosites. Based on published literature, as well as on knowledge achieved in previous research on geoheritage in various morphoclimatic contexts, the methodological approach adopted for the recognition and assessment of geoheritage on the Maltese Islands comprises the following operational phases (Figure 5.2): (1) identification of boundaries in the view of the definition of a study area suitable for its recognition as UNESCO Global Geopark; (2) recognition of potential geosites within the study area, mainly based on literature reviews, satellite image analysis and field surveying; (3) analysis and characterisation of potential geosites; (4) preliminary selection of potential geosites, based on their representativeness in terms of geohistory and geo(morpho)diversity (Reynard, 2016; Feuillet and Sourp, 2011); (5) quantitative assessment of potential geosites through the application of two methodologies internationally tested and adapted on the study area (Reynard, 2007; Brilha, 2016), and final selection of geosites based on the scores obtained; (6) classification of the geosites considering their degree of interest as local, national or international; (7) development and application of a new methodology to assess the risk of degradation of the geosites, based on three main factors: natural vulnerability, anthropogenic vulnerability and public use.

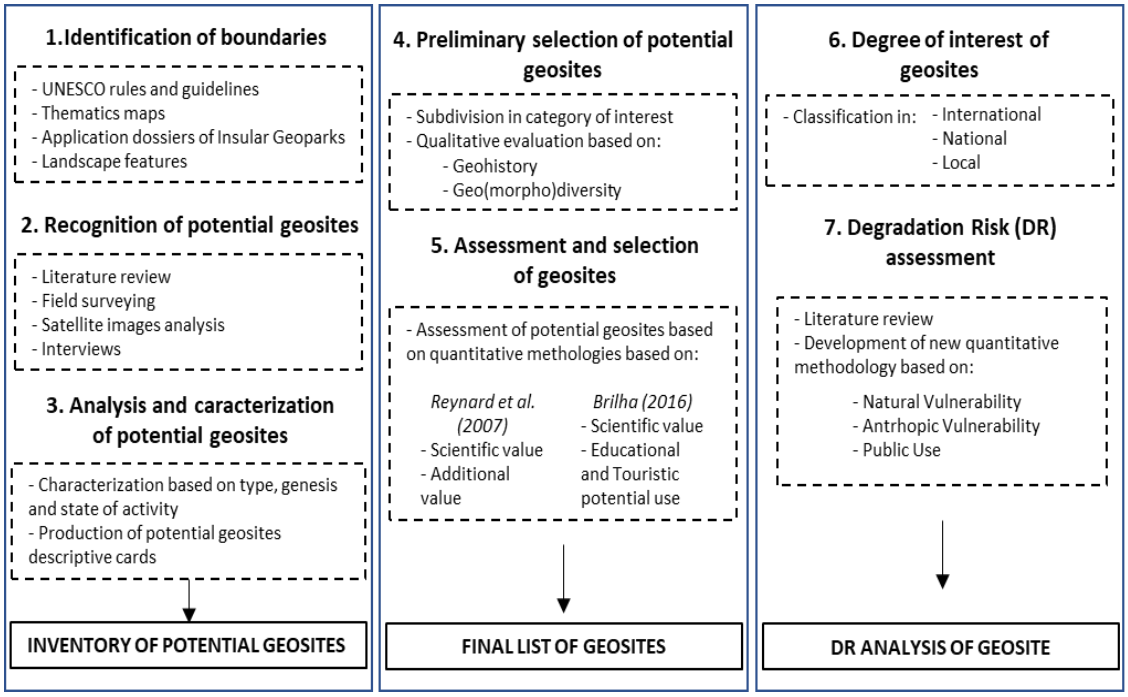


Figure 5.2: The seven main stages of the methodological approach.

5.1 Identification of boundaries: the study area

In order to identify the best area suitable for its possible application as UNESCO Global Geopark, the following documents and materials have been analysed: (i) operational guidelines for UNESCO Global Geoparks, to take in consideration all the rules and requests dictated by UNESCO; (ii) thematic maps of the Maltese Islands, documents that define the environmental frame, the administrative and legislative frameworks of the area; (iii) application dossiers of Insular UNESCO Global Geopark and their respective websites to investigate the characteristic of existing insular Geopark.

(i) Operational guidelines for UNESCO Global Geopark

The document contains clear indication of what can be considered as a geopark and clarifies the criteria for UNESCO Global Geopark. Following, the criteria considered to define the geopark boundaries are reported:

> *'Criteria (i): UNESCO Global Geoparks must be single, unified geographical areas where sites and landscapes of international geological significance are managed with a holistic*

> *concept of protection, education, research and sustainable development. A UNESCO Global Geopark must have a clearly defined border, be of adequate size to fulfil its functions and contain geological heritage of international significance as independently verified by scientific professionals.'*

Analysing the criterion, it follows that the Geopark must have clearly defined border, not segmented in different portion of the archipelago. With this first criterion it is also underlined that the area must comprise geological heritage with international scientific interest.

> *'Criteria (iv): In the case where an applying area overlaps with another UNESCO designated site, such as a World Heritage Site or Biosphere Reserve, the request must be clearly justified and evidence must be provided for how UNESCO Global Geopark status will add value by being both independently branded and in synergy with the other designation.'*

According to criterion (iv), it is important to consider the presence of already recognised sites in the archipelago for other values as cultural and biological. The presence of World Heritage Sites or other UNESCO sites can be comprised in the geopark's area, especially if they are related to geological characteristics and bring additional value.

> *'Criteria (v): UNESCO Global Geoparks should actively involve local communities and indigenous peoples as key stakeholders in the Geopark.'*

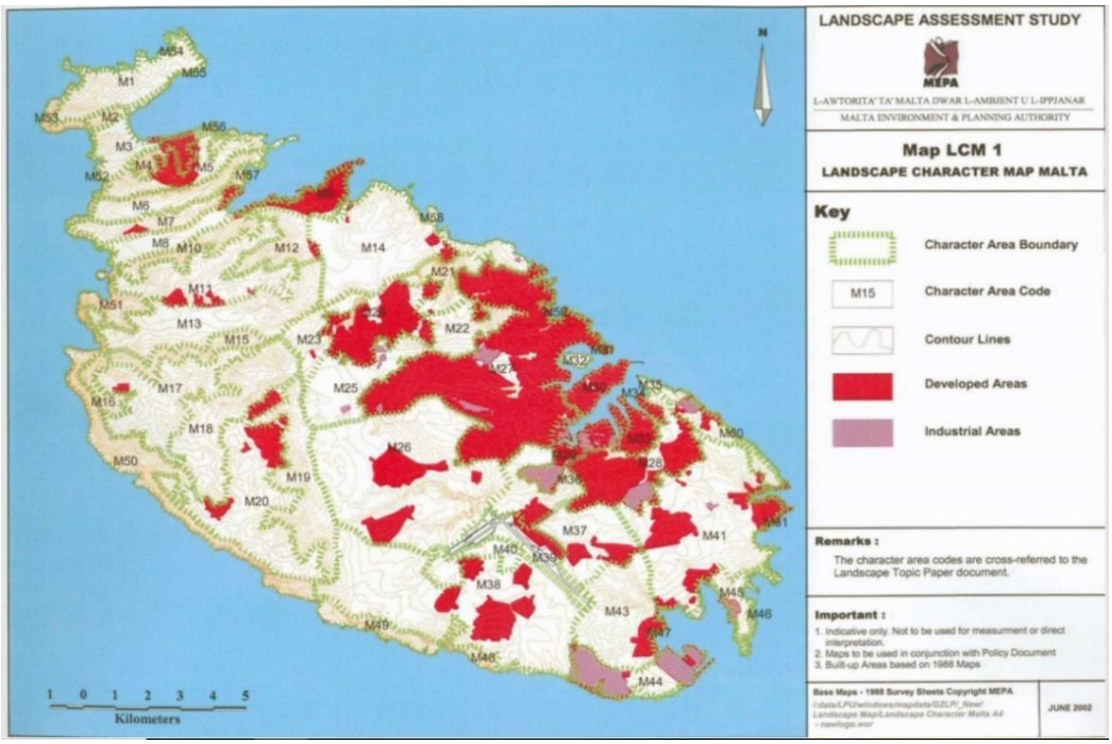
As specified also in the main definition of a UNESCO Geopark, the criterion number five reiterates that inside the area of a geopark the local community must be an important and present stakeholder. The geodiversity often coincides with cultural diversity and hence, conservation and management cannot be undertaken with-out the involvement of people closest to these resources. Considering that, the boundary must comprise both rural areas and urbanised one.

(ii) Thematic Maps of the Maltese Islands

The Landscape Characters maps of Malta and Gozo published by MEPA (2004) and the Natura 2000 Map were analysed in order to define the environmental, administrative

and legislative frameworks of the study area. Analysing the thematic maps, it was possible to identify the urbanised regions of the archipelago and the areas that are protected by environmental regulations.

The Landscape Characters maps of Malta reported that the industrial areas are limited in the south east of the main island (Figure 5.2a); the developed area is mainly concentred in the core of Malta, where the capital Valletta is located, followed by other populated and touristic coastal cities Sliema and St Julian's. Regarding Gozo (Figure 5.2b), the developed areas are circumscribed and fragmented mainly on the centre of the island. The island of Comino has a handful of permanent residents and thus does not present relevant development area. The island is usually visited for daily trips, especially in summer.



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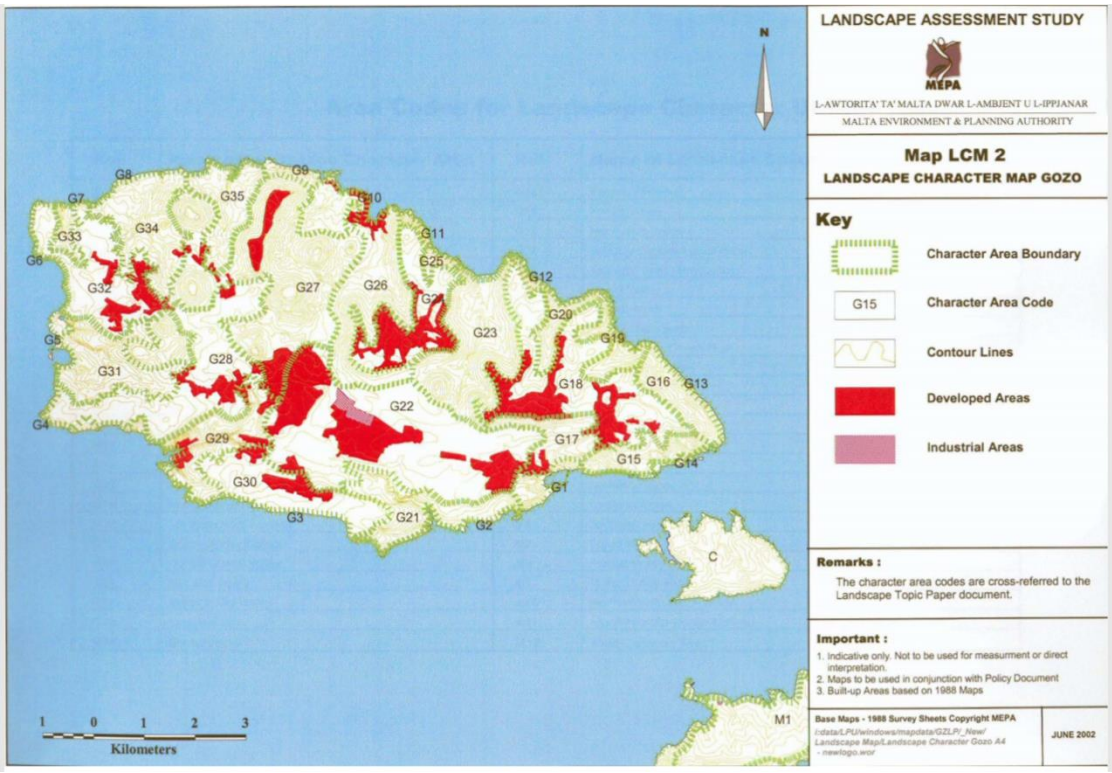

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Figure 5.2: a) Landscape Character map of Malta; b) Landscape Character map of Gozo and Comino (source: MEPA, 2004).

The Natura 2000 Map (Figure 5.3) shows that the terrestrial Natura 2000 sites, under the Habitat Directive 92/43/EEC, correspond to Special Areas of Conservation (SAC) that principally include the coastline from the north-west to the south of Malta, the entire island of Comino and a restricted portion of the island of Gozo. In the island of Malta, Special Areas of Conservation (SAC) of marine international importance cover the marine connection from the mainland to the island of Filfla, located around 5 km far from the south of the Maltese coast, the seaside surrounding the Majjistral Nature and History Park and the northeast coast. In the island of Gozo, the marine protected areas cover small features as Dwejra, Mġarr ix-Xini and the marine bridge that connects the northest Gozo with Malta, comprising the island of Comino.

The last mentioned marine protected area, Site number MT105, named Żona fil-Baħar fil-Grigal ta' Malta, covers more than 150 km² and it is the biggest marine protected area of the archipelago. No protected sites are present in the developed areas.

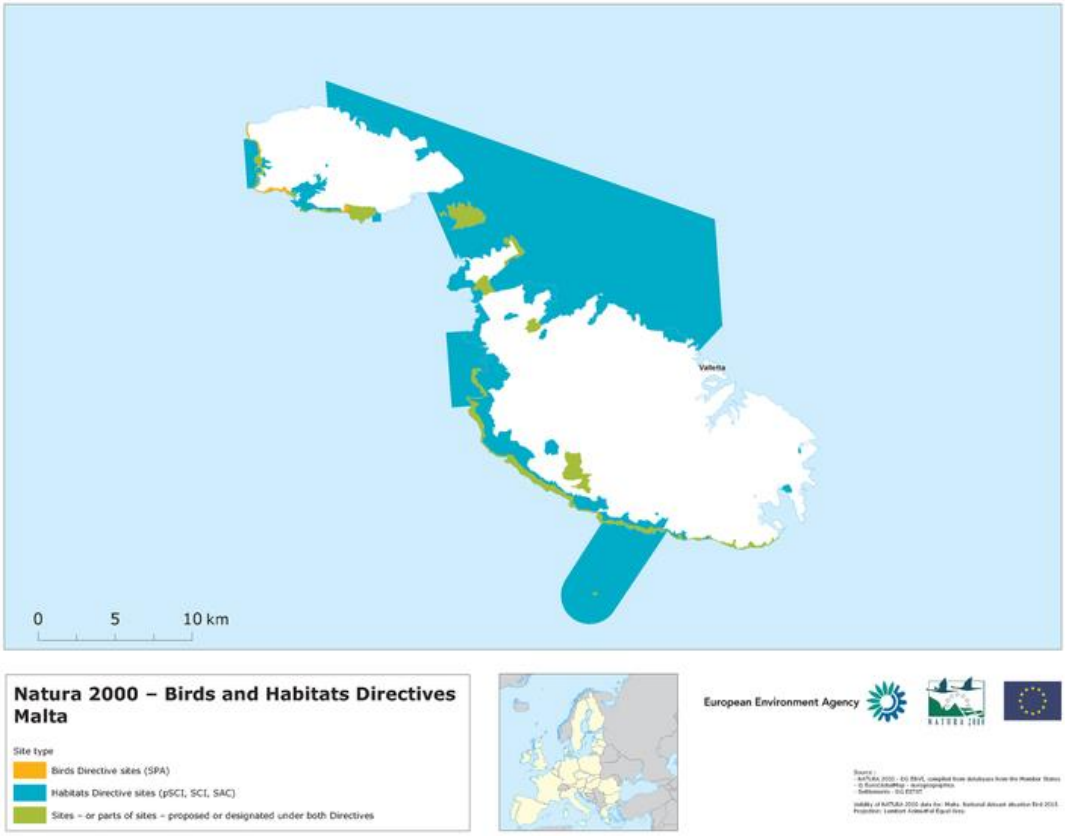


Figure 5.3: Terrestrial and marine Natura 2000 sites on the Maltese archipelago (Source: European Environment Agency).

(iii) Insular UNESCO Global Geoparks

In addition to the analysis of the documents described, an investigation on the present insular UNESCO Global Geoparks has been conducted in order to identify the peculiarities and characteristics of existing island Geoparks. On the UNESCO Geopark Network is present a working group on insular geoparks. In Table 5.1 the members of the working group are reported, in association with their areal dimension:

Table 5.1: Insular UNESCO Global Geoparks and their areal dimension.

UNESCO Global Geopark	**Country**	**Area (km^2)**
LANGKAWI UNESCO GLOBAL GEOPARK	Malaysia	478
OKI ISLANDS UNESCO GLOBAL GEOPARK	Japan	673,5
TROODOS UNESCO GLOBAL GEOPARK	Cyprus	1.147

SHETLAND UNESCO GLOBAL GEOPARK	United Kingdom	1.468
LESVOS ISLAND UNESCO GLOBAL GEOPARK	Greece	1.636
JEJU ISLAND UNESCO GLOBAL GEOPARK	Republic of Korea	1.847
QESHM ISLAND UNESCO GLOBAL GEOPARK	Iran	2.063
VIS ARCHIPELAGO UNESCO GLOBAL GEOPARK	Croatia	6.661
AÇORES UNESCO GLOBAL GEOPARK	Azores	12.884

At first sight, the Maltese archipelago could be considered the smallest insular geopark with its only 360 km² of terrestrial area. On the contrary, its small size may result as a strength: all parts of the park can be better monitored and carefully managed. In addition, the people can really live the park and easily access to it.

Anyway, the dimension is not a prerogative if all the criteria are satisfied. For example, in Europe are present active UNESCO Geoparks with small dimension as the case of the English Riviera UNESCO Global Geopark (UK) with a total area of 104 km², or the Basque Coast UNESCO Global geopark that comprises a small area of 89 km², with 13 km of coast.

Some insular geoparks, as the Lesvos Island UNESCO Global Geopark or the Açores UNESCO Global Geopark, include the whole archipelago, whilst others comprise a mix of land and marine area of the archipelago. This is a peculiarity of the insular geoparks: comprising both terrestrial and marine sites, there is a significant additional value of the geopark due to its habitat variety and topography shaped by sea action.

5.2 Recognition of potential geosites

The recognition of potential geosites within the study area was achieved through three main steps: (i) literature review; (ii) interviews; (iii) field surveying.

The literature review is fundamental to investigate the geological setting of the area and to set up a list of potential geosites refereed in the literature, such as sites where relevant

data were obtained, stratotypes, stops of scientific fieldtrips, key outcrops for certain formations, etc. (Brilha, 2016). The review includes the collection and analysis of scientific papers, doctorate and master theses, geological, geomorphological maps of the area under study and environmental agencies' reports. It comprises also the analysis and interpretation of topographical maps, aerial photographs and satellite images. Despite their secondary role, informal literature as historical sources, touristic publication and guides can also help in the recognition of sites: they often use certain nature landmarks that are in fact geodiversity elements selected merely for their high aesthetic value, with tourism managers not aware of it. The review is also useful for the definition of geological frameworks that will support the inventory during the preselection (deLima, 2010).

Scientific papers dealing with the geological and geomorphological features of the Maltese archipelago compiled in the last decades are available, some of which specifically devoted to the geoheritage of the northwestern sector of the island of Malta (cf. Selmi et al., 2019 and references therein).

Consulting with experts that are working or that have developed research in the Maltese Islands are also fundamental to enrich the knowledge on the study area and to define a list of sites that are used for academic purpose such as geological and ecological fieldworks with students. The sites investigated for academic purpose are used as a starting point for the field visits.

The literature review and the consultation of the experts with work experiences in the study area led to the acquisition of all available information on the study area and to identify the data that needs to be implemented during the field surveying. The field surveys are essential to integrate the list of sites previously identified with new sites not mentioned in bibliography. It is also fundamental to collect site-specific updated information as state of conservation, state of activity, accessibility, visibility and presence of services relevant to the completion of the sites' characterisation and the following selection and assessment steps.

At this stage, all the sites that may have geological relevance are considered, comprising also similar features located in different places on the archipelago.

5.3 Analysis and characterisation of potential geosites

Broad description of each potential geosite can be made by combining all the information collected through literature review, field visits and expert interviews. Indeed, the analysis provides for the identification of a series of parameters collected in descriptive cards including elements of textual description and pictorial data.

In literature there are a number of papers that present different scheme of descriptive cards that are usually associated with national inventories (Reynard et al., 2007; Reynard, 2009; Erhartič, 2010; Comănescu et al., 2012; Kubalíková, 2013).

5.3.1 Descriptive cards in national inventories

A national inventory is fundamental to understand and protect the geological heritage. In Europe several national inventories have been produced, this is the case of the British inventory started in 1977, known as the Geological Conservation Review (Ellis et al., 1996), of the Spanish inventory of 1978, of subsequent national projects in Norway (Erikstad, 1984), the Netherlands (Gonggrijp, 1988), Ireland (Daly, 1990), Switzerland (Grandgirard, 1996, cited in Bruschi, 2007) or the United Kingdom (UKRIGS, 2001), and of international inventories, such as the Global Geosites project (Wimbledon, 1996; Cowie, 1993). National inventories are usually made up by a combination of regional inventories conducted on the country. This is the case of Spain where in 1978 the Geological Survey of Spain (IGME) launched a systematic project called INPIG (National Inventory of Points of Geological Interest) that involved various inventories of different region of the country. However, the national inventories sometimes do not comprise all the territories and the surveys are undertaken by attempting different methodologies. Another problem is that a complete inventory, especially for big countries, requires time and substantial financial allocation. Often the inventories are interrupted for budgetary reasons.

The inventories are usually composed of a database that collect descriptive cards for each selected site. Analysing the myriad of different descriptive cards proposed in literature, it is possible to identify the sections that usually occur (Serrano and Gonzàlez-

Trueba, 2005; Reynard et al., 2007; Fuertes-Gutiérrez & E. Fernández-Martínez, 2010; Lima et al., 2010; IELIG, 2014). Two basic data sections which are always present in a descriptive card are: (i) general data and (ii) scientific-geological importance. The general and scientific characterisations are enough to characterize the sites from their geological interest. However, as mentioned in paragraph 2.5 'Geosites', the sites may have other kind of values, and thus, they can be used in further steps as part of a wider geoconservation strategy. Therefore, it is convenient to enlarge the characterisation and include the description of their (iii) additional value and the potential use (apart from the scientific one).

(i) General characterisation

The general characterisation of potential geosite aims at the collection of a set of wide-ranging data (Table 5.2).

Table 5.2: Summary of data collected in the general characterisation of sites.

General Characterisation	
Data	**Contents (e.g.)**
Geosite identification	identification code, name of the geosite, date of visit, identification of the proponent
Location	GPS coordinates, municipality, toponym or specific locality, position of the sites (inland or coastal)
Type of the site	distinguished by its geometrical characters
Dimension	size area in km², m², ha or ft²
Administrative status	identification of the owner (public or private)
Iconographic sources	maps or photos that show the site

Table 5.2 schematize the main data that are frequent in descriptive cards discussed in literature. According to Reynard et al. (2007), the location has also to report the minimum and maximum altitude of the site.Data related to type of site were well explained by

Fuertes-Gutiérrez & E. Fernández-Martínez (2010) who identified three types of geometrical characters: (i) points, small-size isolated single form or object (e.g., a sinkhole or a spring); (ii) linear, as sections or features having linear spatial development (e.g., a canyon or a chronological stratigraphical sequences); (iii) areal: a set of large simple landforms related to just one type of genetic process (e.g., a karren field).

(ii) Scientific-geological characterisation

This section is entirely focused on the scientific value of the site and its geological characteristics. It usually comprises a synthetical part and a descriptive text on the geological context. The synthetical part comprises the data summarised in Table 5.3. (García-Cortés et al., 1992; Alonso Herrero and Gallego Valcarce, 1995; Fuertes-Gutiérrez and E. Fernández-Martínez, 2010):

Table 5.3: Data collected on scientific characterisation.

Scientific Characterisation	
Main scientific interest	e.g. stratigraphy, marine geology, geomorphology, applied geology, hydrogeology, palaeontology, sedimentology, archaeology, mineralogy, geography
Secondary scientific interest	
Genesis	formation of the site, main lithology, morphogenesis
Integrity	state of conservation
Rareness	number of geosites in the study area presenting similar geological features
Representativeness	concerning the appropriateness of the geosite to illustrate a geological process or feature that brings a meaningful contribution to the understanding of

	the geological topic, process, feature, or geological framework
Scientific knowledge	based on the existence of scientific papers and dissertations about the site.
Grade of interest	international, national, regional, or local

(iii) *Additional information*

`The two fundamental sections described above are usually accompanied by other additional sections that help to have a holistic view of the sites. In order to save time and efforts, this additional section should be done at the same time as the general and scientific ones, since much information can be easily collected during the bibliographic review or on the field. The additional sections collect information about the natural, cultural, historical characteristic of the site and on its public use and management. The additional natural value comprises the possible important elements of biodiversity, including flora and fauna, and ecosystems that could be added to the geological importance.

Considering the literature (e.g. Grandgirard, 1996; Bruschi, 2007; Reynard et al., 2007; de Lima et al., 2010; Fuertes-Gutiérrez and E. Fernández-Martínez, 2010; Bilha, 2016; Randrianaly et al., 2016; Lima et al., 2018; Selmi et al., 2019) the additional information can be grouped into three main categories reported in Table 5.4. Reynard et al. (2007) proposed a final section called 'global value' as conclusion of the card that consists of a textual part that summarizes the central geological and additional values of the site, the natural and human threats, potential threats and references.

Table 5.4: Main categories of additional information described in descriptive card of sites.

Additional characterisation	
Contextual interest	it specifies the additional interest of the site (e.g. cultural, faunistic, floristique, educational, panoramic, historical, archaeological, architectural, touristic)
Public use	e.g. position of the site, accessibility, presence of services, visibility, safety, current use
Management information	the legal protection of the site, the need of protection, the presence of infrastructure to protect the site and presence of interpretative centre.

Randrianaly et al. (2016) also propose legends/folks paragraph to stories, anecdotes, myths and legend drawn primarily from the site/area, considered part of the intangible cultural heritage. The contextual interest, mainly the cultural-historical value and the natural value, could make the site more attractive to tourist and educational activities.

Serrano et al. (2005) added to the two fundamental sections another part that defines the 'uses' of the site that comprises different kind of information as cultural content, accessibility, level of interest, state of conservation, current uses, infrastructures, impacts and legal status. In particular cases, the descriptive cards are more comprehensive and include a section of the state of conservation, as in the United States (Bostick et al., 1975), Australia (Duque et al., 1979), Valle del Tevere, in Italy (Casto & Zarlenga, 1992), Switzerland (Strasser et al., 1995), or in the Italian regions of Modena (Bertacchini et al., 1999) and Emilia-Romagna (Bertacchini et al., 2003; IELIG, 2019). Some authors as Cendrero (1996), Bruschi & Cendrero (2005), Bruschi et al. (2011) claim that the cards must also show the fragility and vulnerability of the sites of interest. More recent descriptive cards consider also the natural and human potential and existing threats, helpful to provide a correct management of the area. These demands are met in the inventories proposed by Italy (ISPRA, Brancucci & Burlanco, 2001), by the Spanish regions of Catalonia (Druguet et al., 2004; Herrero et al., 2004), Andalusia (Villalobos et

al., 2004; Jódar et al., 2012), by the Basque Country (Mendía et al., 2010; 2013), and France (De Wever et al., 2006).

5.3.2 Descriptive card proposed

The analysis of national inventories comprising different descriptive cards has led to the production of a descriptive card to depict the potential geosites evaluated for the present research.

The descriptive card proposed is formed by 4 sheets.

The first sheet reports all the generic information of the site as location, size area, type of site and property (Figure 5.4). An iconographic source is also present on the first sheet.

General Data:

Date of visit		
Compiler		
Name of site		
Location	coordinates	
	inland	coastal
	municipality	
	city/community	
Type	punctiform	
	linear	
	areal	
Size area		
Property	private	
	public	
	association	

Pictures of the site

Figure 5.4: Sheet number 1 of the descriptive card: General Data.

The second page is entirely dedicated to the scientific value, the main geological interest of the site and the possible second ones, the state of conservation, rareness, representativeness and scientific notoriety. A brief descriptive data on the lithology, morphology and geological evolution of the site closes the scientific section (Figure 5.5).

Scientific value

Scientific interest			Level			
	Principal	Secondary	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology						
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Figure 5.5: Sheet number 2 of the descriptive card: Scientific value.

Sheets number 3 and 4 are designed to collect any other secondary information of the site: the possible additional value, its used value and management information (Figure 5.7). It also comprises a blank space for supplementary information on the site that does not fit in the mentioned sections.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
easy	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	
equipper for people with physical deficit, elderly and infants	

Figure 5.6: Sheet number 3 of the descriptive card: Additional and Use value.

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World Heritage Site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Figure 5.7: Sheet number 4 of the descriptive card: Management value and References.

The compilation of the additional sections helps to have a holistic view of the site, in order to connect the geological heritage with all the other aspects of the area's natural cultural heritage, as required by the UNESCO guidelines for the application as UNESCO Global Geopark.

5.4 Preliminary selection of potential geosites

The procedures for the recognition of geosites are always described in literature, but there is another optional step before the assessment of potential geosites: the preselection. Most of the time, papers do not present a preselection, whilst others incorporate the preselection during the recognition procedure and the details are generally not clear, making it difficult to fully understand the procedures and to replicate the method. The preselection data are useful when used for a large area with

a high number of sites, in helping to exclude from the list of potential geosites the sites that present similarities and to focus the assessment on a restricted number of sites. In the present thesis, it was decided to implement a preselection, separated from the recognition and assessment steps, in order to get more transparency in the selection of potential geosites, to minimize the subjectivity and to focus the assessment only on a list of potential geosites worthy of recognition. To carry out a preliminary selection, it is important to determine principal categories as stressed by Brilha et al. (2005), Pereira et al. (2007) and de Lima et al. (2010) and who divided the potential geosites recognised accordingly. The categories are defined due to the bibliography review and they usually refer to the main scientific interest of the sites or the geological frameworks based on Earth sciences domains (Reynard, 2016).

In this work the five following categories of interest were considered (Figure 5.8): 1) structural geology, 2) stratigraphy, 3) geomorphology 4) palaeontology, 5) human activity.

For the category 'geomorphology' different sub-categories have been assigned to the sites considering the main geomorphological processes that act in the study area: a) gravitational, b) marine, c) karstic, and d) fluvial.

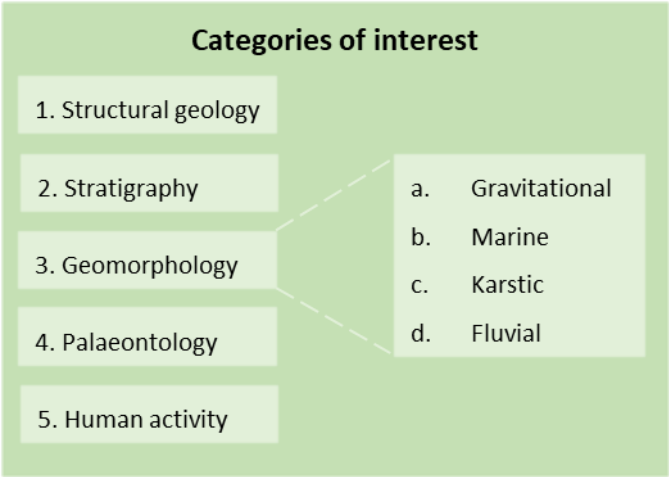


Figure 5.8: Categories of interest and related sub-categories.

Once the potential geosites are divided into their respective categories, a qualitative evaluation process is carried out in order to choose the best examples for each category.

The qualitative assessment is based on two set of criteria (Figure 5.9) described as follows (Reynard, 2016):

- the sites have to be representative of the geo-history and geomorphological evolution of the study area at a regional scale. Both active and inherited geological and geomorphological features can be considered as potential geosites;

- the sites have to represent the regional geo(morpho)diversity, i.e. a complete set of geomorphological processes that acted over time in the study area. Unique or rare landforms as well as more common and abundant ones can be useful to provide an overview of the landforms visible in the area.

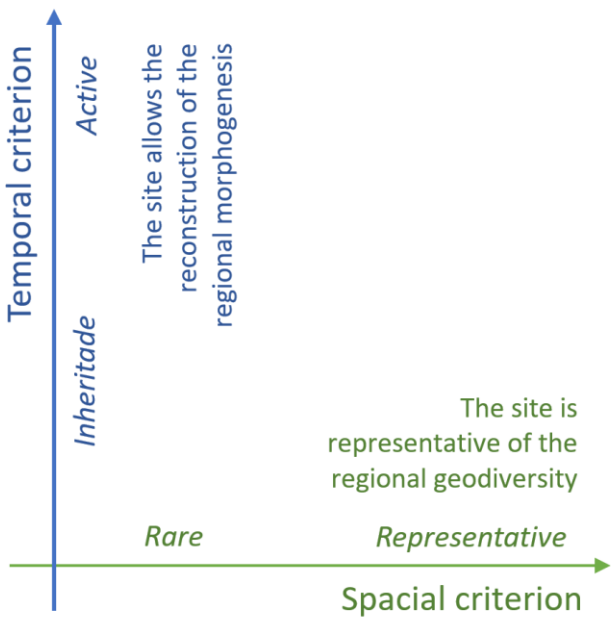


Figure 5.9: Preselection process based on two criteria (modified from Reynard et al., 2016).

In order to facilitate the evaluation, a score has been given to the representativeness, the rareness and the integrity of the sites. The score comprises a number from 1 to 4, with 1 as low representativeness / rareness / integrity and 4 as high representativeness / rareness / integrity (Figure 5.10).

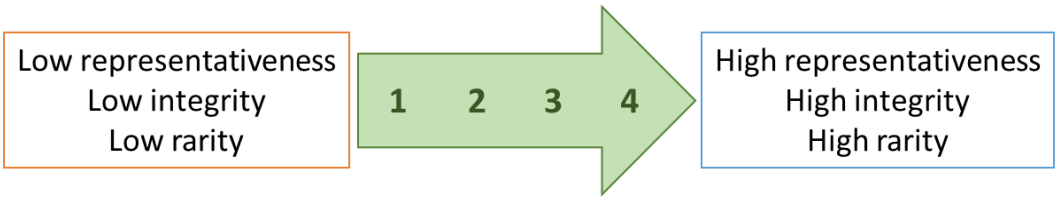


Figure 5.10: Preliminary qualitative selection of potential geosites.

For each category the sites that reach the highest score have been preselected. The high score in integrity was decisive for the preselection between two sites with same high score in representativeness and rarity.

5.5 Assessment and selection of geosites

Among the myriad of sites of the Earth's surface, there are a limited number of elements with one or more high value(s) (Brilha, 2018).

During the last three decades, the growing interest in geoheritage has led to the development of methodologies for its recognition, assessment and conservation (Carton, 1994; Reynard, 2016; Reynard and Brilha, 2018 and reference therein). Several methods are described in literature for the recognition and assessment of geoheritage in various context (cf. Reynard, 2009; Reynard et al, 2013): inventory of natural heritage sites (e.g. Lima et al., 2011; Fuertes-Gutiérrez and Fernández-Martínez, 2011; García-Cortés et al., 2014); territorial planning and Environmental Impact Assessment (EIA) (e.g. Barba et al., 1997; Rivas et al., 1997; Coratza et al., 2005; Bruschi and Cendrero, 2005); management of protected areas and natural parks (e.g. Zouros, 2007; Fassoulas et al., 2012; Coratza et al., 2019); tourist promotion (e.g. Pralog, 2005; Vujicic et al., 2011; Pereira and Pereira, 2012; Kubalíková, 2013; Corbí er al., 2018). In general, it should be emphasized that all the methods proposed inevitably imply a degree of subjectivity since their intrinsic value cannot be measured (Selmi et al., 2019). In order to properly evaluate the various components of geoheritage and to minimize the subjectivity, it is necessary to define clear and transparent criteria, functional to the aim and the study area of concern.

In view of this, the establishment of a well-structured systematic inventory is fundamental in order to identify those special elements selected for protection, especially if they are rare and representative of the Earth's history.

The aim of the inventory and assessment of geoheritage have to be clear, taking into consideration the following four issues (Lima et al., 2010; Brilha, 2018):

1. the topic: what is the topic of the inventory? The focus will be different if the topic is the geological heritage as a whole or if it is focused on a specific heritage such as paleontological, geomorphological or stratigraphical. It defines the choice of the methodology and restricts an area which is examined.
2. the scale: the scale is one of the most important considerations for a geosite inventory, that reflects also the purpose of the inventory and the level of detail required. The scale refers to the size of the study area. Generally, the highest number of geoheritage inventories with different purposes (scientific, geotourism and geoconservation) have been created for restricted areas as regions or national parks (e.g. Coratza et al., 2011; Fuertes-Gutiérrez and E. Fernández-Martínez, 2012; Del Monte et al., 2013). If the inventory will take place over a large area as a state or a whole country, it could be helpful to select geological frameworks to subdivide the area and consider all the sites;
3. the value: from the abundant potential geosites in a study area, only a few should be selected and included in the inventory. Through the assessment of sites value it is possible to select which sites are more exceptional than others. The values that can be assessed with the different methodologies refer to the geosites values reported in paragraph 2.5. The most widely values assessed in geoheritage inventories are: scientific, touristic, educational, aesthetic and cultural.
4. the scope: this last fundamental issue answers the following question: what is the purpose of this inventory or assessment? The outcome could be to support a national geoconservation strategy, to promote geotouristic activities and to develop educational project focused on geoheritage. The definition of the inventory scope does not exclude the other standpoints, but emphasis would be put on the main purpose (Vereb et al., 2020). For the variety of typical inventory

scope implemented by private or public institutions, the following ones are the most common:

(i) geoconservation, inventory based on the implementation of strategies of conservation and management of geosites;

(ii) geotourism, inventory focused on the touristic potential of geosites and their possible economic value;

(iii) geoeducation, inventory focused on the educational value of the geosites, their use in educational activities and for popularization of geosciences.

A clear definition of the inventory aim is essential to build a solid inventory that will facilitate the subsequent steps. Once the aim of the inventory is clarified, the next step is to draw up a list of potential geosites. It is obtained from a literature review of all geological data published about the study area, considering geological maps, scientific papers, reports and other useful documents. The literature review is important to gather knowledge about the geological setting of the area and to set up a list of potential geosites referenced in the literature, such as sites where relevant data were obtained, stratotypes, stops of scientific fieldtrips and key outcrops of certain formations. The successive step consists of field visit aimed to identify and characterise all the sites included in the list of potential geosites. During the field visits, the list can be enriched with the recognition of new potential geosites not mentioned in the reviewed literature. Each potential geosite must be qualitatively evaluated using the following criteria: representativeness, integrity, rarity and scientific knowledge. At this stage some potential geosites can be removed from the list because they do not comply with these criteria. The bibliography review combined with field visit leads to a list of potential geosites in the study area that better represent a certain geological material or process, that are in the best possible conservation status, that show rare features, and where significant scientific data have been obtained and published (Brilha, 2018). However, the last criterion is sometimes considered additional due to the fact it can occur in a site with high scientific value but without any existing or detailed bibliography.

The assessment of potential geosites is a crucial task to establish ranks according to their value and identify a final list of geosites. Due to the increase in geoheritage recognition and conservation studies, several methods of geosites assessment have been published since the 1990s. In fact, it is possible to state that there is not one widely accepted or the best method to assess geosites, and the criteria used to decide whether or not to include geosites in the assessment are manifold (Mucivuna et al., 2019). The different methods reflect the type of research, the aim and the application context.

5.5.1. Qualitative and quantitative methods

The assessment methods are based on different criteria and parameters. Ranking methods used for assessing geosites can be grouped into two main categories: qualitative (e.g. Sharples, 1995; Gray, 2008; Panizza, 2009; Gordon et al., 2012; Kale, 2015) and quantitative (e.g. Bruschi and Cendrero, 2005; Serrano, E. and Gonzàlez-Trueba, 2005; Coratza et al., 2011; Pereira et al., 2013; Melelli, 2014; Silva et al., 2013, 2015).

Qualitative methods are based on site description without setting points or scores. The assessment is conducted by an expert or an expert's group. Their advantage are their expedience and simplicity, but a main disadvantage is their subjectivity. In fact these methods are sometimes considered unclear and ambiguous since they are based only on an expert judgement (Watson and Slaymaker, 1966; Crowther and Wimbledon, 1990; Sharples, 1995; Bertacchini et al. 1999; Reynolds, 2001).

Quantitative methods are based on the measurement of specific features. They are characterised by a series of parameters that are used for the description of sites and evaluated separately, usually using numerical ranks. Once the scores are obtained, different procedures are adopted to integrate individual parameter values into site's values (Cendrero 1996; Rivas et al., 1997; Barba et al. 1997; Bruschi and Cendrero 2005; Carcavilla Urquí et al. 2007; Pereira et al. 2007; Gray, 2013; Brilha, 2016). This type of procedure allows different operators to replicate the method and obtain similar results with transparency and reduction of subjectivity (Bruschi, 2011). Quantitative methods do not require more than one expert because they are based on objective parameters.

Their main disadvantage is that they require more time and effort due to their complexity.

However, quantitative methodologies are more operationally accepted and useful, especially for the preparation of management plans, due to their high grade of objectivity and transparency (Bruschi and Cendrero, 2005).

Both qualitative and quantitative methodologies can respond to different purposes and are applied at different scale and morphoclimatic contexts. Most of them are primarily focused on the assessment of the scientific value of geosites and are addressed to professionals in the field of geology, geomorphology, geoheritage protection and conservation (Štrba et al., 2018). Recent methodologies are designed for conservation or touristic-educational purpose, thus they mainly assess educational and touristic potential of the geosites (e.g. Panizza and Piacente, 2009; Kubalíková, 2013; Kubalíková and Kirchner, 2016). Specific methodologies were simply adapted for particular features of the geological heritage: an example is the research conducted by Rovere et al. (2010) that developed a methodology for the assessment of the submarine geological heritage. Zouros (2005, 2007) presented a method for the scientific assessment of coastal geomorphosites in Lesvos Petrified Forest Geopark (Fassoulas et al., 2012). The geomorphological heritage is often considered separately from the generic geoheritage and several methodologies were proposed for its assessment, as described in detail in paragraph 5.2.2.

5.5.2. Assessment of geomorphosites

In the last few decades, assessment methods have been increasingly developed to the measurement of specific geomorphological features of geoheritage. Geomorphological sites (Hooke, 1994), better known as geomorphosites (Panizza, 2001), are often considered peculiar types of geosites by three main characteristics (Mucivuna et al., 2019): the aesthetic dimension, the dynamic dimension and the imbrication of scale (Reynard, 2009b; Coratza and Hobléa, 2018). For these reasons, scientists have designed several methodologies to assess the geomorphological heritage (Reynard and Coratza,

2013; Nesci et al., 2005). Also in this field qualitative and quantitative methodologies have been proposed. Both qualitative and quantitative methods should be clear about the parameters and criteria which allow them to be replicated by other researchers, but quantitative methods are considered more focused on reducing the weaknesses associated with overlapping criteria and with the lack of clarity of some criteria. Some methods are based on the restrictive definition of geomorphosites and evaluate exclusively the scientific value from the geomorphological point of view (Grandgirard, 1999). Others are based on a broader definition under which the geomorphosites are evaluated based on human perception or exploration (Panizza and Piacente, 1993; Panizza, 2001) and assess three main groups of values: scientific, additional and use (Coratza and Hobléa, 2018). The methods in literature present several combinations of values as reported in Table 5.2 (Mucivuna et al., 2019).

Table 5.2: Values considered for the assessment of geomorphosites, according to different authors.

Values considered	Authors
Scientific + Additional	Reynard et al. 2007, 2016; Comănescu and Nedelea 2010; Feuillet and Sourp 2011; Niculi ţă and Mărgărint 2018
Scientific + Use	Bosson and Reynard 2012; Del Monte et al. 2013; Pica et al. 2017; Zgłobicki et al. 2018
Scientific + Additional + Use + Management	Serrano and González-Trueba 2005; Zouros 2005, 2007; Comănescu et al. 2012
Scientific + Use + Protection	Coratza et al. 2011; Warowna et al. 2014
Scientific + Additional + Use + Protection	Pereira et al. 2007; Pereira and Pereira 2010; Kubalíková and Kirchner 2016

As reported in Table 5.2, the scientific value is always considered on the geomorphological assessment and has a central role. With regard to additional values, ecological, cultural, aesthetic and economic aspects were the ones most frequently evaluated (Mucivuna et al., 2019). According to a recent work conducted by Mucivuna et al. (2019) on papers on geomorphosites assessment, the main objective of the study is clearly described, but the description of procedures to assess geomorphosites is often

not sufficient to avoid subjectivity, due to most authors failing to explain how the selection was made and which criteria were applied. Most of the geomorphosites assessments are mainly designed to promote tourism, and for a smaller percentage the main objective is the valorisation and promotion and scientific use. Analysing the literature, the most widely used methods to assess the geomorphosites are those of Pralong (2005), Serrano and González-Trueba (2005), Pereira et al. (2007) and Reynard et al. (2007), Erhartič (2010), Ilinca and Comănescu (2011), Coratza et al. (2011), Kubalíková (2013), Maghsoudi and Rahmati (2018) and Safarabadi and Shahzeidi (2018).

5.5.3. Quantitative methods analysis

In the present thesis it was decided to apply quantitative methods since the use of a systematic and well-structured method with transparent criteria is generally preferred by the scientific community for their objectivity. A detailed review on quantitative assessment methods has been conducted and scientific papers were analysed. Nowadays, several similar assessment methodologies, which differ in assessment criteria, are used. In most of the cases new methodologies are developed based or inspired by previous ones, leading to the creation of a large number of similar methodologies. Table 5.3 gives a brief review of some of the most cited quantitative methodologies used for geosite assessment. This table is not intended to be a comprehensive compilation, but merely an example of quantitative valuation methodologies and the criteria considered from European and American authors (in particular by Brazil, France, Greece, Italy, Spain and United Kingdom) (García-Cortés et al., 2019). Some of the mentioned approaches (Pereira et al., 2007; Reynard et al., 2007) were originally proposed to evaluate geomorphosites, but they can be easily applied to geosites assessment as well.

From the analysis of the methods is possible to state the following considerations. The first criteria assessed is always the scientific importance and the most relevant parameters frequently used to establish the scientific value of a particular site are:

representativeness, rareness, integrity, level of scientific knowledge, geological diversity, paleogeo(morpho)logical importance and exemplarity.

The additional value is defined by UKRIGS (2001) as the 'cultural and economic value' of the site, considering the association of the geological value with elements of the cultural and historical heritage and the potential economic interest. Most commonly, the additional value comprises also the aesthetical, biological and ecological relevance of the site. The association with natural and cultural values is sometimes comprised in the assessment of the scientific value (e.g., Bruschi and Cendrero, 2005; De Wever et al., 2006). A third criteria is the use value or potential use that usually comprises accessibility, visibility, potential use for educational and touristic activities, presence of infrastructure, equipment and support services, annual number of visitors, attractiveness, economic potential and products. The protection value (Pereira and Pereira, 2007) mainly concerns the vulnerability, fragility, level of protection, existing or potential threats or impacts, and integrity of the site. This value is usually incorporated in the potential use (Lima et al, 2010), but in recent assessments it is considered as a separate criterion (e.g. Degradation risk by Brilha, 2016).

Tabella 5.3: Criteria and parameters used for the geosites assessment, according to different authors (modified by García-Cortés et al., 2019).

JNCC (1993)	**Scientific value**			
	representativeness			
	rarity			
	type locality or historical locality			
UKRIGS (2001)	**Scientific value**	**Cultural and economic value**	**Accessibility and safety**	
	representativeness	historical site of science	roads and parking	
	rarity	scenic value	safe access to the site	
		association with cultural value	safe to use	
		economic geology of interest	need of authorizatio n	
			visibility	

Bruschi and Cendrero (2005)	**Scientific Value**	**Potential Use**		
	type locality	potential for activities		
	rarity	visibility		
	representative as a model	accessibility		
	association with other natural heritage	logistic infrastructures		
	extent	extent		
	scientific knowledge	social and economic context		
	geological diversity			
	age			
	association with cultural value			
	state of conservation			
De Wever et al. (2006)	**Heritage value**			
	primary geological interest			
	secondary geological interest			
	educational interest			
	geohistorical interest			
	rarity			
	state of conservation			
	additional cultural or ecological interest			
Pereira et al. (2007)	**Scientific value**	**Additional value**	**Use value**	**Protection value**
	rareness in relation to the area	cultural	accessibility	integrity
	integrity	aesthetic	visibility	vulnerability
	representativeness	ecological	present use	
	number of geomorphological features		legal protection	
	other geological features		equipment and support services	
	scientific knowledge			

	rareness at national level			
Reynard et al., (2007)	**Scientific value**	**Additional value**		
	integrity	ecological value		
	representativeness	aesthetical value		
	rareness	cultural value		
	paleogeographical model	economic value		
GarcíaCortés & Carcavilla (2009)	**Scientific value**	**Educational value**	**Recreational value**	
	representativeness	educational potential	extent	
	type locality	logistic infrastructure	potential for public outreach	
	scientific knowledge	population density	recreational potential	
	state of conservation	accessibility	proximity to recreational areas	
	visibility	association with ecological and cultural value	visibility	
	geological diversity	scenic/aesthetic value	social and economic context	
De Lima et al. (2010)	**Scientific value**	**Educational and touristic potential use**		
	representativeness	representativenes s		
	integrity	quality of the exposure		
	scientific relevance	diversity at the state level		
		educational potential		
		logistics		
		population density		
		accessibility		
		vulnerability caused by human activities		
		monumentality		

		recreational potential		
		social setting		
		proximity to recreational facilities		
Coratza et al. 2012	**Scientific value**	**Additional value**	**Use value**	
	paleogeomorpholoical model	ecological role support	accessibility	
	rareness	panoramic quality	visibility	
	representativeness	colour diversity	services	
	integrity	vertical development	importance for education	
		naturalness		
		religious importance		
		historical importance		
Fassoulas et al. (2012)	**Scientific value**	**Additional**	**Potential for use**	
	representativeness	ecological impact	intensity of use	
	geological diversity	protection status	impacts	
	rarity	cultural value	fragility	
	integrity	aesthetic value	accessibility	
	geological history	economic	acceptable changes	
Fuertes (2013)	**Scientific/intrinsic value**	**Potential use**		
	representative of regional geology	potential use		
	rarity	visibility		
	relevance	accessibility		
	representative as a model	extent		
	geological diversity	land ownership		
	state of conservation	state of conservation		
	aesthetical or scenic value	association with ecological and cultural value		
	geohistorical value	educational potential		

		accessible for disable people	

	Scientific/ intinsic value	Educational value	Economical value	Conservation value	Added value
Kubalíková and Kirchner (2016)	rarity	exemplarity	number, distance and quality of services	conservation activities	cultural
	scientific knowledge	representativeness	accessibility	risks and threats	ecological
	morphology	presence of educational facilities		current status	aesthetic

5.5.4. Applied quantitative methodologies

From the analysis of quantitative assessments, universally adapted for various scales and purpose, two distinct methods were chosen and used in the study area of the present thesis. The two methods were applied in parallel, and their results were compared in order to give an overview of their performance and reduce to the minimum the assessments' subjectivity. The two methods chosen are Reynard et al. (2007) and Brilha (2016). The two methods were compiled with the intention of synthetizing previous assessment techniques. Being both quantitative methods, they are based on a reasonable number of parameters and indicators. Both methods can be easily undertaken, are repeatable and obtained results can be well summarized in textual and visual form for comparative purposes. The majority of the indicators of both methodologies are not scale dependent and thus they can be used in different geological and geomorphological contexts (Vereb et al., 2020). However, the first method was applied directly to the sites, the latter was adapted considering the characteristics of the study area.

Methodology 1: Reynard et al. (2007)

The Reynard et al. methodology was originally designed to assess geomorphosites, but could be easily adapted to general geosites assessment. The methodology was chosen due to the fact that it is clear and already tested and used as a base for different methods by several authors (Coratza et al., 2011; Pererira et al., 2012). The geosites assessment is

based on 13 criteria divided into two main groups of values: Scientific Value (SV), the central one, and Additional Value (AV), always assessed numerically. Each criterion is ranked from zero to one point, considering also the intermediate scores 0.25, 0.5, 0.75. The sub-criteria are averaged using an arithmetic mean (Table 5.6).

Table 5.6: Criteria and parameters according to Reynard et al. 2007

Scientific value SV = (a+b+c+d)/4		a) integrity
		b) representativeness
		c) rareness
		d) paleogeographical value
Additional value AV = (ECO+AEST+CULT+ECON)/4	ecological value (ECO)	ecological impact
		protected site
	aesthetical value (AEST)	view point
		vertical development
	cultural value (CULT)	religious importance
		historical importance
		artistical importance
		geohistorical importance
	economic value (ECON)	economic products

The scientific value aims to reveal the value of the site for the geosciences and it incorporates four parameters proposed by Grandgirard (1999): rareness, representativeness, integrity and palaeogeographic value. This last parameter is meant to encourage greater sensitivity of analysis in terms of Earth and climate history (Reynard et al., 2007).

The additional value is linked to the importance that a geosite assumes for its non-geological aspects and as result, there is an increase in its overall value. It is made up of four independent sub-values: ecological, aesthetic, cultural and economic value. The ecological sub-value takes into consideration the presence of a particular fauna and vegetation, the development of a particular ecosystem on the site and the protection status of the site. The latter would consider if the site is already protected in a national inventory, on a local level or not subject to protection. The ecological value corresponds to the arithmetical mean of these two criteria.

The aesthetic value comprises the visibility of a site (viewpoint) and its landscape perception (Droz and Miéville-Ott, 2005). A higher score is given to the sites with a vertical development, with colour contrasts (e.g. contrasts due to lithological changes) or with spatial structures (e.g, braided rivers, landslides). The aesthetic value corresponds to the arithmetical mean of the two criteria (Reynard et al., 2007).

The cultural value is a heterogeneous criterion made up of four independent sub-criteria: religious importance, historical importance, artistic importance and geohistorical importance (Lugon and Reynard 2003, Reynard, 2007). The total score value corresponds to the arithmetical mean of these four sub-criteria.

The economic value considers the income produced by the site based on the number of the visitors (direct or indirect connected with the geological heritage) and the products generated by the site.

Methodology 2: Brilha (2016)

The methodology based on Brilha (2016) is articulated in several criteria, indicators, and parameters, that makes it one of the most objective and detailed evaluation. The original method proposed by the author comprises four main values: scientific value, educational potential use, touristic potential use and degradation risk. In the present Thesis, the original methodology was modified, in particular: (i) the educational and potential use value was combined with the touristic potential use value; this merge led to a unique resulting value that can be compared with the additional value score obtained from the Reynard methodology; (ii) the degradation risk assessment was not included: this topic will be discussed in detail in the next chapter.

Other changes have been done in order to adapt indicators and parameters on the particular study area.

As a result, the methodology applied on the Maltese potential geosites comprises two assessments:

- Quantitative assessment of scientific values; seven criteria have been considered: representativeness, key location, scientific knowledge, integrity, geological diversity, rarity and use limitation. Each indicator is marked on a scale from one to four, with

two remarks set by the author: score three is omitted in order to better distinguish the score four from lower scoring ones, and an indicator can also be ranked zero if appropriate. Points in accordance with the indicators are reported in Table 5.7. The total scientific value corresponds to a weighed sum of all criteria considered. Different weight has been given to the different criteria, based on their relative importance. According to Brilha (2016), representativeness is considered the most important criterion (30%), followed by the key locality (20%). Integrity and rarity are weighted 15% and the use limitation 10% of the total score. The geological diversity and scientific knowledge criteria are weighted only 5% each, not because they are considered less important, but for the following considerations: a site located in an area with low geological diversity could have a higher scientific importance; similarly, the inexistence of scientific publications about a certain geosite does not necessarily represent a low scientific value. It may just mean that no studies have yet been conducted or published.

- Quantitative assessment of educational and touristic potential use. The first related to the capacity of geological features to be easily understood by students of different educational levels, the second considers the remarkable additional relevance of the site and the potential to be easily understood by the public with no scientific background. Each criterion is scored from one to four according to the indicators reported in Table 5.8. Zero can be given to any criterion if needed. Several indicators were also modified in order to adapt the general methodology proposed by Brilha to the scale and to the characteristics of the study area. The final educational potential use is the weighted sum of all 12 criteria.

The weights assigned to the different criteria of scientific and educational and touristic values are reported in Table 5.9, following the ones proposed by the author.

Table 5. 7: Criteria and indicators used for the quantitative assessment of the scientific value (modified by Brilha, 2016).

Scientific Value		
Criteria	**Indicators**	**Score**
Representativeness	The geosite is the best example in the study area to illustrate elements or processes, related with the geological framework under consideration (when applicable)	4
	The geosite is a good example in the study area to illustrate elements or processes, related with the geological framework under consideration (when applicable)	2
	The geosite reasonably illustrates elements or processes in the study area, related with the geological framework under consideration (when applicable)	1
Key locality	The geosite is recognised as a GSSP or ASSP by the IUGS or is an IMA reference site	4
	The geosite is used by international science, directly related with the geological framework under consideration (when applicable	2
	The geosite is used by national science, directly related with the geological framework under consideration (when applicable	1
Scientific knowledge	There are papers in international scientific journals about this geosite, directly related with the geological framework under consideration (when applicable	4
	There are papers in national scientific publications about this geosite, directly related with the geological framework under consideration (when applicable	2
	There are abstracts presented in international scientific events about this geosite, directly related with the geological framework under consideration (when applicable)	1
Integrity	The main geological elements (related with the geological framework under consideration, when applicable) are very well preserved	4
	Geosite not so well preserved, but the main geological elements (related with the geological framework under consideration, when applicable) are still preserved	2
	Geosite with preservation problems and with the main geological elements (related with the geological framework under consideration, when applicable) quite altered or modified	1
Geological diversity	Geosite with more than three types of distinct geological features with scientific relevance	4
	Geosite with three types of distinct geological features with scientific relevance	2
	Geosite with two types of distinct geological features with scientific relevance	1

Rarity	The geosite is the only occurrence of this type in the study area (representing the geological framework under consideration, when applicable)	4
	In the study area, there are two to three examples of similar geosites (representing the geological framework under consideration, when applicable)	2
	In the study area, there are four to five examples of similar geosites (representing the geological framework under consideration, when applicable)	1
Use limitations	The geosite has no limitations (legal permissions, physical barriers,…) for sampling or fieldwork	4
	It is possible to collect samples and do fieldwork after overcoming the limitation	2
	Sampling and fieldwork are very hard to be accomplished due to limitations difficult to overcome (legal permissions, physical barriers,…)	1

Table 5.8: Criteria, indicators, and parameters used for the quantitative assessment of the potential educational and touristic uses (modified by Bilha, 2016).

Educational and Touristic potential Use		
Criteria	**Indicators**	**Score**
Vulnerability	The geological elements of the geosite present no possible deterioration by anthropogenic activity	4
	There is the possibility of deterioration of secondary geological elements by anthropogenic activity	3
	There is the possibility of deterioration of main geological elements by anthropogenic activity	2
	There is the possibility of deterioration of all geological elements by anthropogenic activity	1
Accessibility	Site located less than 100 m from a paved road and with bus parking	4
	Site located less than 500 m from a paved road	3
	Site accessible by bus but through a gravel road	2
	Site with no direct access by road but located less than 1 km from a road accessible by bus	1
Use limitations	The site has no limitations to be used by students and tourists	4
	The site can be used by students and tourists but only occasionally	3
	The site can be used by students and tourists but only after overcoming limitations (legal, permissions, physical, tides, floods, …)	2

	The use by students and tourists is very hard to be accomplished due to limitations difficult to overcome (legal, permissions, physical, tides, floods, …)	1
Safety	Site with safety facilities (fences, stairs, handrails, etc.), mobile phone coverage and located less than 5 km from emergency services	4
	Site with safety facilities (fences, stairs, handrails, etc.), mobile phone coverage and located less than 25 km from emergency services	3
	Site with no safety facilities but with mobile phone coverage and located less than 50 km from emergency services	2
	Site with no safety facilities, no mobile phone coverage and located more than 50 km from emergency services	1
Logistics	Lodging and restaurants for groups of 50 persons less than 15 km away from the site	4
	Lodging and restaurants for groups of 50 persons less than 50 km away from the site	3
	Lodging and restaurants for groups of 50 persons less than 100 km away from the site	2
	Lodging and restaurants for groups less than 25 persons and less than 50 km away from the site	1
Density of population	Site located in a municipality with more than 1000 inhabitants/km²	4
	Site located in a municipality with 250-1000 inhabitants/km²	3
	Site located in a municipality with 100-250 inhabitants/km²	2
	Site located in a municipality with less than 100 inhabitants/km²	1
Association with other values	Occurrence of several ecological and cultural values less than 5 km away from the site	4
	Occurrence of several ecological and cultural values less than 10 km away from the site	3
	Occurrence of one ecological value and one cultural value less than 10 km away from the site	2
	Occurrence of one ecological or cultural value less than 10 km away from the site	1
Scenery	Site currently used as a tourism destination in national campaigns	4
	Site occasionally used as a tourism destination in national campaigns	3
	Site currently used as a tourism destination in local campaigns	2
	Site occasionally used as a tourism destination in local campaigns	1

Uniqueness	The site shows unique and uncommon features considering this and neighbouring countries	4
	The site shows unique and uncommon features in the country	3
	The site shows common features in this region, but they are uncommon in other regions of the country	2
	The site shows feature rather common in the whole country	1
Observation conditions	All geological elements are observed in good conditions	4
	There are some obstacles that make difficult the observation of some geological elements	3
	There are some obstacles that make difficult the observation of the main geological elements	2
	There are some obstacles that almost obstruct the observation of the main geological elements	1
Geological diversity	More than 3 types of geodiversity elements occur in the site (mineralogical, palaeontological, geomorphological, etc.)	4
	There are 3 types of geodiversity elements in the site	3
	There are 2 types of geodiversity elements in the site	2
	There is only 1 type of geodiversity element in the site	1
Interpretative potential	The site presents geological elements in a very clear and expressive way to all types of public	4
	The public needs to have some geological background to understand the geological elements of the site	3
	The public needs to have solid geological background to understand the geological elements of the site	2
	The site presents geological elements only understandable to geological experts	1
Proximity of recreational areas	Site located less than 5 km from a recreational area or tourist attraction	4
	Site located less than 10 km from a recreational area or tourist attraction	3
	Site located less than 15 km from a recreational area or tourist attraction	2
	Site located less than 20 km from a recreational area or tourist attraction	1
Didactical potential	The site presents geological elements that are taught in all teaching levels	4
	The site presents geological elements that are taught in elementary schools	3
	The site presents geological elements that are taught in secondary schools	2

	The site presents geological elements that are taught in the university	1

Table 5.9: Weights for the different criteria used for the assessment of the scientific value (left side) and the educational and touristic potential use (right side) of the potential geosites.

Scientific value	
Criteria	**Weight (%)**
Representativeness	30
Key location	20
Integrity	15
Rarity	15
Use limitation	10
Geological diversity	5
Scientific knowledge	5
Total	100

Educational and touristic potential use	
Criteria	**Weight (%)**
Vulnerability	10
Accessibility	10
Use limitation	5
Safety	10
Logistics	5
Density of population	5
Association with other values	5
Scenery	5
Uniqueness	5
Observation conditions	10
geological diversity	10
interpretative potential	10
Proximity of recreational areas	5
Didactical potential	5
Total	100

Once assessed the potential geosites, the scores obtained were fundamental to select the geosites. The scores obtained from the two different methodologies were uniformed in order to compare the results. The sites that reached value more than 60/100 on scientific value in both the methodologies were selected as geosites.

At this stage, the sites that present a scientific value lower than 60/100, but an additional value higher than 60/100 in both the methodologies were considered as geodiversity sites.

5.6 Degree of interest of geosites

In 2015, with the adoption of the designation Global UNESCO Geopark, the geopark must comprise at least one geosite of international relevance. For this reason, in the

present thesis it was decided to define the degree of interest of the geosites selected. How it is possible to define the degree of interest of one geosite with respect to another is a current topic of debate in the geoheritage world.

In 2017 the Working Group on Geoheritage Assessment (IUGS) tried to produce guidelines to assess sites with international significance and help the geopark's evaluators, but the results remain unpublished to date. In literature, there is no tested methodology in order to assess the degree of importance of the geosites, but it is agreed that the expression "geoheritage with international significance" means international significance of the scientific value of geoheritage.

In national surveys and scientific studies, the geological significance is usually classified as local, national and international. The international relevance is usually considered for outstanding sites, which are rare or better represent an important step in the history of geoscience and which improve the understanding of the Earth, including its dynamic processes, climate, and the history of life.

Regarding the national relevance, Fuertez-Gutierrez and Martinez (2010) proposed to consider sites which are included in any national protected area with the same category. In other cases, experts must grade the interest of each element, considering their rarity and representativeness at national level.

Local relevance is assigned for sites that are representative or rare, not on a national level, but rather on a smaller scale.

Some early studies on the degree of interest were conducted by García-Cortés et al. (1992) and Alonso Herrero and Gallego Valcarce (1995), that also introduced the term of regional significance. The term 'regional' is considered in different ways with respect to the scale of the study area. According to White and Mitchell (2006), in their study conducted in the whole Australia, the regional significance includes landforms or geological features representative of regions of about 60km radius, but within the same country. In other investigations, the regional significance is used to identify sites belonging to different countries, but share a similar morphoclimatic context, for example the Mediterranean region in Europe.

One of the most detail assessments on the degree of interest has been done by Geological Society of Australia that classified the geosites in five different categories: international, national, regional, local and unknown. The term 'unknown significance' is used to classify those sites that do not present sufficient data to allow a complete classification. Typically, these sites are either under investigation or subject to continual change eg. active quarry faces. White and Wakelin-King (2014) pointed out that a significance assessment may require deciding between an excellent representative from a group of very similar places and an unusual place: a geosite, in fact, may be representative of the type, or be expressive of the diversity within the type.

On the base of the bibliography research, in the present thesis the geosites were analysed and a classification into three categories of value has been made: international, national or local.

• International Significance: this category comprises geosites that represent significant geological processes or features which are rare in the world, or by the nature of their scale, in a good state of preservation. It includes landforms, structures, rock formations or fossils that brings a meaningful contribution to the understanding of the Earth, climate or life history. They may be global type examples and are widely known as reference sites by the international geological community. The geosite should be uncommon in the geographical area under consideration, and the geological features must be well preserved in order to be verified for their scientific relevance. Examples of sites with international significance are stratotypes of major boundaries, chronostratigraphy (including GSSPs and ASSPs). In addition, the geosite had to be known by international scientist and should have been sufficiently studied to demonstrate their scientific relevance or recognition.

• National: the category includes geosites that are rare in the country or important nationally by virtue of their scale or state of preservation. In this category the best examples of a given feature which occur state-wide are included. A national geosite is known by national scientists and mentioned on national papers. It is used for educational activities and fieldworks.

- Local: the geosite does not present any particular scientific publication, but shows features representative or well preserved of a smaller area as a local municipality. It has local interest and used for educational activities and fieldworks.

In order to classify the geosites, national and international papers available for each geosites were analysed for their inclusion of the studied geosites in academic surveys or educational activities, and their inclusion in protected area with national or international relevance.

5.7 Degradation risk assessment

The geosites are constantly under pressure from natural or anthropogenic factors. These factors can affect the geosites, leading to damages with partial or total loss of the features that make them valuable (Garcia-Ortis et. al., 2014). This susceptibility to deterioration is known as degradation risk. Its assessment is fundamental to understand the state of integrity of the geosite and to schedule a correct monitoring plan in order to conserve the geoheritage relevance and re-establish stable conditions that were lost. A periodic assessment of the degradation risk helps the researchers to understand the environmental and anthropogenic processes that act on a geosite and to monitor its possible changes across time. In many countries, geosites are at risk of degradation or even total loss due to the lack a systematic inventory of the geological heritage and the consequent inadequate management (DeLima, 2010). As discussed in the previous sections (mainly 5.5. and 5.6), in literature there exists a high number of methodologies to assess the geosites considering their values (scientific and additional), their potential educational and touristic uses. A new challenge is to investigate in the geosites' assessment also the current status of the sites and their susceptibility of degradation. The degradation risk should be correctly reported at the early stage of any geoheritage inventory, as it provides key information to facilitate the management and conservation of geosites. This will lead to identify recommendations and measures needed in order to

improve the conservation of the geosites and to determine whether protection should be prioritized. Recent studies (Gordon et al., 2018) underline that a risk-based approach is important to also tackle the effects of climate change and to assess their future impact on a study area. As indicated in the assessment reports of the Intergovernmental Panel on Climate Change (IPCC, 2012; Hoegh–Guldberg et al., 2018), the extreme weather/climate events are increasing worldwide both in frequency and in severity, combined with sea level rise, with an undoubtedly greater impact on coastal areas (Rizzo et al., 2020). The Maltese archipelago has been classified as one of the Mediterranean regions most sensitive to climate change (Giorgi, 2006) with an estimated future sea level rise to min 10.7 cm and max 25.8 cm (Galassi and Spada, 2014).

Equally, human activities play an important role on the geosites degradation. For this, the human impact needs to be assessed and monitored, especially considering the constantly increasing number of population and tourists (standing at 2.6 million in 2018) (Rizzo et al., 2020).

For this reason, in the present research, in addition to the geosites assessment, a degradation risk methodology has been designed and applied in order to assess the fragility and vulnerability of the geosites, and then identify the areas that can be more negatively affected by climate- and marine-related processes.

5.7.1. Degradation risk in literature

There is little literature about degradation risk in connection with geoheritage. The terminology is not univocal and same terms are used by the authors differently. The degradation risk assessments proposed in literature always present different methods and parameters. Thus, a standard methodology that supports the recognition and prevention of threats affecting geosites is missing. In 2005, Brilha first introduced the concept of fragility and the need of geosites protection, considering exclusively the human threats. Other works have been conducted subsequently by Pereira et al. (2007), Carcavilla et al. (2007), Fuertes-Gutierrez and Fernandez-Martinez (2010), Fassoulas et al. (2012) and Garcia-Cortes and Carcavilla Urqui (2012) but they always present

different terminology and consider partially the aspects that contribute to the degradation risk.

De Lima et al. (2010) used the term vulnerability to define the natural and human processes that might affect the geosites. Fuertes-Gutiérrez and Fernández-Martínez (2010) introduced the concept of vulnerability as being the risk of destruction only due to human activity. According to them, the geosites are vulnerable when intensive human activity affects them or when their dimensions are so small that any human activity can cause damage. The same authors in a later work (Fuertes-Gutiérrez and Fernández-Martínez, 2012) present the degradation risk as a combination of vulnerability, that involves the intervention of human activities, and fragility, that involves the natural conditions. According to Fassoulas et al. (2012), the risk of degradation can be estimated considering the geosite's value and its need of protection. Hence, in order to evaluate the degradation risk of a geosite the authors assessed the scientific interest, the state of conservation, the ecological value of the geosite and its contribution to ecotopes.

The first comprehensive work on degradation risk assessment has been conducted by Garcia-Ortiz et al. (2014) with the intent to establish a common framework for specialists working on geoconservation. It presents the degradation risk as a combination of three main criteria (Garcia-Ortiz et al., 2014):

- fragility, that is directly related to the geological characteristics of the geosite and comprises the possibility of a geosite to being damaged by intrinsic factors. This criterion deals with all the active processes involved in the creation of the geosite that are still acting and can damage or destroy it;
- vulnerability, the possibility for a geosite to be damaged by extrinsic factors that could be natural or anthropogenic. The natural vulnerability considers all the natural factors that are not involved in the creation of the site, but can damage or destroy it. The anthropogenic vulnerability analyses all the human activities that are directly related to the geosite's geological characteristics and can actually or potentially affect the site (e.g. quarrying, mining or collection of fossils);

- public use. This criterion considers all the anthropogenic activities that are not directly related with the economic value of the geosite, but related to its use. It comprises several parameters based on Bruschi and Cendrero (2005) and Garcia-Cortes and Carcavilla Urqì (2012) that include accessibility, proximity to road, number of visitors, physical protection etc.

On this mentioned work, the researchers conducted a detailed analysis of the risk of degradation of the geosites in La Rioja (Spain), but considering only the natural criteria: fragility and natural vulnerability.

A more recent research (Brilha, 2016) considers the degradation risk as part of the geosites' assessment and it is based on five parameters: (i) deterioration of geological elements by natural or anthropogenic actions, (ii) the proximity to area/activities with potential to cause degradation, (iii) the legal protection, (vi) the accessibility that reflects the conditions of access to the site for the general public, (v) the density of population of the area. In this work the author recognizes the importance of an assessment of the degradation risk in parallel with the scientific assessment of the geosites, but does not distinguish anthropogenic threats from natural ones.

5.7.2. Proposed degradation risk methodology

Given the range of possible conceptual interpretations of terms related to the degradation risk, it is deemed essential to clarify which definitions are adopted by this study, prior to proposing the methodology. For the present research, the concepts of fragility, natural and anthropogenic vulnerability proposed by Garcia et al. (2014) were adopted and the definitions are reported in the previous paragraph (*5.7.1*).

The analysis of degradation risk's literature (Santucci et al. 2009; Garcia et al., 2014; Brilha, 2016, Gordon et al., 2018) led to the designation of a new quantitative assessment methodology. This new methodology seeks to comprise all the measurable criteria that contribute to the degradation risk. The methodology is based on three criteria: natural vulnerability, anthropogenic vulnerability and public use. Each criterion comprises several parameters that are ranked with a score from zero to three, with zero for low

risk, and three for high risk. The methodology proposed aims to determine the main threats affecting the geosites in order to identify the best way to conservation and management.

The fragility criterion was also considered for each geosite, but not included in the degradation risk methodology. Although the fragility may influence the risk of degradation, it arises exclusively by natural factors that are related to the geological characteristic of the geosite. For this reason, the fragility is generally impossible to avoid and tricky to mitigate. In fact, it is also ethically unfair of thinking to reduce the natural intrinsic factors. This point will be explained in the following paragraph.

5.7.2.1.Fragility

The fragility arises from natural intrinsic factors and it is important to measure in order to have a knowledge of the state of the site, its dynamic state and integrity. However, it is generally impossible to prevent it due to its unavoidable natural origin.

Four parameters are considered to assess the fragility of a geosite (Table 5.10):

(i) The dynamic state of the geosite. According to Pelfini and Bollati (2014) the activity of a site depends on two main elements: the morphoclimatic system and the tectonic context and structural features. The sites are classified in 3 main categories: (a) active, those evolving under the action of the processes that generated them and thus are still evolving (Bisci and Dramis, 1991) or modified over time by different processes. An active geosite documents the processes of earth's surface and the ongoing landscape evolution. Active sites are in turn classified as active-continuous or active-episodic, considering that some processes are acting throughout all the year and other just for short recurrent periods (Thomas, 2016). The site is considered active when the visualization of the processes in action and the consequent activity are visible during the time interval of the fieldwork (Reynard, 2004; Castaldini, 2009). (b) Quiescent, those geosites that are not currently active because they are in equilibrium in the present morphoclimatic system. Quiescent geosites can be reactivated and be modified over time by different processes. Their activity is not perceptible during the time interval of the fieldwork, but they are considered to have a return time 1-10

years. (c) Relict or inherited geosites are site isolated from the action of active processes (e.g. landform covered by deposits).

The dynamic state of a geosite opens a controversial discussion. Some authors (e.g., Rivas et al., 1997) consider active geosites as consumable, due their continuing evolution may be responsible for hazard and risks related to fruition. For this reason, the active geosites are considered more at risk of degradation with respect to the quiescent and relict ones. Actually, both active and inactive geosites are susceptible to modifications due to processes that change in time, frequency and intensity (Pelfini and Bollati, 2014). The quiescent and inherited geosites, that may be no longer linked to the morphoclimatic context in which they were generated, may undergo modifications that might be irreversible if they are involved in new types of processes that deeply modify their original and distinctive features (Lugon and Reynard, 2003). In addition, high level of activity is not always related to a high risk of deterioration and destruction: in some cases the constant activity of a geosite may lead to evolve more complex features and increase their value with the physical development of new landforms. Furthermore, geomorphosites are usually recognizable as a process, not as elements of geological importance and the activity is considered an intrinsic value of the site.

(ii) Geological characteristics. This parameter reflects the possibility of loss of geological elements in the site as a consequence of its intrinsic characteristics: it is mainly related to its lithology including the chemical and physical properties of the rock that make up the site. The geosite could be made up of a very hard or hard consolidated lithology, soft consolidated lithology slowly developing unconsolidated lithologies, or consolidated, with a soft and heavily fractured nature. This may influence its erosion grade and also the resistance to natural and anthropogenic processes.

(iii) Type of site. The classification of the type of site follows the one proposed by Fuertez-Gutierrez and Fernandez Martinez (2010): punctiform, linear, areal-viewpoint. The punctiform sites are small-sized isolated features (e.g. sinkhole, spring). In literature, the punctiform sites, also known as points, are always

considered vulnerable due to their dimension. Linear sites are sections, stratigraphical sequences or features having linear spatial development (e.g. a gorge, a fault). Areas are a set of large simple landforms related to just one type of genetic process (e.g., a karren field). Their vulnerability and fragility are low, when considering their large size and the possibility to with stand the higher natural and anthropogenic pressures.

(iv) Dimension of the geosite. The dimension of the site depends from the scale on the study area. Considering the scale of the Maltese Islands and the dimension of all the geosites selected, the geosites were classified in a scale less than 1.000 m² until more than 100.000 m². In literature, it is reported that the size of the geosite is related with its degradation risk: the smaller the site, the more it is exposed to natural and anthropogenic pressure (Fuertes-Gutierrez and Fernandez-Martinez, 2010).

As discussed regarding the dynamic state of a geosite, also the type and dimension open a controversial debate. In literature the punctual sites and the small dimensions are most of the time related with higher risk of degradation, but it should be evaluated considering the situation.

Table 5.10: Parameters considered for the fragility assessment of geosites.

Fragility (Intrinsic factors)	Dynamic state of the geosite	relict geosite
		quiescent geosite
		active geosite - episodic
		active geosite - continuous
	Geological characteristics	no potential loss of geological elements
		potential loss of one geological element of the geosite
		potential loss of two geological element of the geosite
		potential loss that more than two geological elements of the geosite
	Type of geosite	punctiform
		linear
		areal - viewpoint
	Dimension of the geosite	the area of the geosite is less than 1.000m²
		the area of the geosite is between 1.000 m² and 10.000 m²
		the area of the geosite is between 10.000 m² and 100.000 m²
		the area of the geosite is more than 100.000 m²

The fragility should be reported in the inventory, as it provides key information to facilitate the management and conservation of geosites. However, since fragility as an intrinsic factor cannot usually be mitigated and for the controversial issues discussed in this paragraph, its value does not contribute to the degradation risk total score.

5.7.2.2. Natural vulnerability

The assessment of the natural vulnerability is based on the following two parameters:

(i) The active extrinsic processes. It comprises the active processes which are not involved in the creation of the geosite, but effect it. The processes that can cause damage could have different origin as geological, climatic and biological. Thus, it is important to identify the active natural processes in the study area that can cause degradation (Garcia-Ortis et al., 2014). The possible conditions and processes considered during the evaluation on the field are listed by origin in Table 5.11. The processes and conditions identified are effective for the Maltese archipelago. In other morphoclimatic context it would be necessary to consider other natural processes. As for the active processes considered in the fragility, the natural extrinsic factors are acting in either a continuous or episodic manner. A score of zero is given to the sites affected by no one extrinsic natural process, one and two respectively to the sites that are affected by episodic or constant natural process; three is given to the sites that are affected by two or more extrinsic natural processes.

Table 5.11: Possible conditions and processes by origin affecting the geosites (Maltese archipelago context).

Active natural processes on the geosite		
Origin		**Conditions and processes**
geological		down-slope movements
		weathering
		transportation
biological activity	animals	trampling
		burrowing
		excretion by animals
	plants	root development
		surface growth by plants
meteo-marine factors		temperature

	humidity
	precipitation
	wind
	flooding
	freeze thaw cycle
	weathering
	salinity

(ii) the proximity to an area of possible degradation due to active natural processes. It is important to identify the conditions that make the geosite's area and its surroundings at risk of degradation. In the context of the Maltese archipelago the following possibilities are considered: proximity to coastal area, proximity to slope or landslides, proximity to fluvial resources. Also in this case, the areas of possible degradation considered are valid for the studied context: in other morphoclimatic contexts it would be necessary to consider other possible degradation processes as e.g. volcanic eruptions or snow avalanches. For each parameter a number from zero to three has been assigned, with zero representing no presence of degradation process and a score of three assigned due to the presence of more than two degradation processes in proximity of the geosite.

The natural vulnerability is strictly related to the fragility and the geological characteristics of the geosite. In fact, the different lithology that form the site can favour or slow the natural processes. As the fragility, the natural vulnerability is difficult to minimize due to its natural origin. Furthermore, when it is possible to mitigate the natural vulnerability, it is necessary to carefully weigh the impact and benefit of an intervention (Garcia et al., 2014).

5.7.2.3. Anthropogenic vulnerability

The following two parameters have been considered to assess the anthropogenic vulnerability that correspond with the risk of degradation by human activities:

(i) the economic interest that express the presence of geological elements with economical interest. With this parameter, one can consider whether the geosites are

actually or potentially of interest for economic exploitation (e.g. elements valuable for quarrying and mining).

(ii) the presence of geological elements collectable for private use: this comprises the possibility of the site having valuable geological elements such as fossils and minerals, which can be illegally collected.

To each parameter a score ranging from zero to three has been assigned with zero for no economic interest and three for more than two elements of economic value. Both parameters are directly linked with the geoheritage and the geosite's geological characteristics. Unlike natural vulnerability, anthropogenic vulnerability is not related to the fragility or alteration of the lithology of the geosites. Moreover, the anthropogenic vulnerability is assessed individually with respect to other public uses because the economic value of the geological element of a geosite is not related to the general anthropogenic pressure as population density, accessibility and proximity to roads, etc.

5.7.2.4. Public use

The public use criterion measures the anthropogenic pressure on the geosite, not directly related to the scientific value or economic value of the site. This depends fundamentally on pressure from urban development, susceptibility to pillaging or vandalism and lack of protection. The public use presents several variables that could be measured and evaluated. Therefore, this criterion includes seven parameters, that are reported as follow:

(i) legal protection: it considers the presence of a legal protection on the geosite. Indeed, the score zero is given to the site that is legally protected due to its geological value, score one and two respectively given to sites inside a natural area and sites inside an area protected for other value as cultural or historical. The maximum score, three, is given to the geosite that is not covered by any legal protection, even for other values;

(ii) proximity to area and human activities that can cause degradation: it measures the distance in meters to human activities that can potentially damage the site;

(iii) accessibility: this parameter is assessed also as an additional value, but here it is considered in a different light. As an additional value, good accessibility is considered an advantage because it allows a higher number of visitors. On the contrary, on the degradation risk assessment a good accessibility to a site is a risk in terms of vulnerability because the more people that visit the site, the higher the risk that the site will be damaged;

(iv) density of population: this parameter has been considered also in the assessment of additional use of geosites, but also in this case, here it is considered in a different manner. As an additional value a high number of persons living near a site is considered an advantage for potential educational and touristic use, but as parameters of the degradation risk, more people living near a site increase the probability of human-induced deterioration;

(v) physical protection: it evaluates the presence of physical barriers and structure to protect the sites. The protection limits the direct contact with humans that can deteriorate the site. Examples of physical protection are fences, stairs or walk trails. The maximum score of three is given to sites that do not present any physical protection; a score of zero is assigned for sites that have physical protection for the geoheritage and adequate structures to receive tourists;

(vi) degrading public use: it refers to the incorrect use of the geosite. Examples are the presence of waste (plastic bottles, papers, cans) and vandalism. The minimum score of zero is given to geosites that do not present any degrading public use; a score of one, two or three are assigned if the sites present respectively one, two or more elements that point to an incorrect public use.

(vii) control of access: this parameter is used to evaluate the presence of a direct control, cameras, indirect controls, patrol surveillances or physical barriers that control the access to the site. The maximum score of three is given to the sites that do not present any control of access, on the contrary zero if the access to the sites is monitored by more than two modes.

All the criteria and the corresponding parameters considered in the quantitative assessment methodology of the degradation risk are summarized in Table 5.12.

Table 5.12: Criteria, parameters, indicators and points used for the quantitative assessment of the degradation risk.

Criteria	Parameters	Indicators	Score
Natural Vulnerability	Active processes which are not involved in the creation of the geosite, but affect it (geological, biological and climatic processes)	no active processes affect the geosite	0
		one active process affects the geosite episodic	1
		one active process affects the geosite in continuous or seasonally	2
		two or more active processes affect the geosite	3
	The site is located in proximity to an area with possible active process of degradation (e.g.: coastal area, volcanic area, slopes/landslides, fluvial resources, etc)	no possibility of degradation	0
		one possible active process in the proximity of the geosite	1
		two possible active processes in the proximity of the geosite	2
		more than two active processes in the proximity of the geosite	3
Anthropogenic Vulnerability	Economic interest	no geological elements with economic interest	0
		the geosite has one geological element with economic interest	1
		the geosite has two geological elements with economic interest	2
		the geosite has more than two geological elements with economic interest	3
	Collectable geological elements from private use (Illegal collecting)	no geological elements of private interest	0
		the geosite has one geological element collectable for private interest	1
		the geosite has two geological elements collectable for private interest	2
		the geosite has more than two geological elements collectable for private interest	3

Public Use	Legal protection	the geosite is protected for its geological heritage	0
		the geosite is inside a protected natural area	1
		the geosite is inside an area protected for other values (historical, cultural…)	2
		the geosite is not in a protected area	3
	Proximity to area and human activity that can cause degradation	the geosite is located less than 100 m of a potential degradation activity	3
		the geosite is located less than 500 m of a potential degradation activity	2
		the geosite is located less than 1 km of a potential degradation activity	1
		the geosite is located more than 1 km of potential degradation activity	0
	Accessibility	the geosite is located less than 100 m from a paved road and bus parking	3
		the geosite is located less than 100 m from a paved road	2
		the geosite is located less than 100 m from a gravel road or between 100-500 m from a paved road	1
		the geosite is located more than 100 m from a gravel road or more than 500 m from a paved road/No direct access	0
	Density of population	Site located in a municipality with less than 100 inhabitants/km²	0
		Site located in a municipality with 100–250 inhabitants/km²	1
		Site located in a municipality with 250–1000 inhabitants/km²	2
		Site located in a municipality with more than 1000 inhabitants/km²	3
	Physical protection (physical structure that protect the site, fence, stairs, walk trail)	The geosite not protected at all	3
		The geosite has structure for tourist but without physical protection of the geoheritage	2

		The geosite has structure physical protection but no structure for the tourists	1
		The geosite has physical protection for the geoheritage and structure for the tourist	0
	degrading public use (vandalism, rubbish, incorrect use of geosites, etc.)	no degradation from public use	0
		one element of degradation	1
		two elements of degradation	2
		more than two elements of degradation	3
	control of access (direct control, indirect control, cameras, patrols surveillance, physical barriers, etc.)	no control at all	3
		the access to the geosite is monitored by one	2
		the access to the geosite is monitored by two	1
		the access to the geosite is monitored by more than two	0

The degradation risk total score can range from 0 to 33 points (Table 5.13a). Once the total score on degradation risk is obtained, it is possible to identify the degradation risk level of each geosite (Table 5.13b): the geosites that reach a score lower than seven points are considered as at low risk of degradation; conversely, the higher degradation risk level is attributed to the sites that reach a total score higher than 25 points. Details concerning the scores and the degradation risk levels related to each range of score are shown in Table 5.13b.

Table 5.13: (a) partial and total score on degradation risk; (b) total score on degradation risk and grade of risk.

Criteria	Partial score	Total Score
Natural Vulnerability	0-6	0-33
Anthropogenic Vulnerability	0-6	
Public Use	0-21	

(a)

Total score on degradation risk	Grade of risk
0-7	low
>7≤15	medium
>15≤25	high
>25	very high

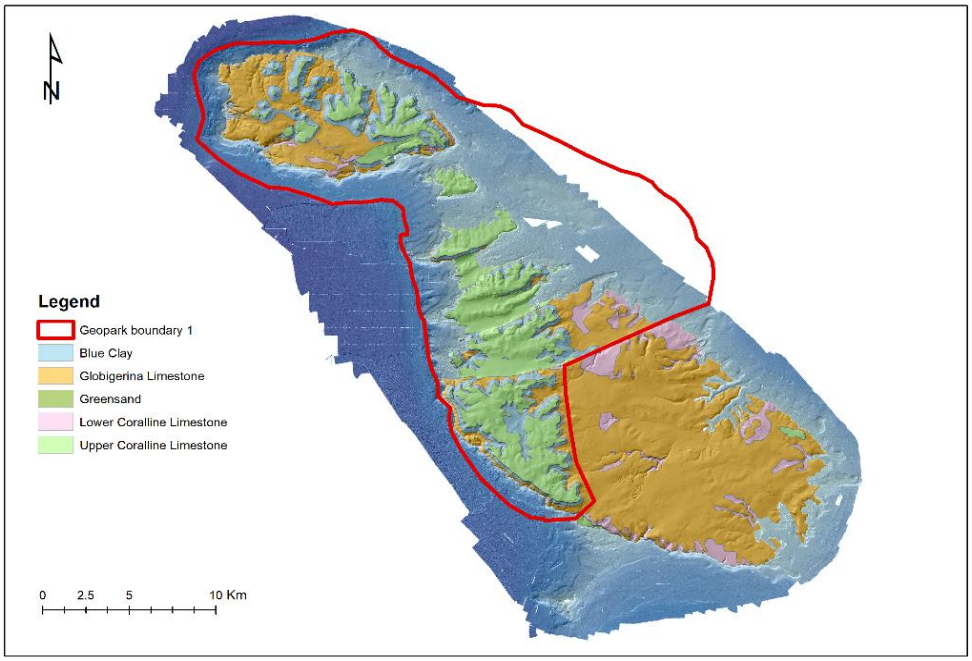
(b)

CHAPTER 6. Results and Discussion

6.1 Identification of boundaries: the study area

The study area was identified considering its possible application as UNESCO Global Geopark. The documents discussed in paragraph 5.1 were analysed and three maps were proposed as a potential boundary of a UNESCO Geopark.

Considering that a UNESCO Global Geopark embodies living, working landscapes where science and local communities engage in a mutually beneficial way, not only rural and untouched landscapes were considered as part of the study area, but also urbanized places, where nature and people are in connection. However, despite the presence of local communities inside a geopark, it was considered appropriate to exclude heavily urbanized area such as harbours and airport from the proposed boundary area. All the three proposed areas (Figure 6.1) are drawn as a single area that comprise the whole island of Gozo and Comino and the north and southwest part of the island of Malta, comprising the marine area that connects the islands.



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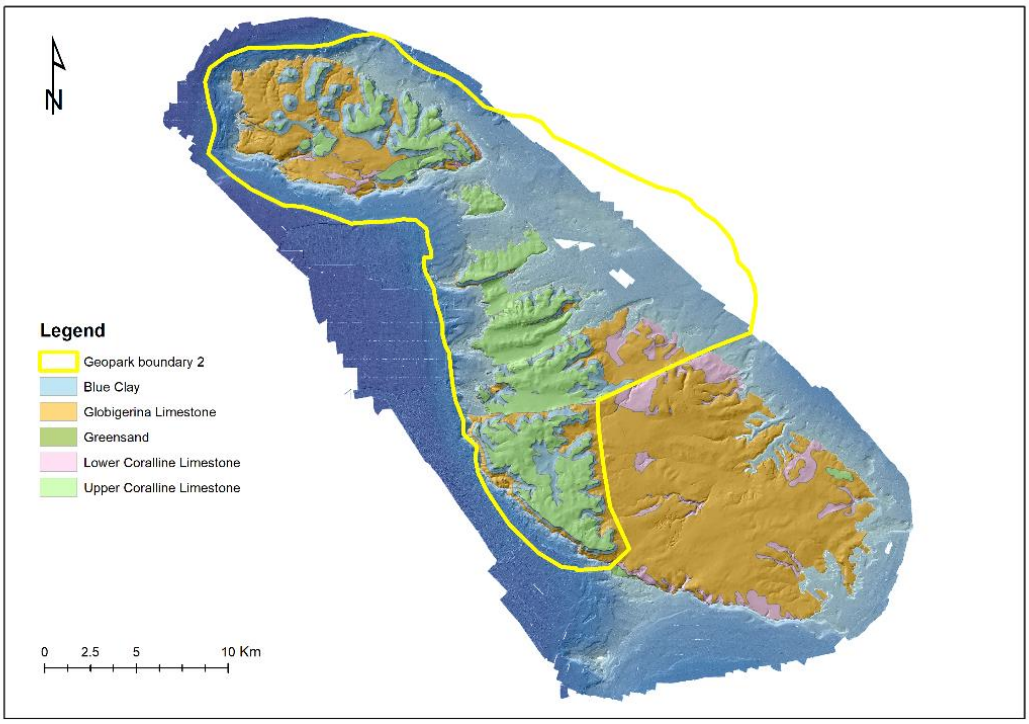

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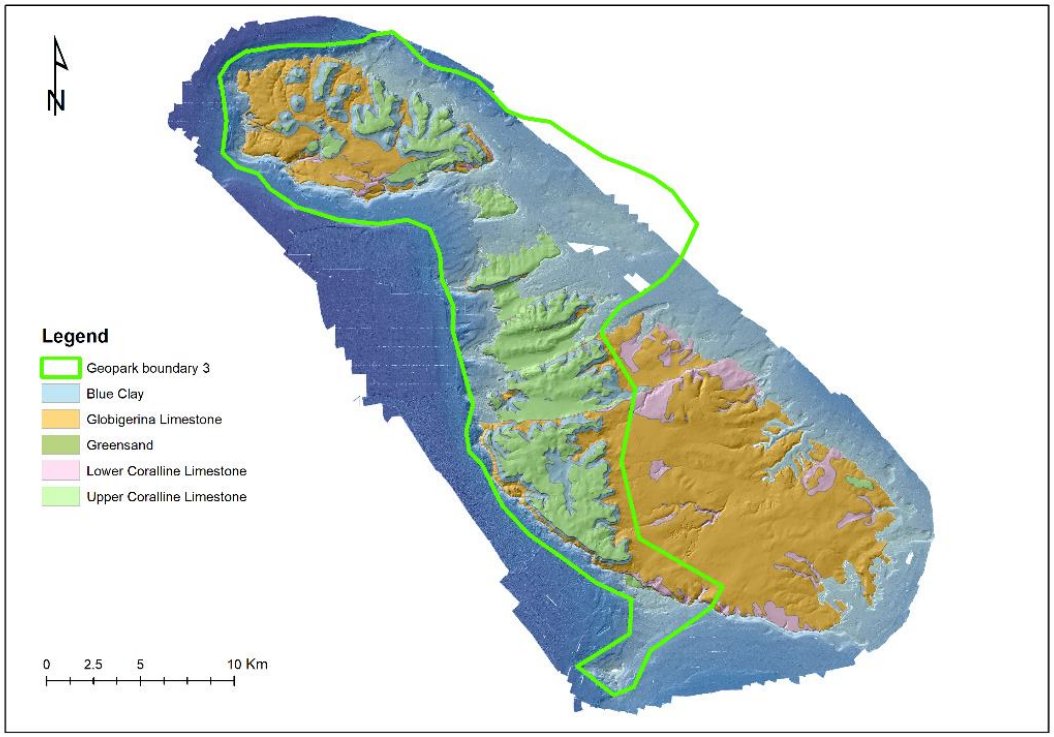

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Figure 6.1: Proposed areas for possible UNESCO Global Geopark.

It was decided to exclude the park of Xrobb l-Għaġin and the interesting coastline from Żonqor to Delimara Point on the east of the island of Malta, due to a criterion established by the UNESCO guidelines that demand a geopark to be a single area and not a fragmented area. All the three proposed areas comprise the World Heritage Site of Ġgantija (Gozo), megalithic temple built with external hard-wearing Coralline Limestone and Globigerina Limestone used for the interior structures. Its inclusion within the Geopark boundary is intended to promote the links between geological heritage and all other aspects of the area's natural and cultural heritage. In this way, the importance of geodiversity as part of all ecosystems is emphasised and it is considered as the basis of human interaction with the landscape. The coastal areas of on the western side and a small coastal zone along the south-eastern districts of Malta, as defined by the Local Administrative Units (LAUs) by the Eurostat, are also included.

The first proposed area (Figure 6.1a) comprises the largest terrestrial area on the north and centre of the main island. It comprises all the Northern Maltese districts (LAUs). Inside this area are included remarkable landscapes and sites of Special Areas of Conservation (SAC) such as Is-Salini, under the Habitats Directive (92/43/EEC). This selected area comprises also a few active quarries and the waste facility site of the archipelago.

The second proposed area (Figure 6.1b) traces the first map, but rules out part of the Northern district, thus excluding the waste facility site and the Is-Salini Special Area of Conservation. Compared to the first area proposed, in the second area the boundary on the island of Malta leans more towards the south coast comprising one of the widest and most spectacular sea caves on the islands, Blue Grotto (Furlani et al., 2019). It also comprises the surrounding inland that covers other three important sites: the World Heritage Sites of Mnajdra and Ħaġar Qim and Il-Maqluba solution subsidence structure. Mnajdra and Ħaġar Qim are prehistoric monumental buildings constructed during the 4th millennium BC and the 3rd millennium BC, ranked amongst the earliest free-standing stone buildings in the world (whs.unesco.org). They are remarkable for their architecture and cultural value but may be considered also for their connection with geology since they are made of Coralline Limestone external walls and of softer

Globigerina Limestone in the more sheltered interiors and decorated elements. Il-Maqluba is an outstanding inland sinkhole, protected for its ecological value as TPA (Tree Protection Area) and SAC (Special Area of Conservation).

The third proposed area (Figure 6.1c) avoids the waste facility site and comprises the area on the south coast of Malta as the map number two, but with the addition of the islet of Filfla situated around 5 km offshore southwest of Ras Ħanzir, south Malta. It also includes the marine protected area that covers ca. 24.5 km² around Filfla. The islet of Filfla was the first Natural Reserve declared in 1988 on the archipelago and also considered a Bird Sanctuary since 1993. Its isolation and inherent difficulty of access have in fact contributed to the survival of a number of endemic, endangered or threatened species of flora and fauna (Furlani et al., 2019) and for this reason, it is also declared as Special Protected Area (SPA), Level 1 Site of Scientific Importance and Level 2 Area of Ecological Importance.

In February 2018, the three proposed areas were analysed and initially discussed with the Maltese National Commission for UNESCO to establish their viability for the application of the UNESCO Global Geopark (Figure 6.2).

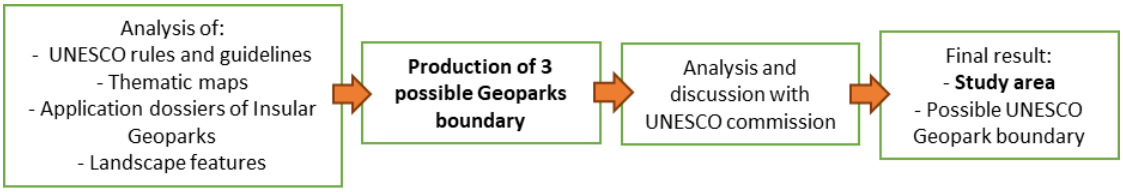


Figure 6.2: Sequential tasks to identify the study area.

The analysis, in accordance with the commission, led to consider the third area as the most suitable for the application as UNESCO Global Geopark.

To sum up, the proposed area covers a surface of 350 km², which covers inland landscapes, coastal features as well as underwater areas. A considerable part of sea area is included since the landforms present on the land extend beneath sea level. On the sea floor in fact there are present palaeo-fluvial channels, sinkholes and landslides, which were shaped during sea level low stands of the last glacial cycle (Prampolini et al., 2017) and which have high scientific relevance and contribute to the geodiversity of the marine environment. The whole archipelago is thus renowned for underwater tours and scuba

diving for its ecological value and its diversity in landforms. The proposed boundary comprises the World Heritage Sites of Ġgantija (Gozo), Mnajdra and Ħaġar Qim (Malta). Natura 2000 marine and terrestrial sites are also included. The study area comprises residential areas but the most urbanised regions are excluded since, despite they present rich cultural value, the natural and geological landscape is covered by houses and infrastructures. The dumpsite, the airport and the surrounding harbour area were excluded from the boundary.

The study area has a wide variety and density of geological, historical and cultural properties, which are very concentrated in relation to its size. It is characterised by easy accessibility and makes an excellent candidate for Geopark designation.

6.2 Recognition of potential geosites within the study area

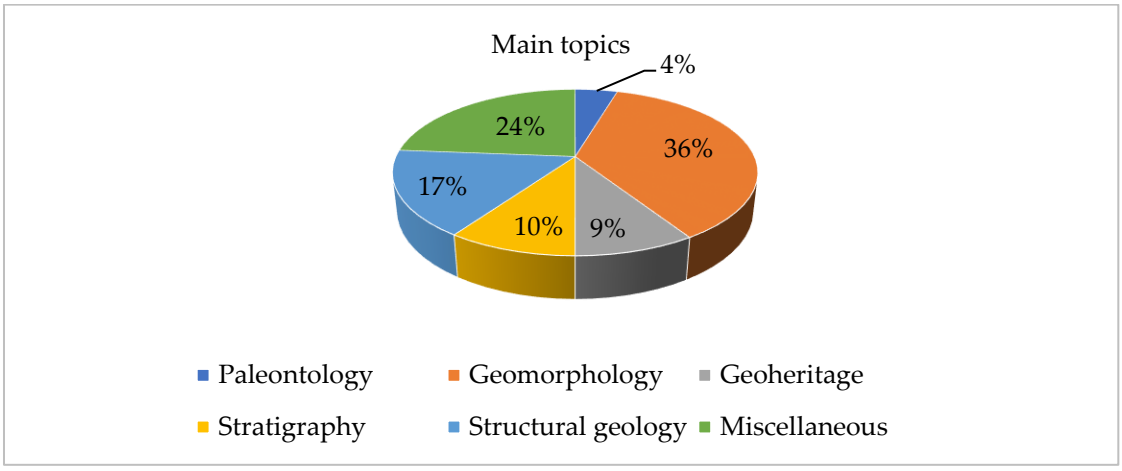
An extensive bibliography research on the Maltese Islands has been done, collecting more than 200 items on the geology of the archipelago, comprising ca. 150 national and international scientific papers, 20 master and PhD dissertations on the geology, geomorphology and ecology of the archipelago, 5 geological and geomorphological maps. In addition, reports of Maltese environmental agencies (Planning Authority, Environmental and Resources Authority, Malta Environment and Planning Authority) have been collected and analysed.

The analysed scientific papers (Figure 6.3a) deal with various geological aspects including geomorphology (36%), miscellaneous geological topics (24%), structural geology (17%), stratigraphy (10%), geoheritage (9%) and palaeontology (4%). The item miscellaneous comprises papers on geology l.s..

The first scientific papers analysed are dated on late 1800 (Adams, 1866; 1870; Illies, 1981) and are related to palaeontology and structural geology. In the 1970s more scientific research have been conducted on the stratigraphy and structural setting of the whole archipelago, with more attention to the island of Malta (Felix et al., 1973; Pedley et al., 1974; 1976; Giannelli at al., 1975). Beginning in 2000, more than 40 scientific papers on

geomorphology have been published, mainly concerning the mass movements occurring in the northwest Malta (e.g. Dykes at al., 2002; Devoto et al., 2012; 2013; Soldati et al., 2011; 2013; 2015; 2017). A new field that is getting attention in the last decade is the seismic history of the Maltese Islands and considerations on seismic risk (e.g. Panzera et al., 2012; Agius et al., 2014; 2015; D'Amico, 2014; Galea et al., 2014; 2018).

In general, in the last three decades scientific papers regarding all the main geological topics have been published and the scientific interest on the archipelago has grown over the years (Graph 6.3b).



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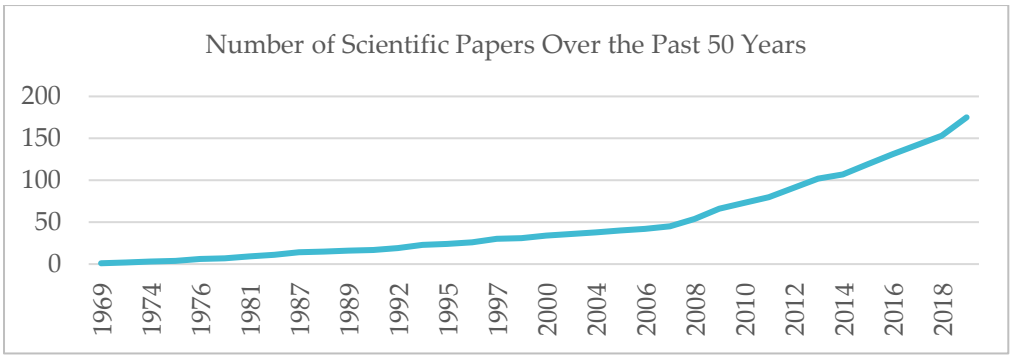

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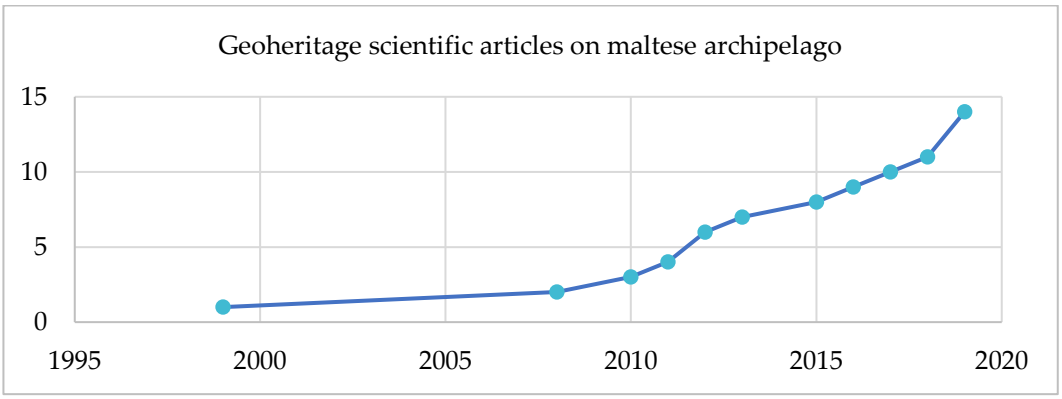
Figure 6.3: a) Distribution of geological literature according to the main topics of the scientific papers analysed; b) graph showing the increasing number of scientific research over the past 50 years.

A similar micro-scale trend could be described for the geoheritage interest.

Geoheritage is a new research topic that started to get attention in the early 2000s, but the number of papers has been increasing through the years (Figure 6.4a).

The articles on geoheritage analysed (14 papers in total) deal mainly with the land use and its connection with geotourism activities (50% of the papers, Figure 6.4b). The 29% (4 papers) proposes geosites assessments of limited regions of the archipelago. Regarding the island of Malta, the assessment studies are focused on the Marfa Ridge peninsula and the Majjistral Nature and History Park and environs (Coratza et al., 2011; Selmi et al., 2019); for the island of Gozo the geosites assessment focused on the Dwejra area (Coratza et al., 2012). The 21% (3 papers) regards the geological heritage l.s.. These papers present the connection of the geological heritage with cultural and historical heritage (e.g. Gauci et al., 2017; Coratza et al., 2016).



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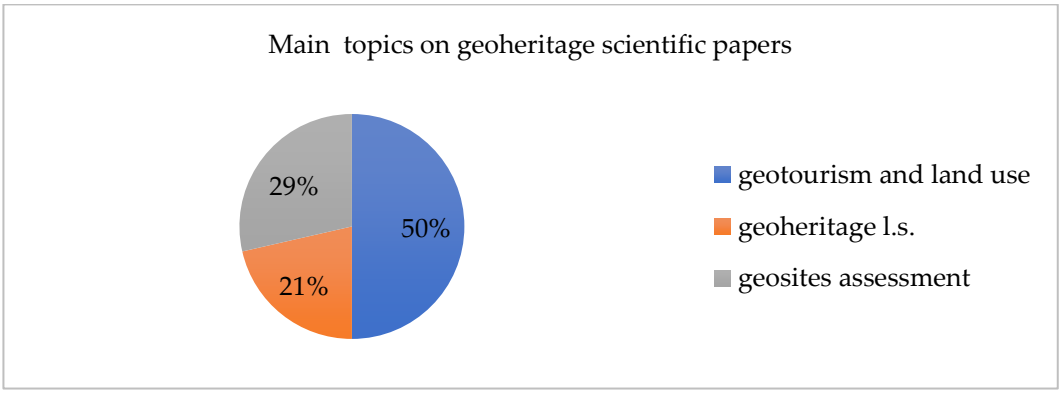

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Figure 6.4: a) distribution of geoheritage literature according to the main topics of the scientific papers analysed; b) graph showing the increasing number of scientific research over the past 20 years.

Interviews to academic experts were conducted in order to consider the areas that are used for field visits at university level. Professors and researchers from the Faculty of Arts (Geography), the Faculty of Science (Geosciences and Biology) and the Faculty of Law (Environmental & Resources Law) of the University of Malta have been interviewed. Interviews have also been conducted with experts of the Majjistral Nature and History Park and with tourist guides of the islands.

The interviews helped to identify the areas of the Maltese Islands that are studied and used at university level. On Figure 6.5 are reported the areas used for university fieldworks on geology and ecology in the last 10 years. Most of the areas are located along the coast and are natural environment, far from urban settlements.

For the island of Malta, the most relevant areas are:

- North: Il-Qammieħ, Għajn Tuffieħa, Anchor Bay, Selmun Bay.
- Centre: Qalet Marku, Pembroke
- South: Dingli Cliffs, Għar Dalam (Birzebbugia). Clapham Junction (Rabat area) and Magħlaq (Zurrieq)

The most relevant area for the island of Gozo is Dwejra.

Comino is not considered for specific scientific research and few field visits have been conducted in the island of Cominotto in past times, mainly for ecological interest.

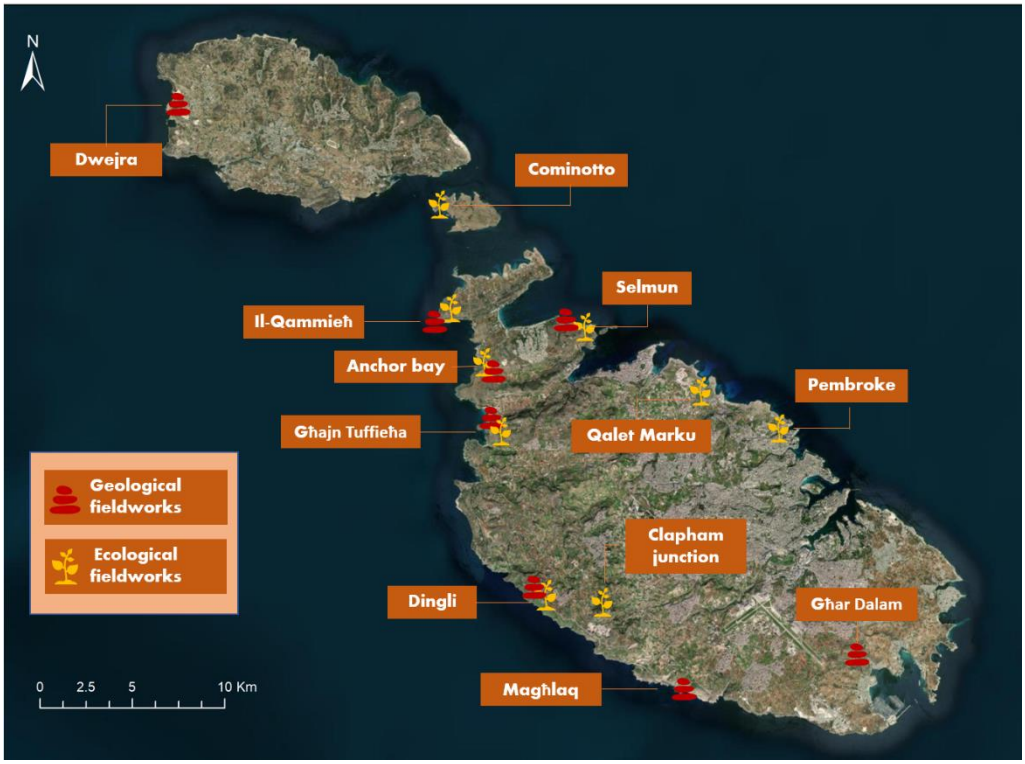


Figure 6.5: Areas used for university fieldworks (base map source: ESRI).

Several field surveys were conducted in all the study area over the three years of the research, in different moments of the year in order to note the seasonal evolution of the sites. In detail, the field surveys were carried out in the following periods: spring 2018 (April 2018), summer 2018 (June-August 2018), autumn 2018 (October-November 2018), early winter 2019 (January-February 2019). Other short field visits were conducted during the last three years with the geomorphological team of the University of Modena and Reggio Emilia. The last field visits were scheduled for early 2020, but were cancelled due to Covid-19.

The aims of the field visits were to identify the geological and geomorphological characteristics of the Maltese Islands and to fundamentally integrate the list of sites previously identified with new sites not mentioned in the bibliography. The detailed literature review combined with experts interviews and field surveys led to the identification of 131 sites of geological and geomorphological interest, as well potential geosites (Figure 6.6).

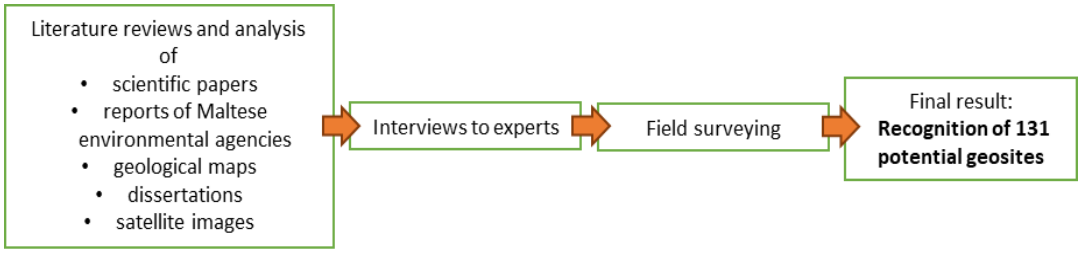


Figure 6.6: Sequential tasks to identify the potential geosites.

The 131 potential geosites are distributed in the archipelago (Table 6.1, Figure 6.7 and Figure 6.7) : 77 located in the island of Malta, 29 in Gozo and 25 in Comino.

Table 6.1: List of the 131 potential geosites recognized on the study area.

Code	Feature	Category	Location	X coord.	Y coord.
MT1	Area affected by rock spreading	geomorphology	coastal	35°57'21.10" N	14°23'26.48"E
MT2	Quaternary sinkhole	geomorphology	inland	35°57'23.40"N	14°23'24.64"E
MT3	Area affected by rock spreading	geomorphology	coastal	35°57'37.08"N	14°23'42.14"E
MT4	Marine caves	geomorphology	coastal	35°57'50.13"N	14°23'56.21"E
MT5	Fault	structural geology	coastal	35°57'54.08"N	14°23'56.60"E
MT6	Salinas	human activity	coastal	35°57'54.60"N	14°23'45.31"E
MT7	Salinas	human activity	coastal	35°57'54.60"N	14°23'45.31"E
MT8	Salinas	human activity	coastal	35°57'54.60"N	14°23'45.31"E
MT9	Badland topography in Blue Clay slopes	geomorphology	inland	35°58'0.82"N	14°23'29.72"E
MT10	Quaternary sinkhole	geomorphology	coastal	35°58'39.20"N	14°21'23.95"E
MT11	Area affected by rock spreading	geomorphology	coastal	35°58'54.90"N	14°21'49.20"E
MT12	Badland topography in Blue Clay slopes	geomorphology	coastal	35°59'1.92"N	14°21'51.26"E
MT13	Area affected by rock spreading	geomorphology	coastal	35°59'4.15"N	14°21'55.93"E
MT14	Area affected by rock spreading	geomorphology	coastal	35°59'9.19"N	14°22'15.01"E
MT15	Area affected by rock spreading	geomorphology	coastal	35°59'18.58"N	14°22'32.55"E
MT16	Area affected by rock spreading	geomorphology	coastal	35°59'24.64"N	14°22'27.21"E
MT17	Marine cave	geomorphology	coastal	35°59'35.21"N	14°22'19.38"E
MT18	Karst landform (limestone pavement)	geomorphology	inland	35°59'46.87"N	14°22'8.18"E
MT19	Quaternary sinkhole	geomorphology	coastal	35°59'52.06"N	14°22'3.84"E
MT20	Extreme-wave events deposits	geomorphology	coastal	35°59'44.34"N	14°21'44.10"E
MT21	Cart ruts	human activity	coastal	35°59'13.44"N	14°20'30.61"E
MT22	Area affected by rock spreading	geomorphology	coastal	35°58'59.00"N	14°20'1.94"E
MT23	Area affected by rock spreading	geomorphology	coastal	35°58'48.10"N	14°19'45.95"E
MT24	Quaternary Sinkhole	geomorphology	coastal	35°58'38.68"N	14°19'43.10"E
MT25	Area affected by rock spreading	geomorphology	coastal	35°58'36.26"N	14°19'33.70"E
MT26	Area affected by rock spreading	geomorphology	coastal	35°58'27.20"N	14°19'29.57"E
MT27	Badland topography in Blue Clay slopes	geomorphology	coastal	35°58'19.01"N	14°19'18.78"E
MT28	Shore platform	geomorphology	coastal	35°58'17.65"N	14°19'10.03"E
MT29	Badland topography in Blue Clay slopes	geomorphology	coastal	35°58'11.26"N	14°19'21.87"E
MT30	Karst landform (limestone pavement)	geomorphology	coastal	35°58'7.76"N	14°19'20.62"E
MT31	Lower Globigerina Limestone terrace	geomorphology	coastal	35°58'11.35"N	14°19'43.92"E
MT32	Fault	structural geology	coastal	35°58'13.20"N	14°20'3.07"E
MT33	Marine cave	geomorphology	coastal	35°58'4.24"N	14°20'12.47"E
MT34	Badland topography in Blue Clay slopes	geomorphology	coastal	35°57'17.43"N	14°20'30.65"E
MT35	Dry valley	geomorphology	inland	35°57'13.18"N	14°20'40.55"E
MT36	Quaternary sinkhole	geomorphology	inland	35°57'13.5"N	14°20'49.0"E
MT37	Dry valley	geomorphology	inland	35°57'17.2"N	14°20'54.5"E

MT38	Quaternary sinkhole	geomorphology	inland	35°57'20.9"N	14°21'02.7"E
MT39	Solution subsidence structure	geomorphology	coastal	35°57'04.5"N	14°20'28.7"E
MT40	Area affected by rock spreading	geomorphology	coastal	35°57'03.9"N	14°20'23.7"E
MT41	Area affected by rock spreading	geomorphology	coastal	35°56'47.1"N	14°20'14.9"E
MT42	Area affected by rock spreading	geomorphology	coastal	35°56'36.0"N	14°19'58.7"E
MT43	Karst landform (limestone pavement)	geomorphology	inland	35°56'30.1"N	14°19'55.0"E
MT44	Area affected by rock spreading	geomorphology	coastal	35°56'31.4"N	14°19'49.9"E
MT45	Area affected by rock spreading	geomorphology	coastal	35°56'26.56"N	14°19'50.83"E
MT46	Badland topography in Blue Clay slopes	geomorphology	coastal	35°56'19.30"N	14°19'55.48"E
MT47	Karst landform (limestone pavement)	geomorphology	inland	35°56'26.24"N	14°20'16.36"E
MT48	Dry valley	geomorphology	inland	35°56'22.50"N	14°20'26.30"E
MT49	Area affected by rock spreading	geomorphology	coastal	35°55'38.45"N	14°20'24.94"E
MT50	Badland topography in Blue Clay slopes	geomorphology	coastal	35°55'36.35"N	14°20'38.70"E
MT51	Shore platform in Globigerina Limestone	geomorphology	coastal	35°55'31.88"N	14°20'35.50"E
MT52	Badland topography in Blue Clay slopes	geomorphology	coastal	35°55'5.43"N	14°20'1.95"E
MT53	Marine caves	geomorphology	coastal	35°55'04.3"N	14°19'59.4"E
MT54	GSSP	stratigraphy	coastal	35°54'51.1"N	14°20'09.1"E
MT55	Badland topography in Blue Clay slopes	geomorphology	coastal	35°54'29.27"N	14°20'27.17"E
MT56	Fault	structural geology	coastal	35°54'22.9"N	14°20'29.2"E
MT57	Marine cave	geomorphology	coastal	35°54'9.91"N	14°19'53.08"E
MT58	Fossil records	palaeontology	coastal	35°54'5.09"N	14°19'52.87"E
MT59	Chert nodules	stratigraphy	inland	35°54'5.25"N	14°19'52.76"E
MT60	Globigerina Limestone cliff	geomorphology	inland	35°53'59.75"N	14°19'53.54"E
MT61	Cart ruts	human activity	inland	35°54'00.8"N 1	4°22'34.1"E
MT62	Cart ruts	human activity	inland	35°54'0.81"N	14°22'34.05"E
MT63	Dry valley	geomorphology	inland	35°54'13.5"N	14°22'41.9"E
MT64	Caves	geomorphology	inland	35°54'13.5"N	14°22'41.9"E
MT65	Dry valley	geomorphology	inland	35°53'40.5"N	14°23'35.1"E
MT66	Caves	geomorphology	inland	35°49'39.59"N	14°25'36.53"E
MT67	Quaternary deposits	stratigraphy	coastal	35°49'35.56"N	14°25'50.40"E
MT68	Fault	structural geology	coastal	35°49'31.65"N	14°26'6.30"E
MT69	Sea Arch	geomorphology	coastal	35°49'21.14"N	14°26'18.77"E
MT70	Fault	structural geology	coastal	35°49'24.26"N	14°26'22.55"E
MT71	Upper Coralline Limestone plateau	geomorphology	coastal	35°47'14.01"N	14°24'35.42"E
MT72	Cart ruts	human activity	inland	35°51'8.94"N	14°23'50.21"E
MT73	Salinas	human activity	coastal	35°53'44.44"N	14°19'47.72"E
MT74	Quaternary sinkhole	geomorphology	inland	35°49'50.22"N	14°27'28.50"E
MT75	Dry valley	geomorphology	inland	35°49'26.98"N	14°27'36.09"E
MT76	Sea cave	geomorphology	coastal	35°49'15.52"N	14°27'24.23"E
MT77	Cave	geomorphology	inland	35°52'53.32"N	14°20'40.41"E
GZ1	Rock arch	geomorphology	coastal	36° 4'46.28"N	14°12'45.89"E
GZ2	Dry valley	geomorphology	coastal	36°04'46.3"N	14°12'45.9"E
GZ3	Salinas	human activity	coastal	36° 4'51.61"N	14°14'18.53"E
GZ4	Salinas	human activity	coastal	36° 4'45.90"N	14°14'48.29"E
GZ5	Mesa	geomorphology	coastal	36° 4'46.65"N	14°14'59.10"E
GZ6	Cart ruts	human activity	inland	36° 3'15.61"N	14°11'23.04"E
GZ7	Blowhole	geomorphology	coastal	36° 3'10.70"N	14°11'18.68"E
GZ8	Fungus rock	geomorphology	coastal	36° 2'48.37"N	14°11'20.22"E
GZ9	Cave	geomorphology	coastal	36° 3'17.60"N	14°11'25.79"E
GZ10	Miocene sinkhole	geomorphology	coastal	36° 3'13.84"N	14°11'28.14"E
GZ11	Solution subsidence structure	geomorphology	inland	36° 2'11.66"N	14°11'56.38"E
GZ12	Miocene sinkhole	geomorphology	inland	36° 1'54.83"N	14°13'1.28"E
GZ13	Globigerina limestone terrace	geomorphology	coastal	36° 1'37.77"N	14°12'47.15"E
GZ14	Dry valley	geomorphology	coastal	36° 1'13.61"N	14°16'15.64"E
GZ15	Salinas	human activity	coastal	36° 1'6.52"N	14°17'13.63"E
GZ16	Badland topography in Blue Clay slopes	geomorphology	coastal	36° 1'11.76"N	14°17'27.19"E
GZ17	Salinas	human activity	coastal	36° 1'6.49"N	14°17'27.55"E

GZ18	Cave	geomorphology	inland	36°03'48.0"N	14°17'22.4"E
GZ19	Cave	geomorphology	coastal	36° 3'4.93"N	14°15'52.94"E
GZ20	Cave	geomorphology	inland	36° 3'4.50"N	14°15'40.91"E
GZ21	Dry valley	geomorphology	inland	36° 1'54.73"N	14°13'22.56"E
GZ22	Globigerina Limestone sequence	stratigraphy	coastal	36° 2'58.79"N	14°19'2.45"E
GZ23	Quaternary deposit	stratigraphy	inland	36° 3'39.57"N	14°16'57.92"E
GZ24	Globigerina sequence	stratigraphy	coastal	36° 4'46.01"N	14°12'45.42"E
GZ25	Collapse contortion	stratigraphy	inland	36° 2'53.92"N	14°12'28.90"E
GZ26	Salinas	human activity	coastal	36° 4'51.87"N	14°14'12.39"E
GZ27	Karst landform (limestone pavement)	geomorphology	coastal	36° 1'8.12"N	14°17'29.64"E
GZ28	Mesa	geomorphology	inland	36° 3'59.16"N	14°15'15.98"E
GZ29	Miocene sinkhole	geomorphology	inland	36° 2'51.36"N	14°12'26.77"E
CM1	Rock arch	geomorphology	coastal	36° 1'11.87"N	14°20'16.93"E
CM2	Extreme-wave events deposits	geomorphology	coastal	36°01'09.5"N	14°20'18.8"E
CM3	Narrow cleft	geomorphology	coastal	36° 1'9.48"N	14°20'19.33"E
CM4	Extreme-wave events deposits	geomorphology	coastal	36° 1'6.94"N	14°20'23.15"E
CM5	Cave	geomorphology	coastal	36° 1'6.57"N	14°20'24.84"E
CM6	Marine cave	geomorphology	coastal	36° 1'3.26"N	14°20'25.17"E
CM7	Marine cave	geomorphology	coastal	36° 1'1.10"N	14°20'24.81"E
CM8	Rock arch	geomorphology	coastal	36°00'50.6"N	14°20'49.0"E
CM9	Rock arch	geomorphology	coastal	36° 0'22.58"N	14°20'50.26"E
CM10	Marine cave	geomorphology	coastal	36° 0'23.99"N	14°20'43.68"E
CM11	Blowhole	geomorphology	coastal	36° 0'18.16"N	14°20'12.83"E
CM12	Narrow cleft	geomorphology	coastal	36° 0'14.94"N	14°19'30.20"E
CM13	Karst landform (limestone pavement)	geomorphology	coastal	36° 0'20.87"N	14°19'37.90"E
CM14	Marine cave	geomorphology	coastal	36° 0'35.12"N	14°19'46.04"E
CM15	Rock arch	geomorphology	coastal	36° 0'36.79"N	14°19'37.38"E
CM16	Rock arch	geomorphology	coastal	36° 0'38.50"N	14°19'31.85"E
CM17	Rock arch	geomorphology	coastal	36° 0'45.30"N	14°19'18.08"E
CM18	Pocket beach	geomorphology	coastal	36° 0'47.65"N	14°19'20.77"E
CM19	Extreme-wave events deposits	geomorphology	coastal	36° 0'51.28"N	14°19'5.32"E
CM20	Extreme-wave events deposits	geomorphology	coastal	36° 1'3.72"N	14°19'23.21"E
CM21	Sea cave	geomorphology	coastal	36° 1'6.68"N	14°19'26.61"E
CM22	Multiple cave	geomorphology	coastal	36° 1'4.89"N	14°19'28.50"E
CM23	Narrow cleft	geomorphology	coastal	36° 1'8.04"N	14°19'40.77"E
CM24	Tunnel	geomorphology	coastal	36° 1'9.61"N	14°19'56.60"E
CM25	Dry valley	geomorphology	inland	36°00'54.7"N	14°20'10.9"E

The main limitation faced on the recognition and the following characterization of sites of geological and geomorphological interest on the study area, was the lack of scientific literature and the lack of detailed geological and geomorphological maps of some regions of the archipelago, especially the island of Gozo. In fact, the scientific research mainly concerns the mainland, such as north Malta and the northwestern coast. A detailed map of the coastal landforms of Malta, its coastal geomorphotypes and wave deposits was produced by Biolchi et al., 2016. They mapped the main structural elements and coastal, fluvial and karst, gravity-induced landforms, and anthropogenic landforms. Recent works on the geomorphology of northern Malta and Comino (covering also the inland area) and the northeastern coast of Gozo were conducted by Prampolini et al., 2017 and 2018. Regarding the island of Gozo, the scientific research is concerned on the Dwejra area and Marsalforn (northeastern Gozo). The other regions, especially the

inland ones, are still not considered for scientific research and thus unexplored. During the research, the problem was faced with a number of field visits in order to make surveys in the unexplored areas. Despite this, more field visits should be conducted on the inland area, in collaboration with experts of different sectors (e.g., palaeontology, geomorphology, mineralogy, structural geology, sedimentology) in order to produce thematic maps that cover all the study area. In particular, a complete geomorphological map of the island of Gozo and of the inland of Malta have to be produced in order to enrich and update the information already present in bibliography. The production of new thematic maps is a work that requires time and money, and for this reason it was not possible to produce within this PhD project. It is a task that needs to be faced in the near future as a future research question.

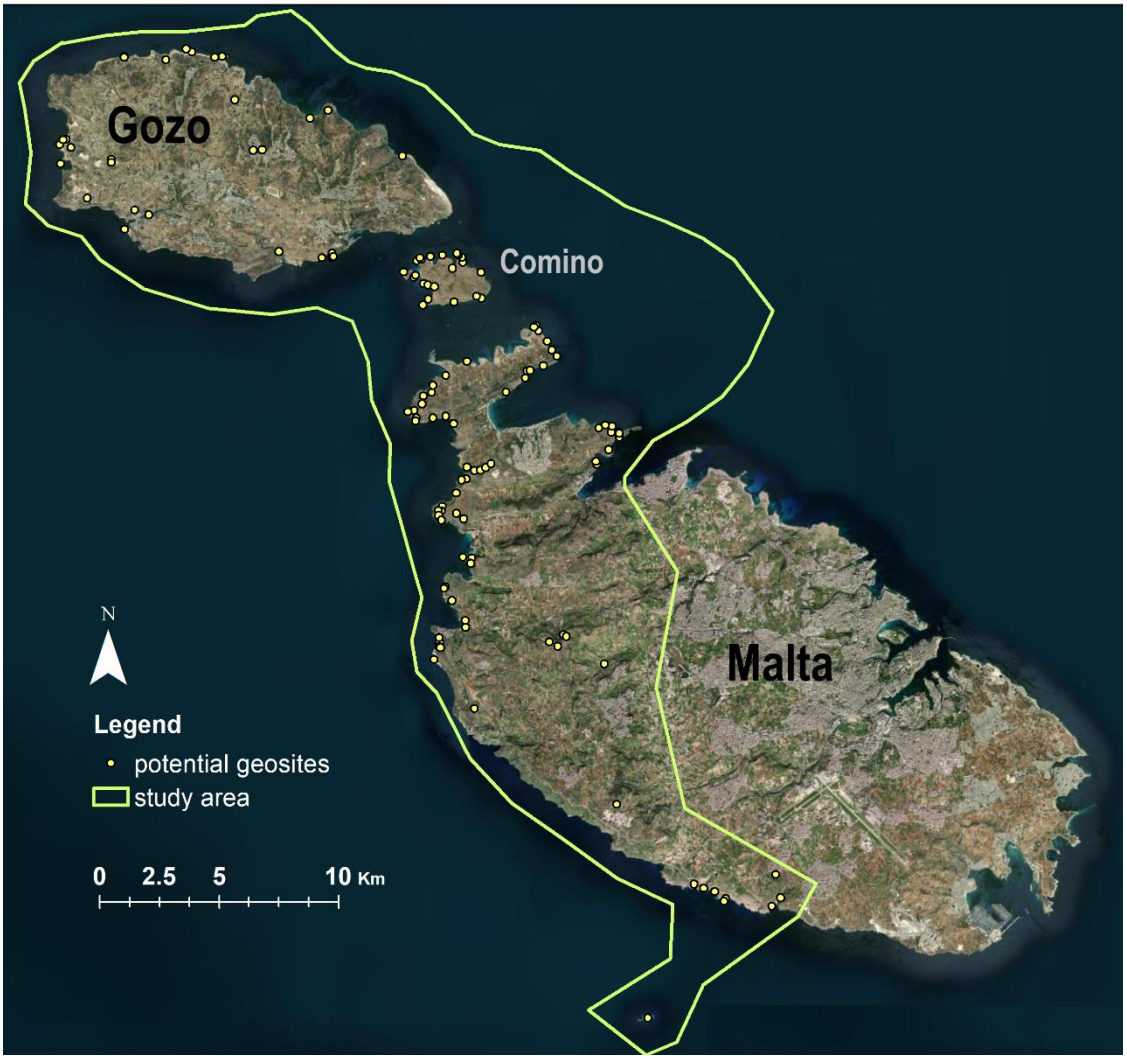
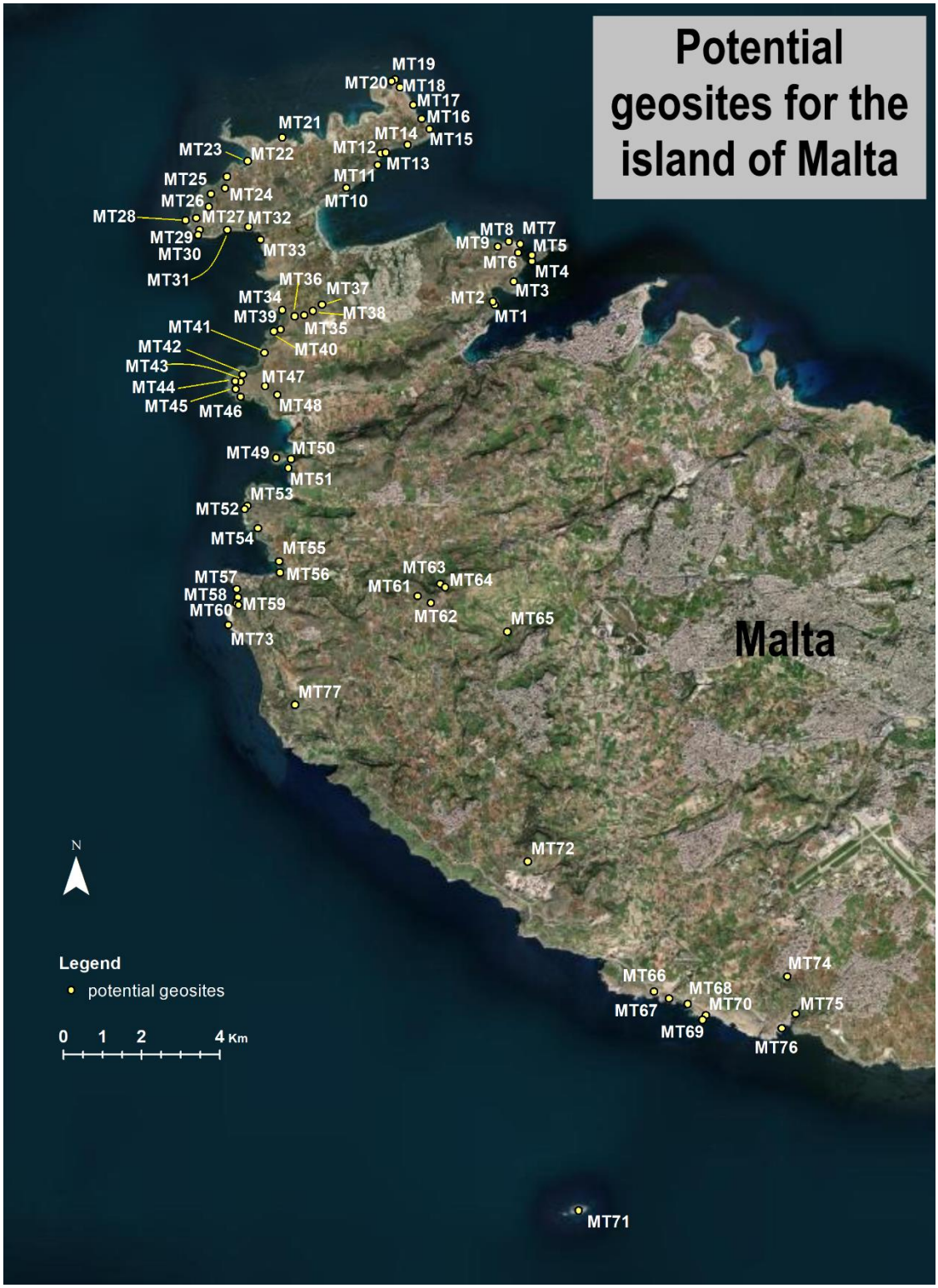


Figure 6.7: Map of the 131 potential geosites recognised on the study area (base map source: ESRI, Digital Globe).


Potential geosites for the island of Malta
Malta
MT19
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MT65
MT77
MT72
MT74
MT66
MT68
MT67
MT70
MT75
MT69
MT76
MT71
N
Legend
potential geosites
0 1 2 4 Km

a

Potential geosites for the island of Gozo
Gozo
GZ1
GZ2
GZ3
GZ4
GZ5
GZ6
GZ7
GZ8
GZ9
GZ10
GZ11
GZ12
GZ13
GZ14
GZ15
GZ16
GZ17
GZ18
GZ19
GZ20
GZ21
GZ22
GZ23
GZ24
GZ25
GZ26
GZ27
GZ28
GZ29
N
0 0.75 1.5 3 Km
Legend
potential geosites

b

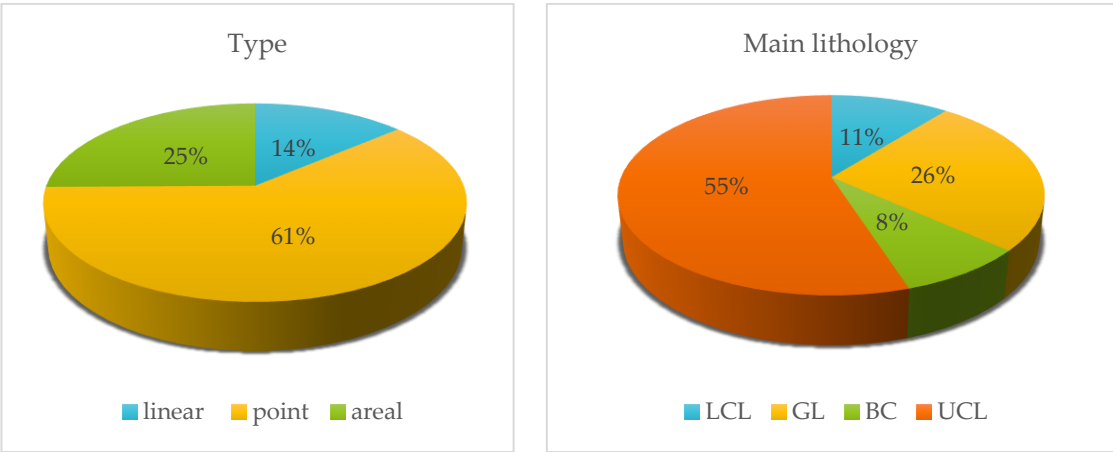
c

Figure 6.8: Maps of the potential geosites located on the a) island of Malta, b) island of Gozo and c) island of Comino (base map source: ESRI, Digital Globe).

6.3 Analysis and characterisation of potential geosites

The bibliography research, field visits and expert interviews have led to analyse 131 selected sites and to compile descriptive cards.

Regarding the type of sites (Figure 6.9a), 80 sites were classified as punctiform (61 %) as they are composed by one limited feature as a sinkhole, a cave or a fossil record; 33 sites were classified as areal (25%) due to their extension in large areas as mass movement or the extreme-wave events deposits that occur in Northern Malta and the North west Comino; 18 sites were classified as linear (14%) due to their linear spatial development as faults or stratigraphical sequences. Most of the sites consist of two or more different lithologies (Figure 6.9b), but considering the main formation that make up the site (Figure 5b), 72 (55%) are composed by Upper Coralline Limestone, 34 (26%) by Globigerina Limestone, 14 (11%) by Lower Globigerina Limestone and the remaining 11 sites (8%) are mainly composed by Blue Clay.



a b

Figure 6.9: a) graph showing the type of the sites; b) graph showing the main formation that made up the sites.

Regarding the main scientific interest (Figure 6.10), most of the potential geosites (77%) have mainly geomorphological primary interest.

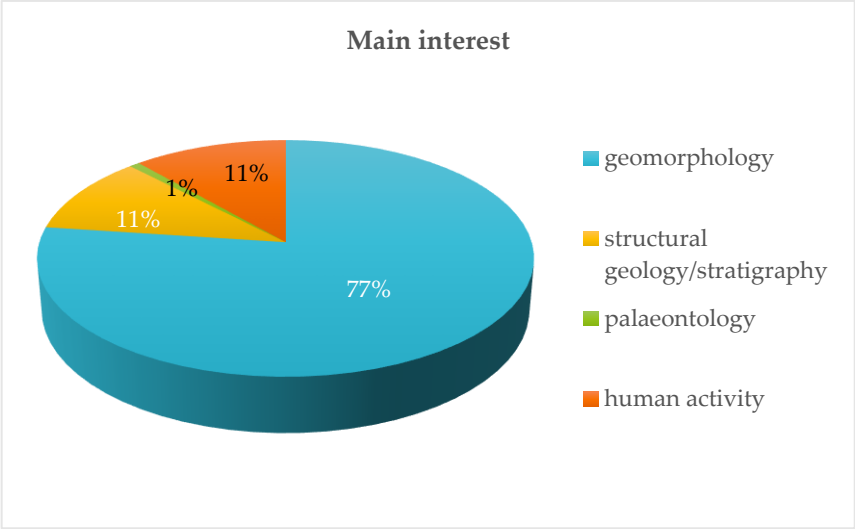


Figure 6.10: Classification of the 131 sites according to the main interest.

The sites with main geomorphological interest display a wide range of features: the features most widespread are impressive mass movements affecting Upper Coralline Limestone plateaus along the coast. They occur especially on the northwestern coastal region of the island of Malta that is characterized by deep-seated gravitational slope deformations, especially lateral spreading and rock topple, due to the different mechanical behavior and diverse hydrogeological conditions of the outcropping lithology (Magri et al., 2008). Karst landscapes are also frequent in the study area: they include solution subsidence structures and dissolution surfaces. The first ones are the most representative landforms in karst landscapes and develop as an outcome of a principal mechanism of solution, collapse and subsidence (Calleja, 2010). Their development is affected by several physical factors, amongst which are lithological, structural and geotectonics characteristics, climate and hydrogeological characteristics (Calleja and Tonelli, 2019). The latter (dissolution surfaces) are karst morphologies characteristic of limestone plateaus that present irregular and rugged shapes and resulting from dissolution processes, usually fulfilled by soil that host a variety of endemic flowers and plants. Along all the coast, the mechanical action of sea waves remodeled the cliffs producing a varied coastal scenery. Stacks, sea arches, marine caves and narrow cleft are the main products of sea erosion. Sites of particular geomorphological interest are also badland landscapes on the Blue Clay slopes, partially

covered by vegetation and partially exposed to the action of water. Last, fluvial landforms both depositional and erosional landforms have been identified: V-shaped small dry valleys in the Upper Coralline Limestone, relicts of former pluvial conditions and extensive groundwater sapping, and large valley beds and alluvial/colluvial cones consisting of Quaternary sediments transported and deposited through gravitational processes and water action (Coratza et al., 2011).

The 11% of the potential geosites (15 sites) have stratigraphic/tectonic interest: examples are the Magħlaq Fault and the Great Fault that show exemplary outcrops with different and contrasting lithology, or St. Paul's Islands that are crossed by one of the major SW-NE faults in the island and which affected the horizontal transition between Upper Coralline Limestone and Upper Globigerina Limestone. In this category are also included a site that shows up all the lithological sequences of the archipelago and the GSSP point that mark the Langhian/Serravallian boundary.

Besides the sites with entirely natural origin, 'anthropogenic sites' were selected. It is about sites of geological and geomorphological interest strictly linked with human activity. On the study area 15 potential geosites were identified (the 11% of all sites) and which display evidence of human activity: such as the cart ruts and salinas (Figure 6.11).

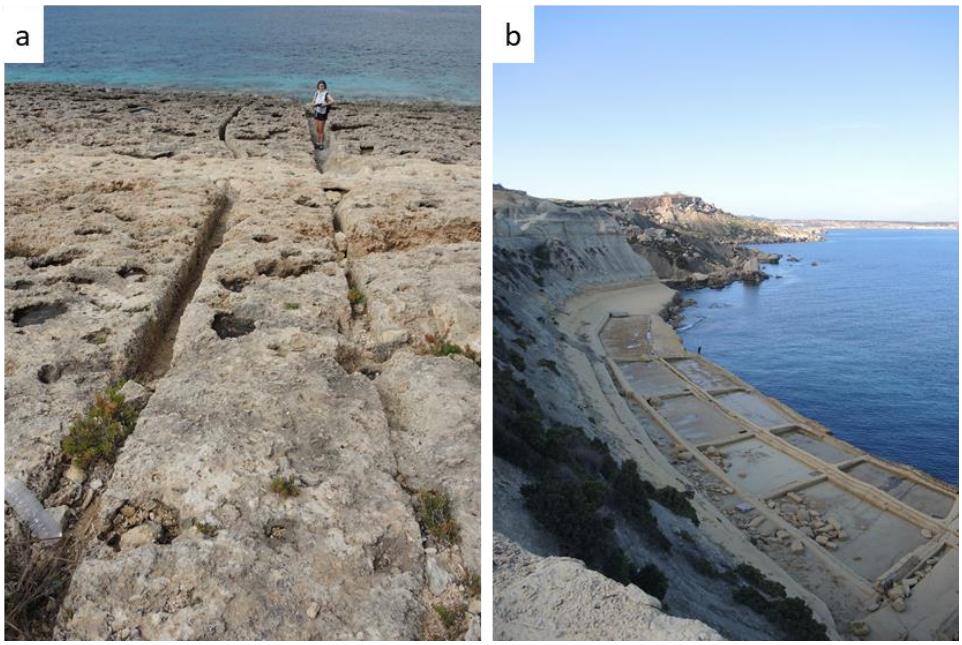


Figure 6.11: Examples of human impact along the Maltese coast; a) cart ruts; b) salinas.

The cart ruts are testimony of ancient human agricultural civilizations - dating more than 7000 years ago – that were hewn in the rock, supposedly by using a slide-cart or wheeled cart. They consist of small-scale erosional landforms incised into Upper Coralline Limestone surface bedrock. Salinas were developed on the rocky shore platforms in soft Globigerina Limestone which provided the ideal coastal setting with the formation of natural pools filled with seawater: these structures were extended and deepened by humans in order to collect seawater for the production of salt (Gauci et al., 2017; Gauci and Inkpen, 2019; Selmi et al., 2019). Both relict and active salt pans can be found along the north-eastern of Malta and northern coasts of Gozo. The remainder 3% have as a main interest in paleontological value and comprises fossils records rich in fossil sharks' teeth in the pelagic limestones and fossil sea urchins (Echinoids).

Almost all the sites are inside a protected area as Natura 2000 or Special Area of Conservation under the Habitats Directive (92/43/EEC) or Special Area of Conservation - International Importance (Marine), but not for their geological significance.

For each potential geosites all the required information was collected to complete the descriptive card. All the cards of the potential geosites are available on Annex 1.

The cards contain information on different values to give a general picture of the sites of geological and geomorphological interest. Considering the main aim of the research, the scientific value is the most detailed section. The additional values as cultural, ecological and historical are reported, but a more detailed characterisation could be required for future research questions, in collaboration with specialists. In particular, the link between geology and ecology is strong in most of the potential geosites, as well as the cultural value. Only the collaboration with specialists of the sector can enrich the information and give high additional value to the potential geosites.

6.4 Preliminary selection of potential geosite

The 131 potential geosites were divided in different categories considering the main interest between geomorphology, structural geology, stratigraphy, paleontology and human activity.

As reported in Figure 6.12, most of the potential geosites, the 77% that consists of 102 potential geosites, have geomorphological main interest. Human activity category consists of 14 potential geosites that correspond to 11% of the total. The 7% (nine potential geosites) has stratigraphical main interest, the 5% (five potential geosites) is classified as structural geology and only one site (corresponding to the 1%) has paleontological main interest. It is important to underline that despite the main interest, almost all the potential geosites present secondary interests. For instance, most of the potential geosites with geomorphological main interest have also paleontological interest, due to the presence of fossil macrofauna represented by echinoids and marine bivalve molluscs. Geomorphological potential geosites may have also stratigraphical secondary interest when the sites are representative of geomorphological features but at the same time show clearly different lithologies.

The 102 potential geosites belonging to the category 'geomorphology' were then subdivided in different sub-categories by considering the main geomorphological processes: gravitational, marine, karstic, and fluvial.

Also in this case the main process acting on the potential geosite was considered. Often the potential geosites are the result of two or even more geomorphological processes. Gravitational, marine and karst processes act almost with the same weighting on the Maltese Islands. The fluvial processes cover only 7% of the total potential geomorphological geosites, since there are few active watercourses in the present morphoclimatic condition. This sub-category comprises dry valleys and fluvial deposits from relict or temporary streams. The sub-category gravitational processes consists of mainly block slides, rock falls and impressive latera spreading phenomena occurring at the edge of limestone plateaus and related landslides accumulations. Marine processes

sub-category mainly includes caves and arches along all the coast. Karst processes are responsible for the development of dissolution subsidence structures, inland and along the coast, and characteristic irregular and rough terrain of surface topography of limestone plateaus and ridges.

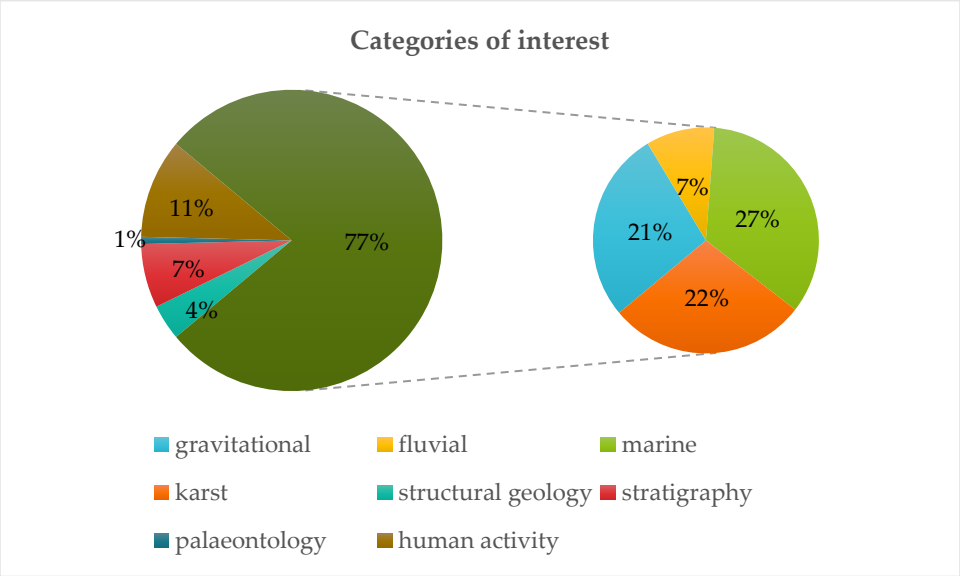


Figure 6.12: Classification of the 131 potential geosites in categories of interest. The category geomorphology is split on its sub-categories based on the main processes.

The 131 potential geosites were analyzed by applying the two sets of criteria proposed by Reynard et al. (2016): the spatial criterion (representative and rareness) and the temporal criterion (active and inherited).

A qualitative evaluation has been carried out on the 131 potential geosites. In order to facilitate the evaluation, a number from one to four was assigned to rareness and representativeness to identify the best potential geosites and preselect each category of interest. The integrity of the potential geosites was also evaluated, to identify the sites in the best state of conservation. The results of the evaluation are reported on Table 6.2.

The potential geosites that reach a high score in integrity and the maximum score in representativeness or rareness were selected for the final list of potential geosites. The maximum score in representativeness ensures that the preselected geosite is one of the best examples of a recurrent feature typical of the archipelago. The maximum score in rareness is reached from the preselected geosites that are exceptionally important due to their uncommon presence.

The preselection of potential geosites led to the establishment of a final list of potential geosites: the list is representative of the principal geological and geomorphological contexts of the study area and comprises both active sites and inherited sites that represent the various stages of the regional morphogenesis. It also contains specific and rare landforms that occurs in the study area. All the potential geosites selected present a good state of conservation.

The list comprises 55 potential geosites, 32 located on the island of Malta, 13 on the island of Gozo and 10 on Comino (Figure 6.13). The preselection of potential geosites allows to narrow the attention on only those sites that are more representative or rare and well preserved in the study area.

In that respect, the quantitative assessment has been conducted only on the list of the preselected potential geosites.

Tabella 6.2: Preliminary selection of potential geosites.

STRATIGRAPHY	representative	rare	integrity
MT67	2	2	4
MT10	2	2	2
MT54	0	4	4
GZ22	2	1	2
GZ24	0	2	4
GZ26	0	2	4
GZ23	2	2	2
MT59	4	2	4
GZ25	2	0	2
PALEONTOLOGY			
MT58	4	2	4
HUMAN ACTIVITY			
MT21	4	0	1
MT61	4	0	2
MT62	4	0	2
MT72	4	0	4
MT6	4	0	1
MT7	4	0	2
MT8	4	0	4
MT73	4	0	4
GZ6	2	1	2
GZ30	2	1	1
GZ3	4	0	2
GZ4	4	0	4
GZ17	4	0	4
GZ15	4	0	4

GEOMORPHOLOGY			
Gravitational			
	representative	rare	integrity
MT1	4	0	4
MT3	4	0	2
MT13	4	0	1
MT14	4	0	1
MT15	4	0	1
MT16	4	0	1
MT22	4	0	4
MT23	4	0	4
MT25	4	0	4
NT26	4	0	4
MT40	4	0	2
MT41	4	0	2
MT42	4	0	4
MT44	4	0	2
MT45	4	0	4
MT49	4	0	4
MT11	4	0	2
MT71	4	0	2
MT9	4	0	4
MT12	2	0	2
MT27	4	0	2
MT29	4	0	4
MT34	4	0	4
MT46	4	0	2
MT50	4	0	4
MT52	4	0	2
MT55	4	0	4
GZ16	4	2	4

Marine	representative	rare	integrity
MT17	4	0	2
MT33	4	0	2
MT20	2	0	2
MT4	4	0	2
MT51	2	1	2
MT53	4	4	4
MT57	4	0	2
MT64	4	0	4
MT66	4	0	4
MT69	4	1	4
MT76	4	2	4
MT77	2	4	4
GZ1	4	4	4
GZ9	4	4	4
CM1	4	0	4
CM10	4	0	2
CM15	4	0	4
CM16	4	0	2
CM17	4	0	2
CM24	4	2	4
CM5	4	2	4
CM6	4	0	2
CM7	4	0	2
CM8	4	2	2
CM9	4	1	2
CM19	4	1	4
CM2	2	1	2
CM4	2	1	2
CM20	4	1	4
CM18	2	2	4
CM12	4	0	2
CM23	4	0	4
CM3	2	0	2
CM21	2	0	2
CM22	2	0	2
GZ13	2	0	2

Karst	representative	rare	integrity
MT18	4	0	4
MT30	4	0	4
MT39	4	4	4
MT43	4	0	4
MT47	4	0	4
MT19	4	4	4
MT2	4	2	2
MT24	4	2	4
MT36	4	1	1
MT38	4	1	1
MT74	4	2	4
GZ10	4	0	4
GZ8	4	4	4
GZ11	4	0	2
GZ12	4	0	2
GZ7	4	2	4
GZ28	4	2	4
GZ29	4	2	1
GZ5	4	4	4
GZ19	4	4	4
GZ18	4	2	4
GZ20	4	4	4
CM11	4	1	2
CM14	4	2	4
CM13	0	2	2
GZ27	0	2	2
MT60	2	2	1
MT28	2	2	2
MT31	4	4	4
Fluvial			
MT35	2	0	2
MT37	2	0	2
MT48	2	0	2
MT65	2	4	4
MT63	2	0	2
MT75	2	0	4
GZ2	4	1	4
GZ14	2	0	4
GZ21	2	0	4
CM25	2	2	2

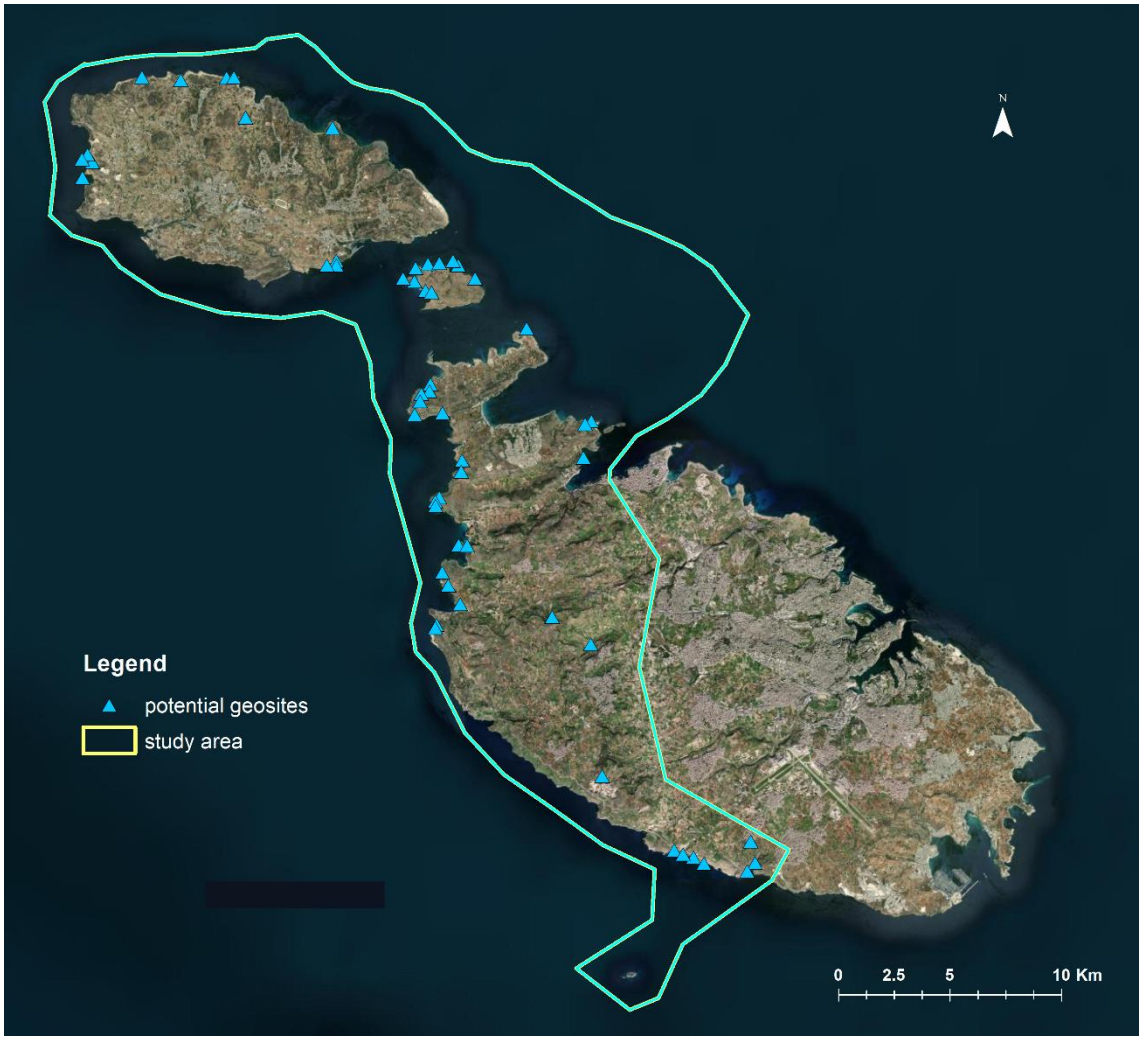


Figure 6.13: Map showing the 55 potential geosites selected with the preselection (base map source: ESRI, Digital Globe).

6.5 Quantitative assessment and selection of geosites

The 55 potential geosites have been assessed through the quantitative methodologies by Reynard et al. (2007) and Brilha (2016), modified and described in paragraph 5.5.4.

The methodologies assessed the scientific value considering several criteria and parameters. The additional value of the potential geosites was also assessed as fundamental to consider the sites for educational and touristic purpose.

The scores obtained from each criterion in both the quantitative assessment methodologies are included in Annex 2.

The assessment methodologies use different scoring systems, zero–one in Reynard et al.

(2007) and zero-100 (with a weighting) in Brilha (2016).

6.5.1 Scientific value and geosites

The scientific value varies greatly per potential geosite. Analysing the total scores in scientific value, graphically shown on Figure 6.14, it is clearly visible that in most of the cases, the potential geosites exceed half of the possible score for this indicator.

Applying the methodology of Brilha (2016) sites MT31, MT32, MT49, MT53, MT54, MT76 and GZ10 ranked above 80/100 of the total score, while applying that of Reynard et al. (2007) only MT5 received a high value. The higher number of criteria and parameters for scientific value for Brilha (2016) gives more scattered range, while the scientific value of Reynard et al. (2007) only depends on four parameters. Therefore, values of geosites in this respect tend to be lower.

Considering the criteria assessed by Brilha (2016) (Annex 3a), most of the potential geosites reached high score in representativeness (vertex number one in the radar graphs, Annex 3a), because they are the best examples to illustrate elements or processes related with the geological and geomorphological framework considered. Use limitations criteria (vertex number seven in the radar graphs, Annex 3a) reached also high scores because all the potential geosites do not present any limitation for sampling or fieldwork. Most of the potential geosites, in particular those located in the island of Gozo, Comino and south Malta have low score or zero in scientific knowledge (vertex number three in the radar graph, Annex 3a), due to the absence of international and national papers directly related with the geological elements or the geological framework under consideration. MT54 reached the maximum score in all the criteria, except for the low geological diversity.

Considering the criteria assessed by Reynard et al. (2007) (Annex 3b), all the potential geosites present high score in representativeness (vertex number one in the radar graphs, Annex 3b). The rareness criterium reach high score in few sites as MT39, GZ10 and GZ28 (vertex number three in the radar graphs, Annex 3b). The paleogeographical criterion (vertex number four in the radar graphs, Annex 3b) is mostly low or zero, except for

MT54 and MT5.

All the potential geosites scored highly in integrity in both methodologies, as the main geological elements and landforms are well preserved.

In order to compare the final results in scientific value obtained from the application of the two methodologies, each value was recalculated as a percentage of the maximum score (Table 6.3). The results were analysed and a list of final geosites was compiled.

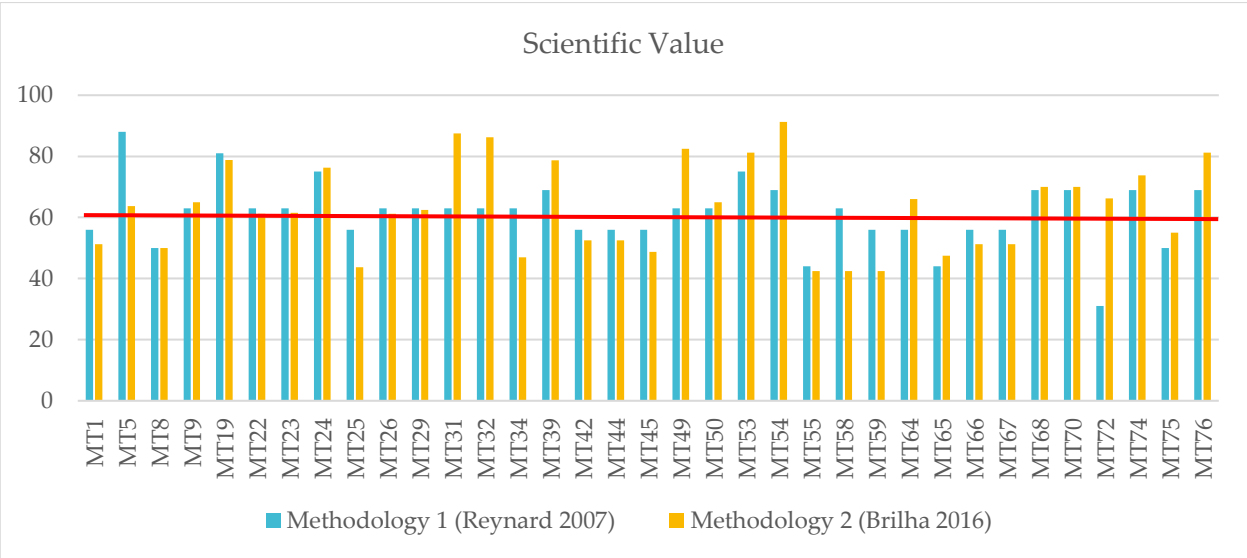
Table 6.3: Selection of geosites from the results of the two quantitative methodologies.

Site	Methodology 1 (Reynard et al., 2007)	Methodology 2 (Brilha 2016)
MT1	56,00	51,25
MT5	88,00	63,75
MT8	50,00	50,00
MT9	63,00	65,00
MT19	81,00	78,80
MT22	63,00	61,25
MT23	63,00	61,52
MT24	75,00	76,30
MT25	56,00	43,75
MT26	63,00	61,25
MT29	63,00	62,50
MT31	63,00	87,50
MT32	63,00	86,25
MT34	63,00	47,00
MT39	69,00	78,75
MT42	56,00	52,50
MT44	56,00	52,50
MT45	56,00	48,75
MT49	63,00	82,50
MT50	63,00	65,00
MT53	75,00	81,25
MT54	69,00	91,25
MT55	44,00	42,50
MT58	63,00	42,50
MT59	56,00	42,50
MT64	56,00	66,00
MT65	44,00	47,50
MT66	56,00	51,25
MT67	56,00	51,25
MT68	69,00	70,00

Site	Methodology 1 (Reynard et al., 2007)	Methodology 2 (Brilha, 2016)
GZ1	63,00	66,25
GZ2	69,00	51,25
GZ4	50,00	50,00
GZ5	69,00	70,00
GZ6	50,00	38,75
GZ7	63,00	73,75
GZ8	56,00	63,75
GZ9	56,00	50,00
GZ10	75,00	82,50
GZ15	50,00	55,00
GZ16	63,00	75,00
GZ17	50,00	50,00
GZ18	56,00	57,50
GZ28	63,00	77,50
CM1	50,00	55,75
CM5	50,00	63,75
CM8	56,00	48,65
CM14	69,00	65,00
CM15	56,00	63,75
CM18	44,00	63,75
CM19	63,00	61,25
CM20	63,00	51,25
CM23	38,00	48,75
CM24	44,00	48,75

MT70	69,00	70,00
MT72	31,00	66,25
MT74	69,00	73,75
MT75	50,00	55,00
MT76	69,00	81,25

The potential geosites that reached a score higher that 60/100 on both the methodologies were selected as geosites (Figure 6.14).



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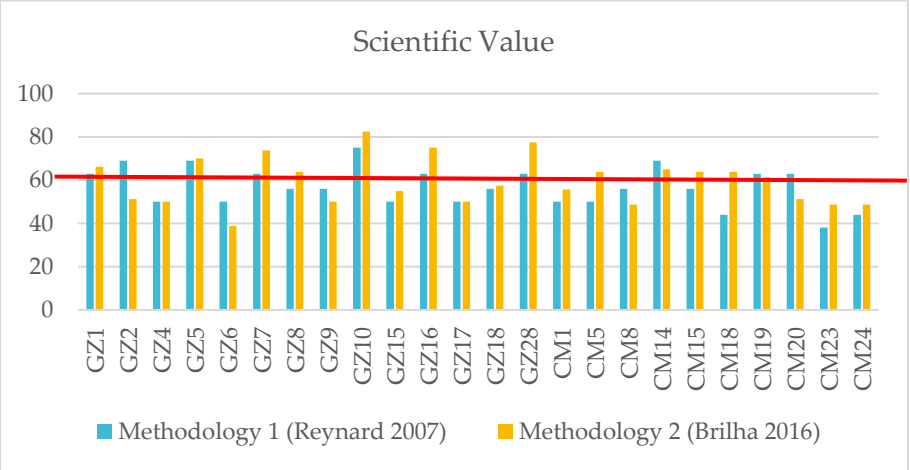

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Figure 6.14: Graphs showing the scientific value achieved from each potential geosites with the two methodologies proposed. a) Potential geosites assessment of the island of Malta. B) Potential geosites assessment of the islands of Gozo and Comino. A horizontal red line marks the score 60 above which the sites are considered geosite.

As a result of the assessment, 27 sites were selected as geosites due to their high scientific value, 19 located in Malta, six in Gozo and two in Comino (Figure 6.15).

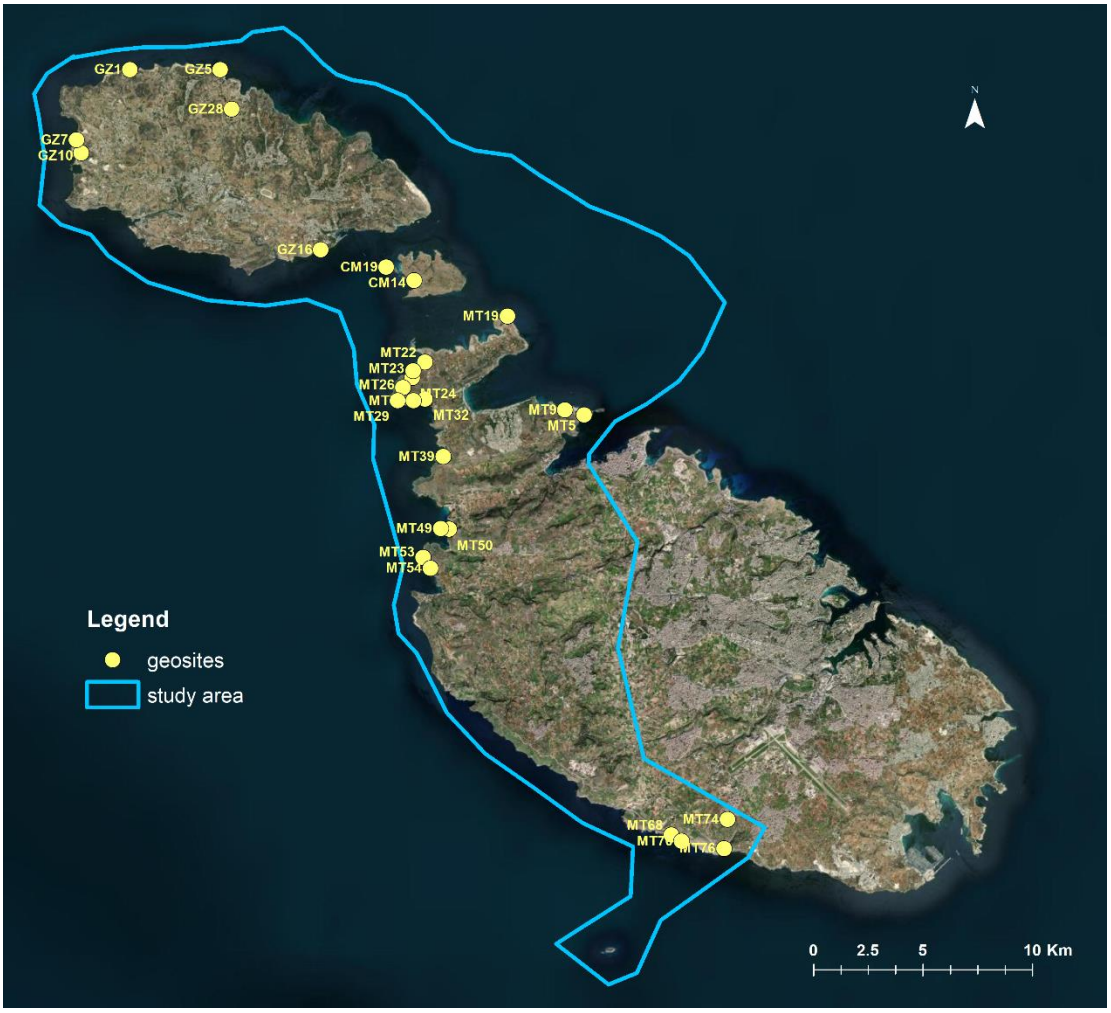


Figure 6.15: Map showing the 27 geosites assessed inside the study area.

The 27 geosites are scattered along the study area. Most of them (89%, 24 geosites), are located along the coast and only 11%, (three geosites) is located inland (Figure 6.16a). The 85% has as primary geomorphological interest, 11% structural geology and 4% stratigraphy (Figure 6.16b). No geosites with primary paleontological and human activity interest were selected due to their low scientific relevance. The latter potential geosites have usually high score in additional value due to their connection with cultural and ecological value. Almost all the geosites (23 on 27) are inside a protected area and are considered Special Areas of Conservation and Natura 2000 under the Habitat

Directive (92/43/EEC), but always considering their international ecological importance (Figure 6.16c).

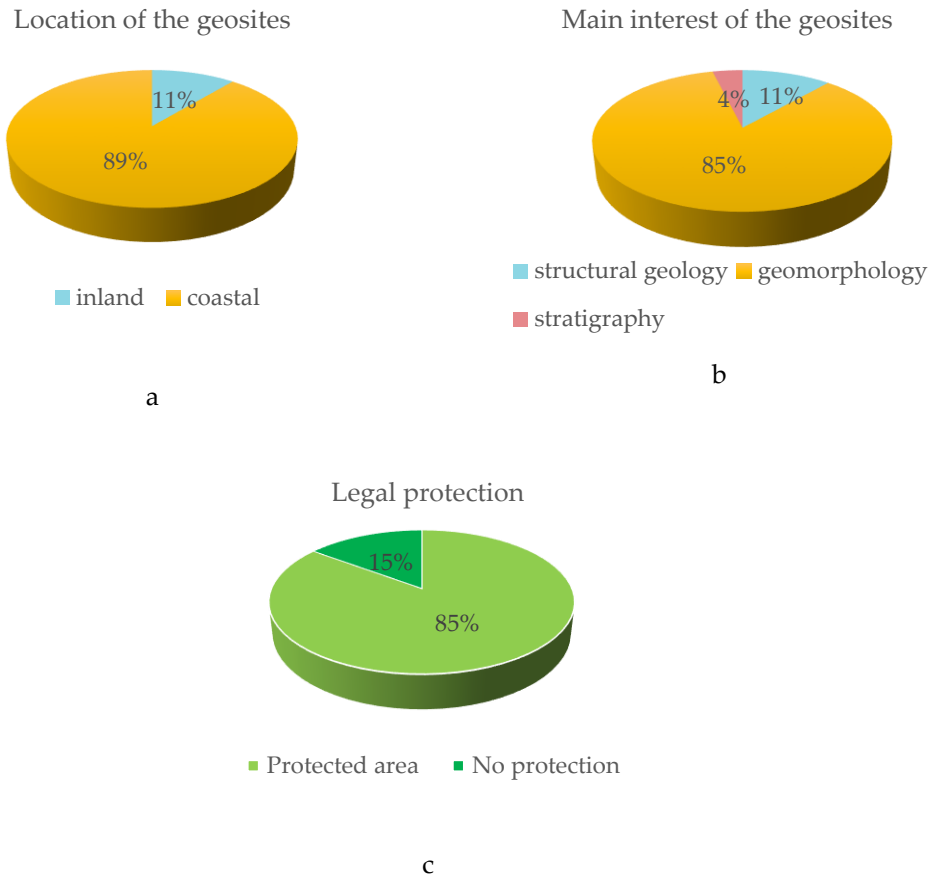


Figure 6.16: a) distribution of the geosites by location; b) main interest of the geosites; c) legal protection of the geosites.

6.5.2 Additional value and geodiversity sites

The assessment of geodiversity sites was not the primary goal of this study, since the focus was on the scientific relevance of the potential geosites. However, the additional value was also assessed and analysed.

The large number of indicators of additional value, in particular in the methodology of Brilha (2016), gave the possibility to consider the high potential of the study area for its touristic, economic and educational interest. Touristic and educational potentials are in fact measured quantitatively only by Brilha (2016).

The aesthetical and ecological values are considered in both methodologies, but the scores are usually low. The high scores on ecological value refer mainly to the location of almost all the potential geosites in protected areas. During the fieldwork, it was observed a rich flora that provides an important environment especially for wildlife. Detailed studies about the assessment of flora and fauna are suggested to acquire more specific data.

The cultural value and ecological value of Reynard et al. (2007) are treated as a separate indicator group. These values are evaluated by Brilha in the criterion 'association with other values'. As evidenced by the Reynard's assessment, the cultural value is generally low, considering the low artistic, literature, religious and historical importance related to the potential geosites. However, high level of cultural value can be found in the surrounding 10 km of the potential geosites. Most of the potential geosites, even the most spectacular and outstanding landscapes, obtained low score in scenery criterion. In fact, most of them are still not considered as tourist destinations, and thus they are not used as tourist's destination in national or even local campaigns.

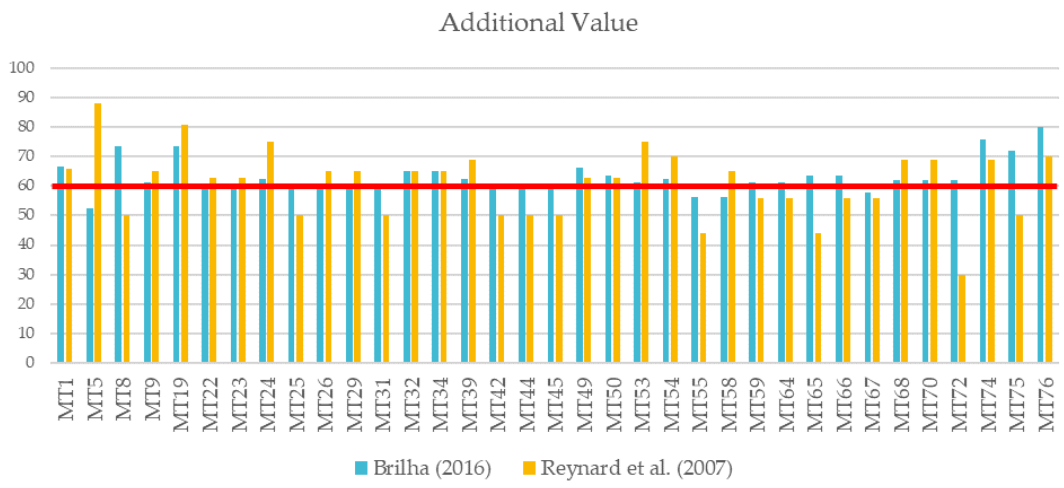
The specific evaluation from Reynard et al. (2007) is based on current and overall viewpoints of how general culture is represented in scientific literature and in individual feedback collected from scientists and local guides. However, future consultation with experts could improve the concept about the cultural impact of the geosites.

In applying the assessment by Brilha (2016), the use limitation criterion reached high scores since currently the potential geosites have no limitation and can be easily reached and used by students and tourists. The small size of the Maltese Islands amplifies the additional value because restaurants, hotels and other important services to accommodate tourists tend to be located in the vicinity of the potential geosites. Almost all the potential geosites have high interpretative potential: they present geological elements and landforms in a very clear and expressive way to all types of public, and hence can be considered excellent for educational activities. In addition, almost all the potential geosites are also related with ecological and aesthetical value.

In order to compare the results for additional value, obtained from the application of the two methodologies, each value was recalculated as a percentage of the maximum

score.

The potential geosites that reached a score higher that 60/100 on both methodologies were considered worthy of recognition for their additional value. The results are reported on Figure 6.17.



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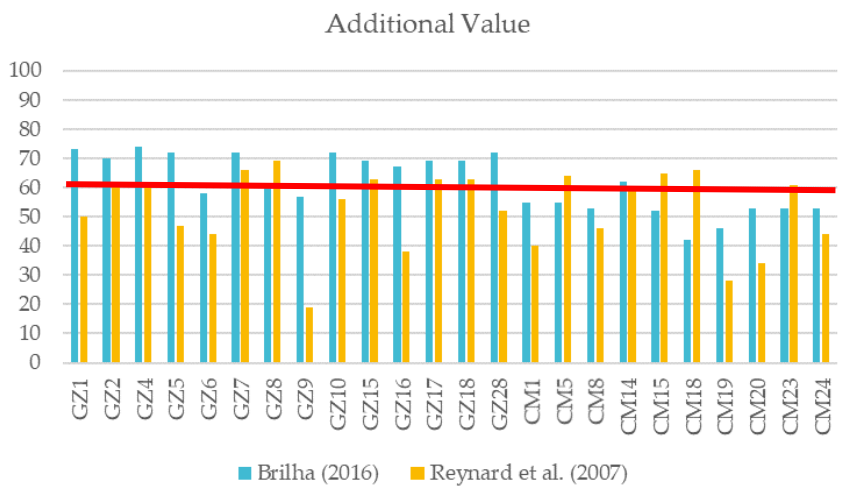

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Figure 6.17: Graphs showing the additional value achieved from each potential geosites with the two methodologies proposed. a) The graph reports the potential geosites of the island of Malta. B) The graph reports the potential geosites of the islands of Gozo and Comino. A horizontal red line marks the score 60 above which the sites are considered site with high additional value.

The potential geosites that reach a high score in additional value are 21. Analysing the 21 sites it is possible to note that most of them were already selected as geosites for their high scientific value. For this, they are considered as geosites with high additional interest. The other sites that were not selected as geosites but have high added vale are considered as geodiversity sites (Figure 6.18).

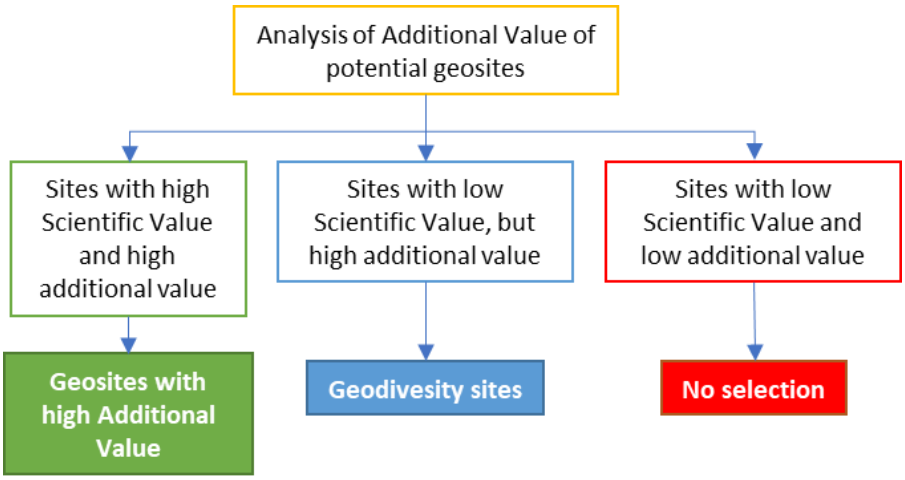


Figure 6.18: Classification of the additional value of the potential geosites.

For this reason, a list of geosites with additional value and a list of geodiversity sites was produced (Table 6.4). Fourteen geosites with high additional value and seven geodiversity sites were identified.

The additional value of geosites and the presence of geodiversity sites on the study area is of paramount importance for its application as UNESCO Global Geopark. Geoparks are in fact designed to promote the sustainable development of local populations and are based on the conservation tools of natural and cultural assets and on the promotion of education and sustainable tourism (Patzak and Eder, 1998; Eder, 1999; Eder and Patzak, 2004; Zouros, 2004; Brilha, 2016). The geodiversity sites have moderate or irrelevant scientific relevance, but are important resources for education, tourism, or cultural identity of communities. Thus, geodiversity sites could be considered complementary to the list of geosites with primary scientific interest. They are geological features which can be easily understood by students of different levels of education, with

comfortable and quick access and where students may observe the site under good safety conditions (Brilha, 2016).

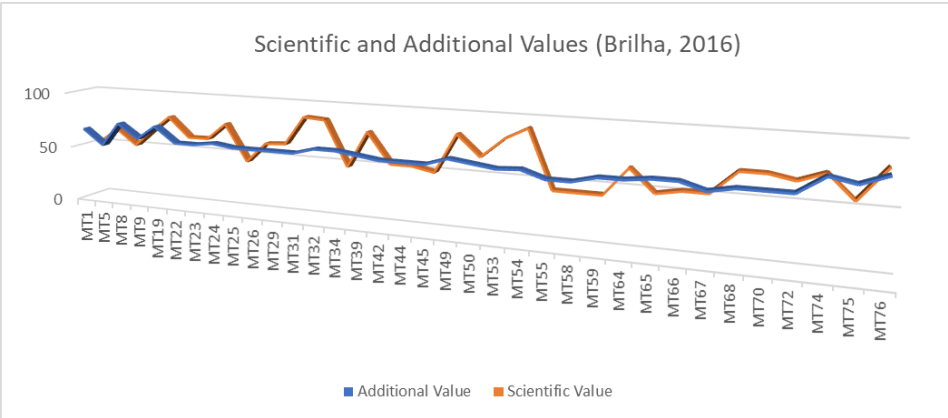
Table 6.4: Classification of the potential geosites with high additional value.

Geosites with high additional value		Geodivesity sites
MT9	MT53	MT1
MT19	MT54	MT34
MT24	MT68	GZ2
MT32	MT70	GZ4
MT39	MT74	GZ15
MT49	MT76	GZ17
MT50	GZ7	GZ18

The geodiversity sites are mainly located on the island of Gozo and in most cases, they are sites that are already known from a touristic point of view. They present a direct connection with cultural and historical values. For example, the sites GZ4, active salinas on Globigerina Limestone platforms located on northeast Gozo, present high additional value due to its cultural and economic importance, but also show the relation between the geology of the island and human landforms. In the same way, sites GZ15 and GZ17, located respectively on the northeast and south of the island of Gozo, present ancient salinas manually hewn out of shore platform surfaces in Globigerina Limestone and have high cultural and historical value that testify the history of coastal land use development on the Maltese Islands (Gauci and Inkpen, 2019; Sammut et al., 2019).
The other geodiversity sites (MT1, MT34, GZ2, and GZ18) are frequented by locals and tourists for recreational activities. They are famous and visited for their high aesthetical value, as they are endowed with both strategic viewpoints and outstanding landscapes.

6.5.3 Final remarks on Scientific and Additional values

An analysis between the scientific value and the additional value has been conducted. In applying the assessment model by Brilha (2016), the additional value of the potential geosites of mainland Malta is constant, while the scientific value shows more range of values for each site (Figure 6.19) .



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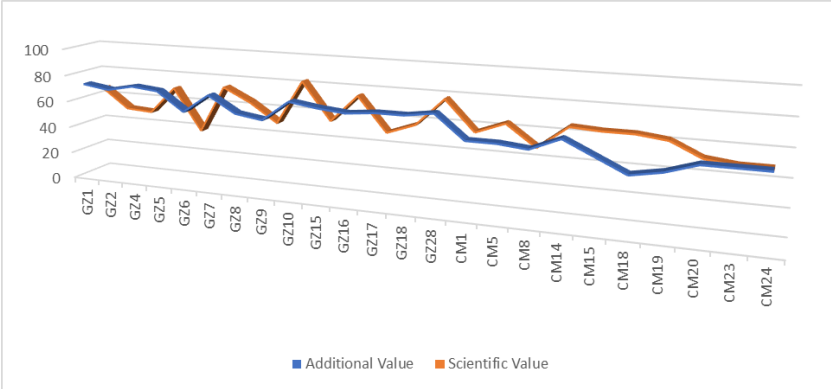

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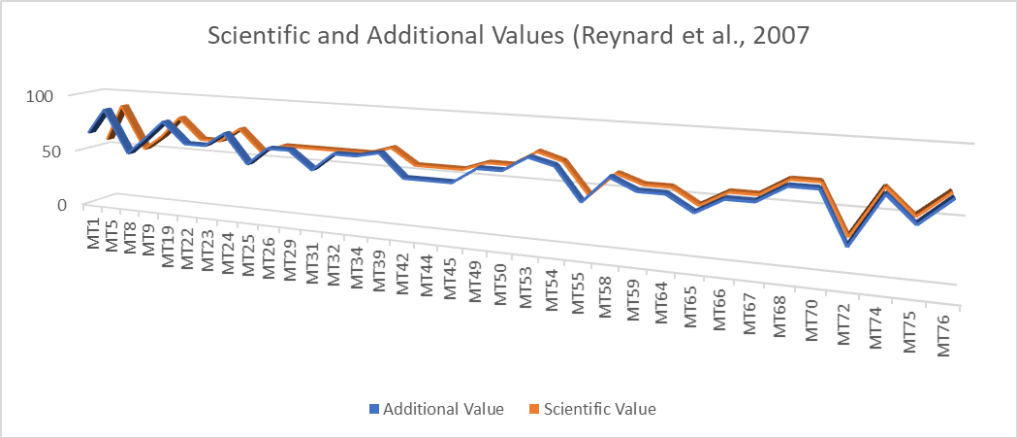
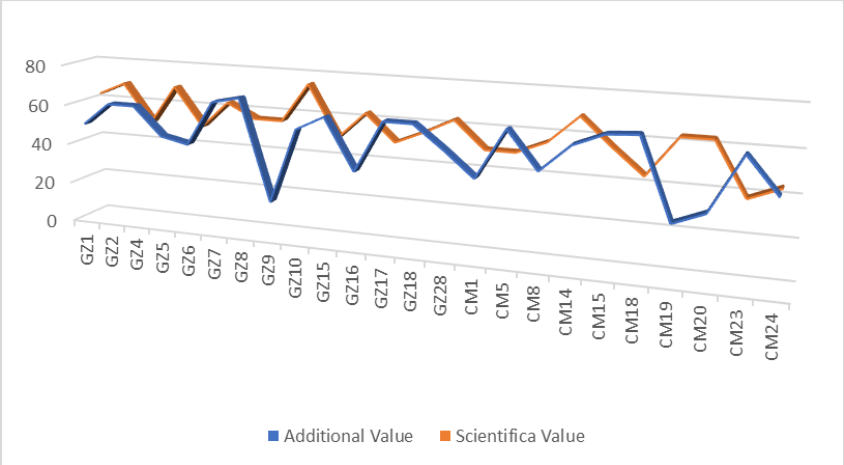
Figura 6.19: Comparison between additional and scientific value by Brilha (2016). a) Geosites in Malta; b) Geosites in Gozo and Comino.

Reynard et al.'s assessment model reveals that the additional value and scientific value follow the same range for the mainland Malta. On the islands of Gozo and Comino the scientific value shows a wider range of scores when compared to the additional value (Figure 6.20). The additional value got very low scores (e.g., GZ9, GZ16, CM19 and CM20) mainly due to the absence of cultural value and low ecological importance assessed.



a



b

Figure 6.20: Comparison between additional and scientific value by Reynard et al. (2007) a) Geosites in Malta; b) geosites in Gozo and Comino.

In terms of the scientific values, the two methodologies indicated a significant outcome, despite their different evaluation criteria. From the viewpoint of the evaluator, both of them show advantages, while in other aspects, they perform less well when compared with others. The parallel use and comparison of multiple assessment methodologies provide the most robust way of (i) recognizing and selecting geosites for their scientific value, (ii) recognizing and selecting geodiversity sites, important for educational and touristic purpose and (iii) raising awareness on geoheritage and promoting geoconservation practices. Parallel application and comparison of different assessment

methodologies are equally advantageous: even though they require extra time, it is worthwhile due to the more diverse overview of characteristics they give.

To conclude, the two methodologies applied to the identification of geosites are focused on the scientific value, and the scientific value was the only one considered on the selection of geosites. The application of other methodologies developed for other purposes as touristic or educational, can lead to a different number of sites.
The results obtained within this inventory shall not be considered immutable, they could be reviewed and revaluated with new scientific knowledge of the study area.

6.6 Description of the 27 geosites

A description of each of the 27 geosites that were finally selected is elaborated in the following sections. The sites are in ascending order considering their ID number, starting from the Maltese geosites, Gozitan and finally Comino. Pictures of the 27 geosites are reported on Figure 6.21.

MT5 St. Paul's Islands fault

St. Paul's Islands are located in the northeast coast of Malta at ca. 80 m away from the Tal-Blata l-Bajda shore platform, Selmun. The Selmun area is niche of diversity in the geomorphological landscape of the archipelago primarily defined by the tectonic structure, geological outcrops and the supply of sediments to the coastal zone, strictly linked with land use and history. St. Paul's Islands are actually not an archipelago, but consist in two islets connected together by an isthmus long about ca. 100 m and 20 - 25 m wide. The isthmus is submerged during bad weather days, giving the appearance of St Paul's Islands as being two separate islets. The total length of St Paul's Islands is 885 m, with a maximum wide of 200 m. The larger section of the islands is closer to the mainland and covers an area of ca. 0.07 km^2, with ca. 480 m in length (Sciberras and Schembri, 2008).

St Paul's Islands are made up mainly of Upper Coralline Limestone, in particular of the Tal-Pitkal Member, that represents the entire surface morphology of the islets. The special feature of the islands is the faulting system that reflects the ones on the nearby mainland: the islands are crossed by a direct fault that has brought the Upper Coralline Limestone in juxtaposition with Upper Globigerina Limestone. The latter outcrops as a small cliff with a narrow shore platform at the base, with morphological characteristics similar to the nearby Blata l-Bajda platform, the latter accessible from the coast of the mainland. The tilting of St. Paul's Islands surfaces was probably caused by the slipping of the Upper Coralline Limestone block over the underlying slippery Blue Clay layer (Sammut et al., 2019). This outcrop is the only one of its kind in the archipelago especially for its clarity and good conservation of the resultant tectonic process. The coast of the islets also features a number of marine caves (Selmi et al., 2019).

Wih regard to legal protection, in 1986 the islands were declared as a Specially Protected Area under the SPA Protocol (Barcelona Convention) and subsequently designated as a Nature Reserve via Government Notice (GN) 25/1993. Nowadays, they incorporate three EU Natura2000 sites (Sammut et al., 2019; Spiteri and Stevens, 2019). In addition, the geomorphologic features of coastal caves, shore platforms and low cliffs in the area fall within the conservation policy of Coastal Cliffs Area of High Landscape Value of 1996 (AHLV) (GN 400/96). The islets are considered Level 2 Site of Scientific Importance (SSI) for their geomorphology (GN 827 of 2002). Archaeological evidence is found on the site: building remains and ruins of dry-stone walled remains, especially in the central and eastern parts of the larger island, that testify the presence of cultivation and animal husbandry, (practices abandoned in the 1940s) and paleochristian tombs (Farrugia Randon, 2006).

MT9 Badland topography in Blue Clay slopes

The geosite is located at Blata l–Bajda, between the salinas in Globigerina Limestone and the fragmented plateau of Upper Coralline Limestone (Selmi et al., 2019). It consists of Blue Clay slopes with occasional scattered vegetation patches. The Blue Clay Fm. is exposed due to tectonic processes in vicinity of Blata l-Bajda: an ENE-trending normal

fault slicing through the area at an angle of 40° to the shore platform, down throwing to the north and exposing both a vertical cliff face and a hanging scarp covered by thick Blue Clay layers facing north-west (Micallef, 2002; Sammut et al., 2019). Badland topography in Blue Clay slopes consists of sequences of alternating paleo-grey and dark-grey banded marls with lighter bands. The different bands of colour derive mainly from the different concentrations of calcium carbonate in the form of fossils of planktonic and benthonic foraminifera. The light-coloured layers are associated to higher calcium carbonate content, mostly in the form of planktonic and benthonic foraminifera with lower kaolinite content and with a clay contentment that ranges from 80 to 60%. The dark-coloured layers are composed by 90 to 94% of pure clay. The low permeability of the clay, the steep gradients and the torrential nature of Mediterranean rainfall combined with the scarce vegetation favour the rills and gullies development, which in turn are responsible for sediment erosion across the steep slopes. The erosional process favours also the debris deposition at the base of the slopes in the form on fanglomerates (i.e. conglomerate rock fragments of all sizes deposited in an alluvial fan) (Sammut et al., 2019). The geosite is included in an area which incorporates three EU Natura 2000 sites (Spiteri and Stevens, 2019). The geosite lends itself to be the destination of a number of activities related to other subjects, such as history, ecology and biology due to the presence of salinas, military fortifications and green areas (Selmi et al., 2019). The geosite is widely used by locals for recreational activities such as hiking, cycling, motorcycling and hunting due to its easy accessibility. These recreational activities are a potential threat to the exposed Blue Clay slopes: for example, the increased force caused by off-roading vehicles on dry clay pulverises the surface layer, meaning that interstices within the clay particles become blocked, enhancing erosion (Axiak, 1999; Sammut et al., 2019).

MT19 Dragonara sinkhole

The site is a closed sub-circular depression linked to a post-Miocene karst system. The site is located along the coast at Il-Ponta tal-Aħrax, on the eastern coast of Marfa Ridge (Malta), developed in the Upper Coralline Limestone Fm.. The structure was classified by Tonelli (2014) as a quaternary collapse sinkhole. This structure is created as a result

of the corrosive action of rainwater with limestone which enlarges a cave to an extent where the cave's roof becomes unstable and collapses. The Aħrax site lies 10 m above sea level; for this reason, it is regarded as a panoramic lookout point from where it is possible to view all Marfa peninsula, Gozo and Comino (Selmi et al., 2019). It is representative as one of the best examples of quaternary collapse sinkholes that characterise various places on the archipelago. It is also a rare feature being the only sinkhole in Malta that present a direct connection with the sea, producing a large blowhole. High is also its score in integrity, since the circular walls that form the sinkhole are still intact.

The site is inside a Natura 2000 and a Special Area of Conservation under the Habitats Directive (92/43/EEC) and a marine area of international importance.

The site is known by the locals as Id-Dragonara and is currently considered as a site with aesthetical value frequented by recreational activities, a place of interest for diving and kayaking due to its connection with the sea.

MT22 Paradise Bay

Semi-circular cove developed from karst process and the surrounding submarine area. Paradise Bay is a boulder 'amphitheatres' formed by sea erosion and wave action in particular on Blue Clay Fm overlain by the Upper Coralline Limestone (Paskoff and Sanlaville, 1978). As a result of these processes, the site is a structure formed by boulder fields which slide down over the Blue Clay and evolve in the shape of an ellipse (Gauci and Scerri, 2019). The geosite has high scientific value for its landslide features, being a spectacular site with lateral spreading and rock topple in Upper Coralline Limestone Fm.. The geosite is representative of the karst processes that play an important role in the whole archipelago due to the extensive presence of limestone. It is the best example of semi-circular coves of the island. The geosite includes also one of the most popular pocket sandy beaches of the archipelago. The site is known by the locals as Il-Bajja tac-Ċirkewwa, better called as Paradise Bay due to the clear sea waters that fringe the white sandy beach. The bay is also popular for shore diving. The whole area is easily accessible via public services and directly connected with a secondary road that could favour

educational activities. It is inside a Natura 2000 and Special Area of Conservation under the Habitat Directive (92/43/EEC) for the ecological importance of the area.

MT23 Ta' Qassisu: Area affected by rock spreading

The site is located at the northwestern coast of Malta, Ta' Qassisu area. The rock spreading phenomena are characteristic of the western sector of Malta, where Upper Coralline Limestone plateaus outcrop on the coast above soft layers of Blue Clay sediments. This geosite consists of one of the best examples of rock spreading in the study area where is possible to distinguish how the blocks detach from the plateau and move slowly towards the coast. The geosite is mainly composed by Upper Coralline Limestone. A layer of Blue Clay lays at the bottom of the plateau favouring the lateral spreading phenomena. The Upper Coralline Limestone plateau is heavily jointed and faulted, resulting from past tectonic activity. Fractures on the plateau, especially on its edge, play an important role in destablizing of the limestone cap rock, favoring processes of detachment and the subsequent displacement of the rock boulders (Selmi et al., 2019). The plateau's surface is also subject to active chemical weathering, especially solution processes, that produces a dense karst terrainvand which aids in widening further the joints and faults and allows deeper infiltration of rainwater and wind erosion (Magri et al., 2008). It is inside a Natura 2000 and Special Area of Conservation for the ecological importance of the area.

MT24 Ċirkewwa sinkhole

A semi-circular sinkhole is found at Ċirkewwa, northwest of Malta, known from the locals as Latnija, or as Għajn Tuta, the latter being the name of the local area in which it is situated. The site is classified as a collapse sinkhole (Tonelli, 2014). Calleja (2010) suggested that it was formed during the last 500 years, thus classified the site as quaternary in age. The sinkhole presents a typical semi-circular shape and has a diameter of 35 m on the ground. It shows overhanging walls visible due to the collapse of a limestone roof of a small cave. The geosite reached a high score in rareness being the only onshore Quaternary collapse sinkhole in Upper Coralline Limestone that still preserves all the walls at significant depth, in contrast with the majority of sinkholes that

are usually unfilled by deposits and soil showing a little sub-area evidence of their existence. The site is the second inland sinkhole in all Malta, together with Il-Maqluba in the south of Malta, in Lower Coralline Limestone. The site is surrounded by a rocky pavement with paleosoil infills on its karstic surface (Selmi et al., 2019). The rocky pavement and the surrounding ground are partly covered by typical Mediterranean scrubland: for this reason, the geological content of the site can be easily linked with other subjects as ecology and biology (Selmi et al., 2019). The site is inside the Natura 2000 network and is considered Special Area of Conservation.

MT26 Rdum il-Qawwi: Area affected by rock spreading

The geosite is located on the north-western sector of Malta. It is located at the south of the geosite MT23 and presents similar characteristics. The site is mainly in Upper Coralline Limestone and consists of a plateau and related rock spreading area. It is representative of gravity-induced processes active on the coast. In particular, from the top of the carbonatic structural platform it is possible to appreciate a parallel trending of faults and deep fissures widened by chemical weathering and rock spreading, especially along its edge. Large limestone blocks are detached from the top and then subject to lateral spreading and slide phenomena across the underlying Blue Clay to create a sloping undercliff strewn with blocks, slowly spreading down towards the sea. The higher number of blocks located on the coast are eroded and shaped by sea action. A characteristic of this geosite is the presence of a small rock window shaped by the action of sea waves along the coastline that testify to a high activity of the marine environment (Selmi at al., 2019). The geomorphological content of the area is closely combined with two other subjects: ecology and history. Indeed, the plateau hosts a variety of endemic flowers and plants and remains of old villages and pillboxes of the Second World War. In addition, the geosite is considered a view-point site since the top of the plateau offers a strategically scenic view of the island of Gozo and north coast of Malta. The geosite is inside a Special Area of Conservation and Natura 2000 under the Habitat Directive (92/43/EEC) for the ecological importance of the area.

MT29 Badland topography in Blue Clay slopes (Il-Qammieħ)

The geosite is located on the southwest coast of Marfa Ridge, in northern Malta. The geosite has a high visual impact due to the accentuated banding of the Blue Clay sequence. The different colour of the bands reveals varying concentrations of calcium carbonate: lighter coloured layers mark a higher calcium carbonate content and a huge amount of foraminifera fossils, whilst darker coloured layers denote concentrations of clay over 90% (Axiak et al. 1999; Sammut, 2019). The slopes are gently corrugated due to the action of surface water that has incised deep rills and gullies making up a landscape of spectacular badlands. In addition to its high scenic impact, the geosite is an exemplary case that helps to understand the geomorphological evolution of coastal areas. On this site in fact the origin of mass movement is clearly visible and easy to understand, with block sliding affecting the Upper Coralline Limestone blocks by being detached from the plateau and transported downslope by gravity. The movement is favoured by the soft Blue Clays that act as lubricated surfaces. The Blue Clay formation is in fact particularly susceptible to seasonal weather variation: during the winter season, rainwater infiltrates through karstic fissures in the overlying Upper Coralline Limestone plateau into the clay, mobilising the clays and favouring the downward movement of the blocks. In the hot summer months, the Blue Clay dries and exfoliates, slowly tilting the overlying Upper Coralline Limestone blocks that subsequently detach, fall and slide (Selmi et al., 2019). In view of these processes, the geosite holds remarkable educational value connected with its scientific importance. The Blue Clay slopes delimits the backshore of the Globigerina terrace selected as geosite (MT31). The slopes are occasionally vegetated by halophytic and endemic species, that provide friction and slow down erosion. The geosite is inside a Natura 2000 and Special Area of Conservation.

MT31 Terrace in Globigerina Limestone Qammieħ area

The geosite consists of a horizontal rock surface developed where Globigerina Limestone Fm. outcrops at sea level. The terrace occurs on low-lying sectors of the coast at Rdum il-Qammieħ, northwest Malta. It is constantly affected by wave action and marine spray. In addition to wave erosion, the shore is shaped by biogeochemical dissolution and other weathering processes. However, considering the micro-tidal

conditions of the archipelago, this platform is never submerged (Schembri, 2003; Biolchi et al., 2016; Gauci and Inkpen, 2019). A massive bedded in pale yellow Lower Globigerina Limestone extends for 1 km, featuring with typical examples of karst terrain. This member is relatively more resistant than the overlying Middle Globigerina Member. It lies exposed as near-vertical cliffs and is composed of a sequence of more resistant layers made up of the C1 conglomerate bed separating the Lower from the Middle Globigerina. Chemical weathering is the main process shaping the surface of the platform and forming small solution pools, also known as honeycomb structures (Selmi et al., 2019). Despite its primary geomorphological interest, the geosite is important from a paleontological point of view because it conserves a rich number of fossils. Over the surface of the Lower Globigerina Limestone, especially within the Lower Conglomerate bed, there is an intensive network of fossilized burrowing channels. Fossils of Echinoids species and scallop shells are frequently exposed at the surface level. Several boulders of Upper Coralline Limestone are deposited on the terrace. The boulders are detached from the Upper Coralline plateau at the top of the slope profile and are the result of rock fall and slide phenomena. These boulders, different in shape and size, are used by climbers for boulder activity (Selmi et al, 2019). Similar platform-cliff morphology exists at Xwejni in Gozo and between St. Thomas Bay and Marsaxlokk Bay, in the south-east coast of Malta (Gauci and Inkpen, 2019). However, high scientific value is assigned to this one terrace in northern Malta, which is a spectacularly flat and yellow-colored exposure of Lower Globigerina Limestone. The geosite is inside a protected area designated under Habitat Directive (92/43/CEE), but exclusively for its ecological relevance.

MT32 Il-Qammieħ fault

The site is located on the south-western side of the Marfa Ridge, northern Malta. The site is made up by the Il-Qammieħ fault that cuts the lithological formations and led to the outcrop of the entire Oligo-Miocene Maltese lithological sequence. The geosite has high scientific and educational importance due to its rare and visible qualities: it is one of the most striking geological features which exposes the complete stratigraphic sequence,

including the Greensand Fm. The fault has allowed the exposition of the Lower Coralline Limestone that is usually hidden below sea level. In this case, an upper bed of the Lower Coralline Limestone is clearly visible along the base of an elevated platform starting from the sea. The top of this first outcrop formation is abundant in echinoids *Scutella subrotunda* that constitute the important marker of Scutella Bed (Selmi et al., 2019). The succession continues with the exposure of the all the three members of Globigerina Limestone Fm., clearly distinguishable from their different fossil compositions and respective tints. The yellowish upper bed of Upper Globigerina Limestone Fm. passes transitionally up into the banded Blue Clay deposit, which in turn gradually passes in Greensand Fm. The latter is 1 m thick and occurs as a friable, green and brown coloured glauconitic micrite. Its presence is not frequent on the islands and its outcrop along with all the other formations, making the geosite the only one of its kind in the study area. Blue Clay and Greensand deposits are often covered by vegetation and converted in agricultural land. To conclude, this stratigraphic section is topped by an Upper Coralline Limestone plateau, typically cream coloured by fossiliferous algal limestones (Mtarfa Member) containing abundant spherical rhodoliths (Selmi et al., 2019). The geosite is inside a protected area designated under the Flora, Fauna and Natural Habitats Protection Regulations (SL 549.44) but exclusively for its ecological relevance.

MT39 Solution subsidence structure

Solution structure located in coastal area at Rdum id-Delli, known also as Il-Masap sinkhole (Prampolini et al., 2017). The geosite is a closed sub-circular natural depression caused by karst processes and dissolution processes, accompanied by differential corrosional lowering of the ground surface (Magri, 2006; Coratza et al., 2011). The landform is considered a solution sinkhole quaternary in age, linked to a post-Miocene karst system. It is mainly developed in the Upper Coralline Limestone Fm., but it presents a relatively shallow closed depression filled by soil, usually *terra rossa*, and covered by deposits and sparsely Mediterranean vegetation. The wall of the structure exposed to the coast is widely subject to block sliding and presents several displaced and cracked units. The primary interest of the site is geomorphological due to its

representativeness as main karst processes acting on the archipelago. It is considered rare since usually the solution structures appear completely fulfilled by sediments and converted into agricultural land. Its geomorphological importance was already identified as a geomorphosite by Coratza et al. (2011). The primary interest is followed by lithological and paleontological secondary interest for the presence of sediments rich in fossils. This geosite is located in the northern sector of the Majjistral Nature and History Park, the first national natural park in Malta. It falls inside a Special Area of Conservation and Natura 2000 under Habitats Directive (92/43/EEC) for the ecological importance of the area.

MT49 Il-Qarraba

The site consists of a rocky peninsula capped by a flatted Upper Coralline Limestone plateau which reaches an altitude of 42 m. The geosite includes the plateau and the scarps around altered by coastal erosion and gravitational processes occurring mainly within the Upper Coralline Limestone Fm.. The plateau is characterized by faults and fractures, widened by chemical weathering. The fissures play an important role in destabilising the limestone cap rock, favouring processes of detachment and the subsequent displacement of rock boulders.

The block slides affecting Il-Qarraba peninsula extend below the sea level and adiates outwards from the land shape of the promontory to a sea depth of more than 25 m. Their extensions are of about ca. 200 m from the present coastline. According to recent cosmogenic exposure dating, the most ancient limestone block detachments dated occurred 15.3 ± 1.0 ka ago (Soldati et al., 2018). Hence, these extensive landslides developed when the sea level was much lower than at present, in correlation with a more humid environment and a higher level of the water table in the aquifers. Their successive activity that lead to the detachment of new blocks is probably related to sea-level oscillations until the final submergence of large portions of the landslide deposits (Prampolini et al., 2019). This extensive submarine deposit testifies to the progressive disruption of the plateau that caused remarkable reduction of its size on a long span of time (Soldati et al., 2019).

Despite its main geomorphological importance, it is possible to note also lithological characteristics. Approximately 1.5 m above its base the Upper Coralline Limestone contains the *Terebratula* Bed, a shell bed which can be traced over large areas of the islands at this horizon. The lowest part of this formation is composed by coralline algal bioherm in which the *Lithophyllum* rhodolites are impressively developed (Pedley and Waugh, 1974). A thick standard succession of the Blue Clay outcrops under the impressive Upper Coralline Limestone plateau, with a prominent bed of glauconitic sand towards the top. The presence of clay and marly terrains under the Upper Coralline Limestone slab has favoured spectacular rock spreading and detached blocks sliding from the overlying plateau. The blocks reach the coastline, armouring the head of the promontory against wave action (Soldati et al., 2019). A thin layer of Greensands outcrops between the contact from the two mentioned lithologies.

The site offers a panoramic view of the north-western coast of the island of Malta, in particular Il-Pellegrin promontory, Golden Bay, Għajn Tuffieħa Bay, and the South of Gozo. The geosite is located inside a Natura 2000 site and a Special Area of Conservation according the Habitats Directive (92/43/EEC) and Special Area of Conservation for international marine importance.

MT50 Badland topography in Blue Clay Slopes (Għajn Tuffieħa)

The geosite consists of Blue Clay slopes steeply descending to the sea on the south of Il-Qarraba, close to Għajn Tuffieħa seaside. The pronounced steepness of the Blue Clay slope is favoured by wave action, which also causes toe erosion. The slopes are also affected by action of surface water that incised erosional features and making up a landscape of spectacular badlands. The erosional features mostly represented are permanent and ephemeral deep rills and gullies which heavily dissected the steep slopes in a parallel downward direction. The rare presence of soil and the resultant sparsely vegetation coverage make the slopes more exposed to mass movements, in particular earth flows and earth slides (Gauci and Scerri, 2019; Rolè, 2019). The geosite has a high visual impact and make up exemplary cases that help to understand the geomorphological evolution of coastal areas. Walking southwards, the contact between

the Blue Clay and the Globigerina limestone is evident, where the latter outcrops as a shore platform (Soldati et al, 2019). Visible banding of the Blue Clay sequence reveals varying concentrations of calcium carbonate in the form of fossil tests of planktonic and benthonic foraminifera. Lighter coloured layers denote a higher calcium carbonate content, mostly in the form of planktonic and benthonic foraminifera with lower kaolinite content. Darker coloured bands correspond an almost pure clay bands, usually from 90 to 94% (Axiak et al. 1999; Scerri, 2019). The geosite is located inside a Natura 2000 site and a Special Area of Conservation according the Habitats Directive (92/43/EEC) and Special Area of Conservation for international marine importance.

MT53 Ta' Marija Caves

The geosite is located in the west coast of the main island, walking south from Ras il-Pellegrin. The site comprises marine caves cut in Globigerina Limestone. The geosite is representative of the erosional features that occur frequently on the whole archipelago due to the mechanical abrasion by waves and chemical erosion resulting from salt crystal growth. The marine waves eroded the soft Globigerina Limestone creating two parallel marine caves with rounded shape: the northernmost one is deeper, reaching about 48 m of depth and 16.3 m wide. The second reaches approximately 20 m of depth and 22.5 m wide. Despite the rich presence of marine caves along the coast, this geosite is considered rare since the majority of the sea caves visible at present sea level are cut into the Upper Coralline Limestone (Sammut et al., 2019). Although its unique characteristic, it is not well known from the scientific community and poor is the scientific literature on it. In addition, the spectacular white cliff in Globigerina Limestone that hosts the caves is cupped by a outcrop of Blue Clay slopes that involves a progressive change in hardness which lead to a marked change in slope (Pedley and Clarke, 2002). The Blue Clay slopes present an accented typical banded colour. This makes the site outstanding also from an aesthetical point of view, but not frequented by tourists due to the difficult accessibility: the site can in fact be reached only by boat or kayak, from the nearby Ġnejna Bay. The site is inside a Special Area of Conservation with terrestrial and marine importance and Natura 2000 under Habitats Directive (92/43/EEC).

MT54 GSSP

The site is located at Ras il-Pellegrin section, in the coastal cliffs along the Fomm ir-Riħ Bay on the west coast of Malta. The site is important due to the presence of the Global Boundary Stratotype Section and Point (GSSP) which is reference point in a rock sequence which defines the boundary of two stages on the geologic time scale: Langhian and Serravallian. This recognition indicates its fundamental scientific importance and international relevance. The site was officially ratified as a GSSP point on 2007 and is nowadays inside the international GSSP register.

In detail, the cliff exposes the contact between the Globigerina Limestone and the Blue Clay Formation, that coincides with the major step in the middle Miocene global cooling. A transitional bed separates the Globigerina Limestone layer, with its typical yellow colour, from the grey clayey marls of the Blue Clay (Abel, 2005). Due to the excellent exposure of clear and distinct sedimentary cycles, the transition between the two mentioned lithologies provides a level suitable for placing the physical reference point for the Langhian/Serravallian boundary. The Global Stratotype Section and Point (GSSP) is in fact located at the top of the transitional bed of the uppermost Globigerina Limestone as well as at the base of the Blue Clay Fm. (Hilgen at al., 2009). Ras il-Pellegrin section is one of the few places where the middle Miocene climate transition can be studied in continuous marine successions on land. The Blue Clay at Ras il-Pellegrin shows a characteristic pattern of homogeneous grey and white coloured marls rich in sapropels and chondrite trace fossils that point to occasional anoxic or dysoxic bottom water conditions. Another particularity of the Blue Clay is the presence in its youngest part of volcanic minerals in residues around 40.45 m point to an ashfall (Abels, 2005).

Unlike other international GSSPs, the present site is not marked and there are no panels or golden strikes indicating its presence. For this reason, it is not known from the population and tourists. The site is in a place difficult to access even for scientists, due to its location on a cliff without a direct access and the absence of a pedestrian path. The site is inside a Special Area of Conservation with terrestrial and marine importance and Natura 2000 under Habitats Directive (92/43/EEC).

MT68 Magħlaq fault: Upper Coralline Limestone Fm.

The geosite consists of a segment of major fault known as Magħlaq fault which can be traced for around 4 km along the south-east coast of Malta forming a stepped scarp, running diagonally along the shoreline (Galea, 2019). The fault exposes Upper Coralline Limestone (Tal-Pitkal Member) and Lower Coralline Limestone (Attard Member) at the same surface level. Trechmann (1938) stated that the Magħlaq Fault had moved during the Quaternary and Galea (2019) considers it as the more recent fault system parallel to the Sicily Channel Rift Zone dated on late Miocene and early Pliocene. The Magħlaq Fault is the major expression of the Pantelleria-Malta Trough System and is responsible in controlling the trend of the southern and north-eastern coasts of the archipelago. The Magħlaq Fault is not a single fault line, but is in part composed of two closely spaced parallel fractures. It is a NW-SE trending fault system with a vertical displacement over 200 m. On the geosite, the Magħlaq Fault exhibits a slickensided fault plane which downthrows the Upper Coralline Limestone to the south by at least 230 m and large blocks that have undergone sliding down steeply dipping fault surfaces together with rotation (Pedley et al., 1976; 1978; Galea, 2019; Gauci and Scerri, 2019). The site is rare because it is only systems of faults which trends in north-western direction totally in Upper Coralline Limestone. The outcrop is partially protected by the direct sea action due to the presence of a rock narrow cleft. An ongoing sequence of microearthquake activity with magnitudes smaller than 3.5 has been recorded since 2015 by seismic stations in the south-east of Malta. Their epicentres are located on the shore or very close to the coast and may imply a reactivation or some continued activity of the Magħlaq Fault and its connected onshore faults (Galea, 2019). The Magħlaq fault is responsible for the plunging cliffs from Bengħisa up to Fawwara and the uplift of the islet of Filfla, 5 km off the southwestern coast of Malta (Furlani et al., 2019). The geosite is in the proximity of Ħaġar Qim, the ancient megalithic temple designed UNESCO World Heritage Site. All the coastline is Special Area of Conservation and Natura 2000 under the Habitats Directive (92/43/EEC) and Special Protection Area under the Wild Birds Directive (79/409/EEC).

MT70 Magħlaq fault: Lower Globigerina Limestone Fm. (Ras il-Ħamrija)

The geosite offers a distinctive contraposition of the youngest and oldest formations of the archipelago, respectively Upper and Lower Coralline Limestone which outcrop at the same level due to the presence of the Magħlaq fault. The site is composed of two parts: from the north, a hand-designed feature in Upper Coralline Limestone and, on the south, a steep coastal cliff in Lower Coralline Limestone that is the main exposition of the Magħlaq fault. The feature in Upper Coralline Limestone can be considered a small peninsula widely exposed to wave action that shaped the cliff creating a steep narrow cleft and a distinctive rock arch. The south part of the site seems at first glance the natural continuity of the site MT68, but it exhibits differences in lithology: in this case the cliff is totally in Lower Coralline Limestone. The geosite has a rich scientific relevance due to its double interest, structural and geomorphological. The geosite is also a viewpoint site where it is possible to appreciate the steep cliffs characteristic on the south of the island and the nearby Filfla island, located 5 km from the south of the coast. Being connected to the previous geosite, it is also part of a Special Area of Conservation and Natura 2000 under the Habitats Directive (92/43/EEC) and Special Protection Area under the Wild Birds Directive (79/409/EEC).

MT74 Il-Maqluba

The geosite is situated in the south-east of the island of Malta, in the village of Qrendi. It is called Il-Maqluba, which in Maltese means 'reversed' or 'upside-down'. Il-Maqluba is a spectacular solution subsidence structure formed by the collapse of a limestone floor situated above a cavity carved by water flowing in a karstic relief (Gauci and Scerri, 2019). The geosite reached high score in representativeness as example of the karstic processes acting on the islands. At the same time, it reached a high score in rareness in being the only onshore Quaternary collapse sinkhole that has its roots in the Lower Coralline Limestone. This sinkhole indicates that large cavities were also developed within the Lower Coralline Limestone formation. It has a surface area of around 6.000 m^2, with a diameter of 50 m and displaying sheer vertical walls extending about 30 m (Calleja, 2010; Gauci and Scerri, 2019). Il-Maqluba has high level of integrity and appears

as an intact natural amphitheatre on Lower Coralline Limestone that exhibits a deep, vertical sides all around its structure (Gauci and Scerri, 2019). Its depth and the presence of scarce deposition and soil that infill the hole, could be correlated with its recent collapse event leading to its formation. Il-Maqluba is in fact considered much more recent than most other Quaternary collapse structures found in Malta: in this way, not enough time has elapsed from the date of its formation to enable the structure to be filled with sediment. There are key indicators that testify that the collapse of the cavern roof did take place fairly recently: examples are its vertical, jagged walls and the presence of part of a bell-shaped water well found to the right of a viewing area. According to Welsh (2002), the formation of Il-Maqluba is thought to have occurred on 24 November 1343. The formation seems to be closely related to one of the worst ever storms recorded in Maltese history hit Malta between the 23rd and 24th November 1343 (Guillaumier, 2005). On that occasion, a huge volume of water gushed down the valleys surrounding the site of Il-Maqluba, at the time a large underground cavern existed in the area. Subsequently, the already weak cavern roof collapsed under the weight of the large volume of rainwater that collected during the storm event. This theory is largely considered realistic, but there is no direct scientific evidence linking this event to the collapse of Il-Maqluba (Calleja and Tonelli, 2019). Il-Maqluba sinkhole and its immediate surroundings are mainly important from a geomorphological perspective with high connection with ecological relevance. The bottom of Il-Maqluba sinkhole is in fact not accessible by humans: this led to an undisturbed habitat where vegetation has taken over this sheltered and humid zone. The sinkhole is home to several animal species: it is considered the only locality in the Maltese Islands for an undescribed endemic species of millipede and ant with biogeographical interest. Being an undisturbed site, it is place of breeding for the Blue Rock Thrush (Monticola solitarius), Malta's National Bird, and hosts two pipistrelle species (*Soprano pipistrelle* and *Kuhl's pipistrelle*) and the Grey long-eared bat (*Plecotus austriacus*) (MEPA, 2009; Calleja and Tonelli, 2019). It's a Special Area of Conservation and Natura2000 under the Habitats Directive (92/43/EEC).

MT76 Blue Grotto

The geosite is located in a half-kilometer wide bay along the southwestern coast of Malta, on the northwestern side of Wied Babu. Blue Grotto, in Maltese 'Taħt il-Ħnejja', is well known as one of the widest and most spectacular sea caves on the islands. In reality, Blue Grotto is part of an extensive karst system primarily tectonic controlled with high scientific relevance. The marine processes, such as wave attack, and subaerial processes, such as rockslides and rockfalls, conditioned the development of scenic landforms such as sea caves, sea arches, karst gorges, partially submerged chambers, coastal notches and spectacular plunging cliffs. The entire cliff is in Lower Coralline Limestone mainly horizontal or sub-horizontal, hard and resistant to erosion. Despite the resistant formation, the Magħlaq Fault created weaker zones that are excavated by water action. Recent studies (Furlani et al., 2019) conducted below the mean sea level reveal that the rock surfaces are usually well smoothed at the sea bottom and along the lateral walls, while above the sea level the degree of roughness is generally higher. The cliffs are littered with scallops and karst holes, when exposed to light, are covered by algae or mosses.

The geosite is composed of a huge cave with a maximum length of 15 m and a maximum height of 10 m. The entrance of the cave is around 3 m and presents a depth from few centimeters in the innermost part, to ca. −2m in the deepest part (Furlani et al., 2019).

Large collapsed boulders, up to some meters in size, are found at the entrance and are widespread at the sea bottom. The peculiarity of this cave is the presence of a sea arch developed just in front of its the entrance. The sea arch develops along the same direction of the fault along which the Blue Grotto was developed and towers to a height of ca. 15 m. The base is some tens of meters large and surrounded by several sharp to rounded boulders. The site is well representative of the abundant karst landforms of the Maltese Islands but it is also rare: the short and narrow natural bridge connected with the cave is in fact a particular stage of the evolution of the arch that is not common in the archipelago. Along the coast in fact are frequent isolated stacks that may be one time connected to the mainland with a natural bridge nowadays collapsed. This peculiarity makes the site an attraction of high number of tourists every year.

The site has strict connection with ecological importance. It is inside a Special Protected Area under the Wild Birds Directive (79/409/EEC) and a Special Area of Conservation and Natura 2000 under Habitats Directive (92/43/EEC).

GZ1 Natural Arch Wied il-Mielaħ

The Wied-il-Mielaħ rock arch is a natural arch in Lower Coralline Limestone Formation, located in the area between Wied I-Għasri and San Dimitri Point in the northwestern sector of the island Gozo. The geosite is surrounded by high and steep cliffs and a narrow valley. The site formation is related to the combination of weathering and erosion. The growth of an initial cave developed along a line of rock weakness through the limestone, and over time, the latter widened into the result natural arch. The stratigraphic sequence of the Wied-il-Mielaħ rock arch is composed by 30 m of the Lower Coralline Limestone, with the Xlendi Member and Il-Mara member layering from the bottom to the top respectively, overlain by a Lower Globigerina Limestone cap. The structure is delimited by vertical cliffs almost 30 m height and presents a 0°-10°N orientation of its major axis. Centimetr-wide open joints are present on the whole arch leading to potentially unstable rock sub-blocks (Grechi et al, 2019). According to a study of the geometry of natural arches in Europe, Wied il-Mielaħ arch is identified as an initial stage of its development: the site in fact presents a rectangular 'window shape' that by time could develop into an arched shape void (as the formerly known Azure Window) until it becomes a stack disconnected to the mainland (Geoscience Consulting, 2013). The site is representative of the coastal features common in the Maltese Islands: it is the highest and best preserved natural sea arch between a total of 26 sea arches recorded prior to the collapse of Azure Window (Geoscience Consulting, 2013). The Wied il-Mielaħ area has also an important ecological value: the cliff area appears to be a possible breeding habitat for Yelkouan Shearwater, a seabird endemic of the Mediterranean, but no scientific research has been conducted yet. For this reason, despite its natural high values, the site is not included in the Natura 2000 sites. The site become popular from a touristic point of view after the collapse of the famous Azure window in the Dwejra area, on the 8th of March 2017.

GZ5 Il-Qolla l-Bajada dome

The geosite is a dome in Globigerina Limestone (all the members), located at il-Qolla I-Bajda, in proximity of Xwejni Bay, northern Gozo. The geosite presents an unusual feature conical in shape resulting from the sub-aerial erosional processes which have acted on the island for the past five million years. The distinctive shape is given due to the different resistance properties of the limestone layers of the stratigraphical succession. The formation of the geosite is related to the erosion of the overlying layers of the stratigraphy succession due to water activity. The water permeates the Upper Coralline Limestone through its joints and fissures, achieving the underlying Blue Clay layer. The clay minerals are subjected to expand in contact with water, due to the forces of repulsion between the particles, and cause structural weakness in the upper coralline limestone blocks above them. In this way, the weakness points favour the detachment of sizable limestone blocks that slide down the valley sides towards the sea. Once slide down and eroded the youngest stratigraphical successions, the Globigerina Limestone finally outcrops and is in turn eroded by flowing water, producing the rounded cone-like structure. The rareness of the site consists of its conical shape and the outcrop of the full Globigerina Limestone sequence (Pedley, 2002).

Despite the fragility of the site, it is not inside any protected area of national or international level.

GZ7 Blue Hole

Small, rounded dissolution feature located in a subcircular bay formed by different erosion of the soft infill sediments by the sea at Dwejra north, west Gozo (Coratza et al., 2012). The term Blue Hole is usually used in the Caribbean region to indicate submarine sinkholes (Coratza et al., 2012). In this case the top of the dissolution feature is submerged most of the time, especially in low tide. This feature contributes to the rich geomorphological diversity of the Dwejra coastline and it is strictly related to the sinkholes and dissolution pans present in the area. The Blue Hole is about 15 meters depth. It seems carved into the surrounding rocks, but an underwater arch located 10

meters below the surface leads from the hole into the open sea. It is more known as an ecological site due to the presence of a rich marine life and a coverage along its walls of colourful coral tubeworms and sponges. For this landform and ecological characteristics, the site is considered one of the best spots for scuba diving on the whole archipelago (www.maltadives.com). It occupies a strategic position due to its proximity to the coast, where the Azure Window once stood (Santariano and Gauci, 2019). From the site it is possible to see the Azure reef that slightly comes up from the sea and result from a great number of large underwater boulders, following the collapse of the Azure Window. With respect to the dissolution features present in the main island, the Blue Hole is totally in Lower Coralline Limestone Fm. The site is inside the Area of Special Conservation and Natura2000 under the Habitats Directive (92/43/EEC).

GZ10 Qawra sinkhole

The site is a karstic solution subsidence structure situated on the Dwejra area, along the western coast of Gozo. The Dwejra area hosts a series of outstanding sinkholes that reach a few hundred metres in diameter and display a vertical displacement comparable in size to the largest sinkholes in the world (Calleja and Tonelli, 2019). The most representative and well preserved is the Qawra sinkhole: in contrast with the sinkholes present in the island of Malta which date back to the Quaternary, this sinkhole is dated to the Miocene (Tonelli, 2014). The site is a steep-sided erosional depression with a diameter of 350 m, controlled by an annular fault. The edges of the subcircular depression are mainly defined by steep scarps up to 50 m high and underlain by the Lower Coralline Limestone (Pedley, 1974). The particularity of this site is the presence of a small semicircular lagoon on its northern sector, connected to the open sea through a narrow karstic channel developed in Lower Coralline Limestone (Tonelli, 2014). The size of the channel is large enough to allow navigation with boats. The mentioned channel, known as L-Għar tad-Dwejra, is fault-controlled and cuts the western margin of the depression for about 100 m long (Calleja and Tonelli, 2019). The lagoon is bordered by a small beach shaped by the sea. The remaining sector of the site is filled by Blue Clay that forms two hills separated by a river in the northeastern sector and covers the entire

southern wall (Calleja and Tonelli, 2019). The Blue Clay lithology is more erodible than the surrounding Lower Coralline Limestone and exhibit a gully system carved on the slopes. The direction of the gullies flows into the lagoon and this confirms that the formation of the sinkhole is mainly related to fluvial incision, and subsequently, that the excavated sediments have been evacuated through the cave that links the lagoon with the sea (Tonelli, 2014). Quaternary deposits rich in fossils of terrestrial gastropods outcrop at the top of the Blue Clay. Other Quaternary deposits are the fluvial terraces located at the base of the hills. Due to their impressive size and high aesthetic interest, the Dwejra sinkholes have also been recognised and assessed as geosites by Coratza et al. (2012). Due to its high integrity, the Qawra sinkhole has allowed detailed investigations to be carried out into the genesis of these large collapse structures found on Gozo (Calleja and Tonelli, 2019). Qawra is also important for touristic purpose, being the best diving sites in the Maltese Islands. It is also an ecological hotspot that hosts rare and endemic species that colonized this limited geographical distribution. The geosite is Special Protection Area under the Wild Birds Directive (79/409/EEC) and a Natura 2000 site and Special Area of conservation under the Habitats Directive (92/43/EEC).

GZ16 Tafal cliffs

An exemplary Blue Clay Fm outcrop is found on the southeast of Gozo. The Blue Clay Fm represents the only terrigenous sediment of the Maltese rock succession. In Maltese the word 'tafal' means Blue Clay, for the site is known by locals as Tafal cliffs. It consists of gentle slopes in Blue Clay Fm. whit marked badlands topography. On the site it is easily possible to distinguish the different colour banding derived from the varying concentrations of calcium carbonate in the form of fossil tests of planktonic and benthonic foraminifera (Scerri, 2019). From the top of the slopes, it is possible to note the olive green marls and clays, followed by bluish grey coloured banded kaolinitic marls and clays and a light coloured layers. The dark layers are composed almost by pure clay with a range from 90 to 94%. On the contrary, the lighter layers correspond to higher calcium carbonate content, mostly in the form of planktonic and benthonic foraminifera with lower kaolinite content and a clay continent that ranges from 80 to 60% (Scerri,

2019). The Blue Clay Fm is composed by a rich assemblage of macrofauna represented by molluscs, echinoids, and solitary corals that are usually visible on the slopes. Other fossils representative of the macrofauna as fish remains and marine mammals can be found as small sediments, though most of the larger pieces have been crushed during consolidation (Scerri, 2019). The slopes are indented by deep rills and gullies produced by the active action of surface water. The different layers colours and the water incisions make up a landscape of spectacular badlands. The slopes are confined at the bottom by a Globigerina Limestone shore platform, mainly in Middle and Upper Members, partially carved by ancient salt pans. The slopes are at times covered by scattered vegetation, especially at the bottom or the top. The geosite is outside of any protected area.

GZ28 Tas-Salvatur sinkhole

The site is located in the northern part of Gozo, south of Marsalforn. The geosite is a product of karst processes through time, that are particularly evident in Gozo. It is one of the best sinkholes from the 17 that have been recognised on the island (Coratza et al., 2012). The already mentioned sinkholes are always attributable to solution structures formed by the collapse of a previous cave. In this case the sinkhole has the shape of a prominent rounded butte in Upper Coralline Limestone (mainly Ġebel Imbark and Tal-Pitkal Members) and emerges from the surrounding landscape as a 65 m high hill. This positive relief developed where the rocks cap the downthrown block were more resistant than the country rock (Calleja and Tonelli, 2019). This type of landform constitutes an example of relief inversion: a butte in an area once being a submarine karstic depression (Calleja and Tonelli, 2019). The geosite is related with cultural value for the presence of a statue of Jesus Christ located on the top of the hill, that increase also its visibility. The statue overlooks a site frequented by locals for trekking and pilgrimage because it is locally considered as a scaled down version of a more famous site located on the Corcovado Hill in Rio de Janeiro (Brazil) (Coratza et al., 2012). It is selected as the best example of sinkhole with positive relief in the study area and is representative of one of

the rich variety of landforms shaped by karst processes. The site is not inside any protected area.

CM14 L-Għar ta' Bla Saqaf sinkhole

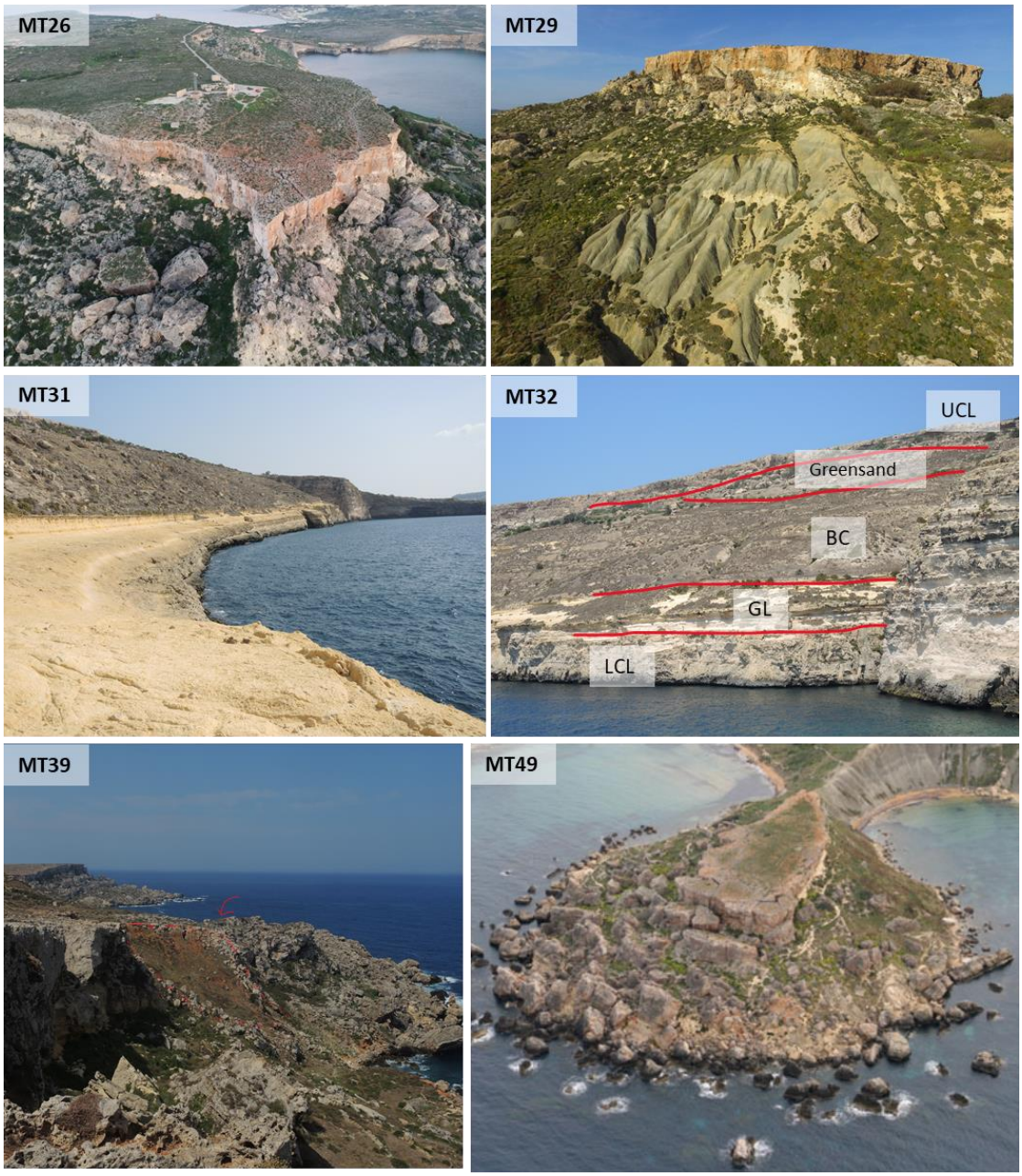
The geosite is found in the western coast of the island of Comino, in the proximity of a dry valley. At least three geomorphological features are identified on the geosite: a dry valley, a marine cave and a collapse sinkhole. The latter was formed by the craving into of the surface above the marine cave. The sinkhole cuts the dry valley at Il-Wied ta' Skalanova into two. It is evident that both terrestrial erosion (watercourse flow on the valley) and marine erosion (wave action) have played a part in shaping it. Two alternative explanations are attributed to genetic pathways (Debono, 1996). The first theory claims that purely terrestrial factors led to the formation of an 'inland' subterranean hollow, followed by collapse to from a concave-sided sinkhole. At a later stage, the action of the sea led to the cliff retreat at Taħt il-Mazz that brought the cavity within the reach of wave action and finally pierced its seaward side to form a large arch. In the second theory the geosite was created by the formation of a large sea cave and the incision of a moderately deep watercourse on the land surface above it occurred as an independent event. As the sea cave was enlarged by violent wave action and/or the valley was deepened by water flow, the two features eventually pierced each other when the cave roof and the valley bed met. At this stage, the cave roof grew too thin and weak, and thus collapsed. The site is inside a Natura 2000, Bird Sanctuary and Special Area of Conservation under the Habitat Directive (92/43/EEC). The geosite is already visited for its outstanding vertical cliff and cave, but with no mention to its geoheritage value.

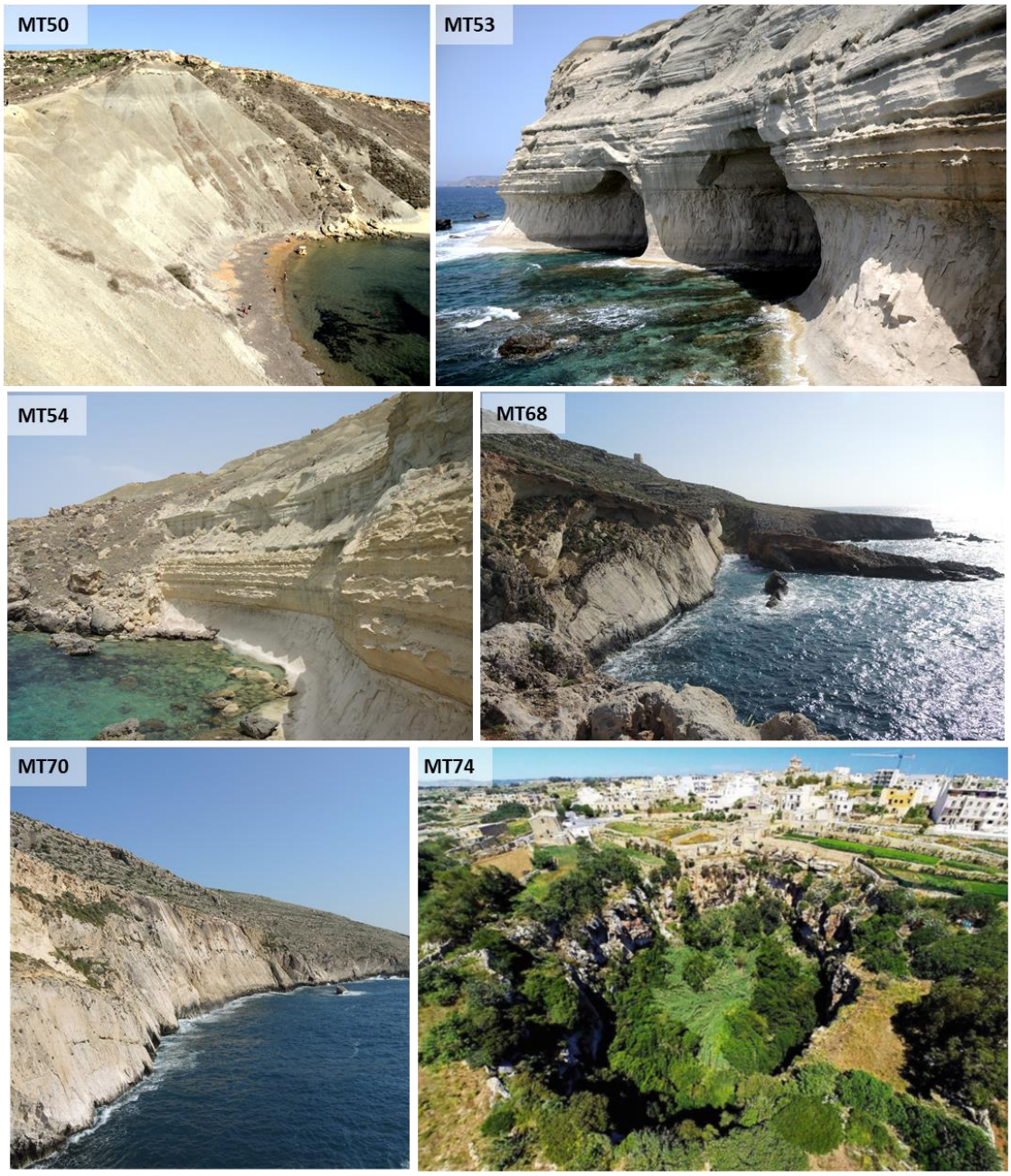
CM19 Extreme-wave events deposits

Extreme wave events are events of low frequency and high magnitude; although they occur infrequently, they are capable of causing great damage that can be recorded all around the coast. The geosite is located on Cominotto, a small islet to the northwest coast of Comino. Its distance from the main island makes the site a spectacular natural site with no anthropogenic influence, except a small number of tourists that reach the island by swim in the summer season, but that stays circumscribed on the small sandy beach

on the east coast. The island, as the close Comino, is totally made up by Upper Coralline Limestone, in particular Ġebel Imbark member and Tal-Pitkal member. A huge number of detached boulders are located along an Upper Coralline Limestone scarp on the site. The detachment of boulders is favoured by the presence of several joints on the coastline that create weak point easily to detach by water erosion. The detached boulders are evidence of high-energy wave impacting from north-western, that may be attributable to both the incidence high-energy waves from the westerlies but also to lateral propagation through the Comino channel from potential tsunamigenic events which may originate from the Hellenic arc. The distribution of clast size, the shape and density contain information about the process of their formation. On the site, the boulder erosion zone elevation is around -1 m above sea level. The deposits reach a maximum of 11 tonnes in weight and can be found at a distance of 55 m from the shore on a maximum elevation of 6 m from the sea level (Mottershead et al., 2014). The boulders present an organized distribution: they are clustered on NW headland and testifiy to the presence of significant large waves approaching from the west and affecting Cominotto and southwest Comino (Mottershead et al., 2014). Extreme-wave events deposits are frequent along various coastal stretches of the Maltese archipelago, but this geosite is one of most representative in the study area: it is in fact possible to note on the coast the places where the boulder detached due to high energy wave impacts and the respective deposits more inland. Cominotto is protected through the Flora, Fauna and Natural Habitats Protection Regulations (SL 549.44) as Special Protection Areas and Special Areas of Conservation of International Importance and is designated as Natura 2000 site under the EU Nature Directive.

MT5
GL
UCL
Sea caves
MT9
MT19
MT22
MT23
MT24


MT26
MT29
MT31
MT32
UCL
Greensand
BC
GL
LCL
MT39
MT49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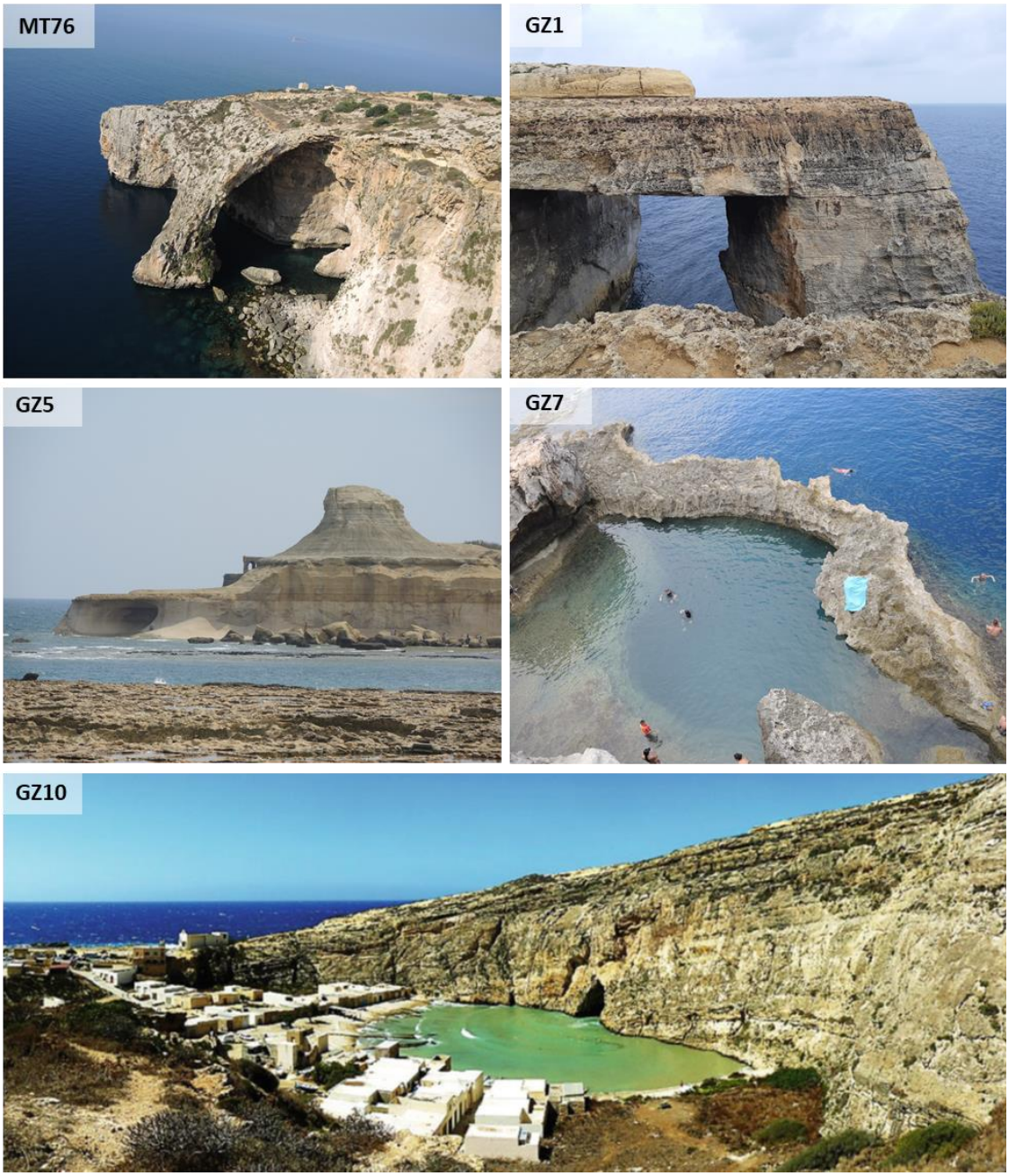
MT53
MT54
MT68
MT70
MT74


MT76
GZ1
GZ5
GZ7
GZ10

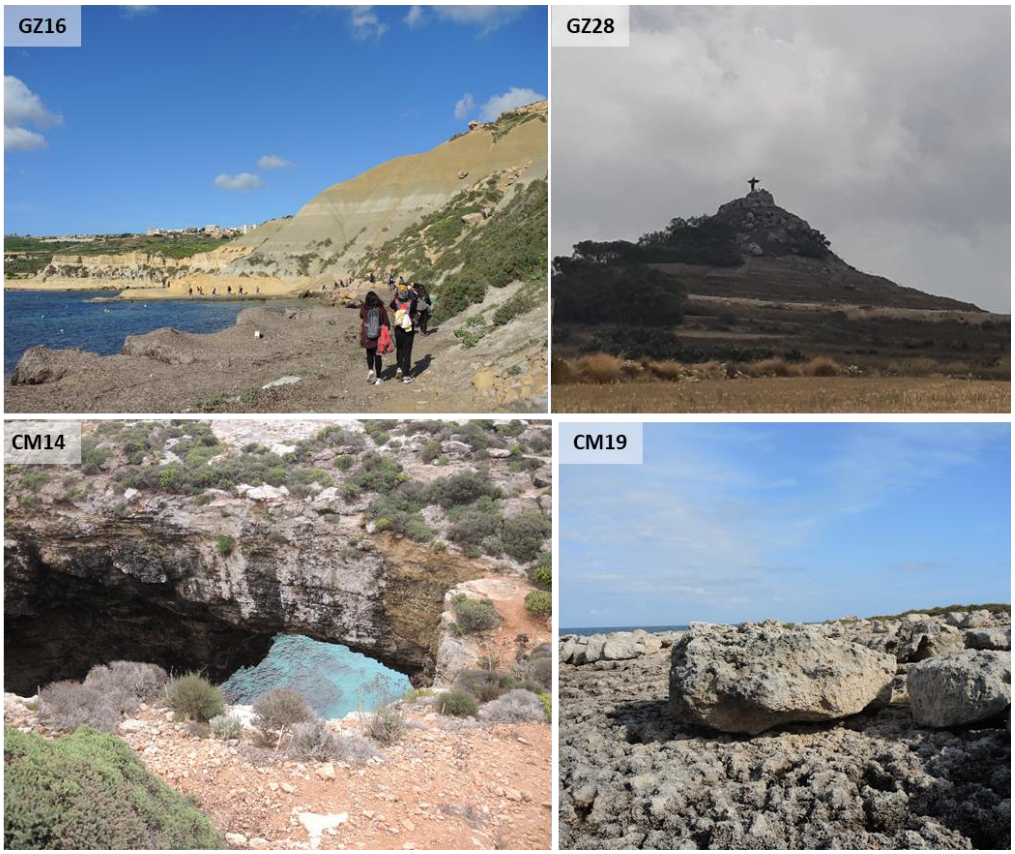


Figure 6.20: Pictures of the 27 geosites.

6.7 Degree of interest of geosites

The 27 selected geosites have been classified by their degree of interest (Annex 4). This classification is important to characterise the study area as an UNESCO Global Geopark, which requires at least one geosite with international relevance within its boundaries.

As discussed in paragraph 5.8, a unique and texted method that identifies the degree of interest of the geosites does not exist. To classify the geosites national and international papers were analysed, for each geosite inclusion in academic surveys or educational activities, and in protected areas with national and/or international relevance have been considered. The details of these selected criteria are laid out in Table 6.5.

Table 6.5: Criteria considered to the classification of degree of interest of the geosites.

International	• the geosite is recognised as a GSSP or ASSP by the IUGS or is an IMA reference site; • the geosite is known by international scientists; • there are international papers about this geosite; • unique example in the study area; • the geosite is inside an international protected area.
National	• the geosite is known by national scientists; • the site is used for educational activities and fieldworks; • there are national papers about this geosite or there are international papers regarding the area of the geosite.
Local	• no scientific publication or scientific papers not directly connected with the geological importance of the geosite; • representative or rare at regional scale; • interest by locals.

Considering these criteria, four geosites were considered of international importance, five national and 18 locals (Table 6.6).

Table 6.6: List of the geosites classified on the degree of interest.

International geosites	National geosites	Local geosites	
MT49 MT54 MT74 GZ10	MT19 MT32 MT53 MT76 GZ1	MT5 MT9 MT22 MT23 MT24 MT26 MT29 MT31 MT39	MT50 MT68 MT70 GZ5 GZ7 GZ16 GZ28 CM14 CM19

The four geosites with international relevance are the MT49 Il-Qarraba, MT54 GSSP point, MT74 Il-Maqluba and GZ10 Qawra sinkhole (detailed description of all these geosites on paragraph 6.6).

MT49 consists of a rocky peninsula capped by a flatted Upper Coralline Limestone plateau whose reaches an altitude of 42 m. The geosite is well known by the scientific community and several scientific papers have been published, especially regarding its exemplary gravitational processes (e.g., Pedley and Waugh, 1974; Mantovani et al., 2013, 2016; Soldati et al. 2018, 2019, Prampolini et al., 2019).

MT54 was officially ratified as a GSSP point in 2007 and nowadays, it is inside the international GSSP register. Despite its international recognition and scientific relevance, the geosite is not protected and a limited number of publications are available (Abel, 2005; Hilgen et al., 2009).

MT74 is the only onshore Quaternary collapsed sinkhole that has its roots in the Lower Coralline Limestone. It is an example of the karstic processes acting on the Mediterranean region. Despite its rarity, only a few international publications have been recently published (Tonelli, 2014; Tonelli and Calleja, 2019).

GZ10 is the most representative geosite and a well-preserved sinkhole of the Dwejra area, comparable in size to the largest sinkholes in the world (Calleja and Tonelli, 2019).

The geosite is the subject of several international studies (Coratza et al., 2012; Tonelli et al., 2012; Tonelli, 2014; Soldati et al., 2013; Calleja and Tonelli, 2019).

18% of the geosites (five geosites) were classified of national interest (Figure 6.22). They are MT19 Dragonara sinkhole, MT32 Il-Qammieħ fault, MT53 St. Marija caves, MT76 Blue Grotto and GZ1 Natural Arch of Wied il-Mielaħ.

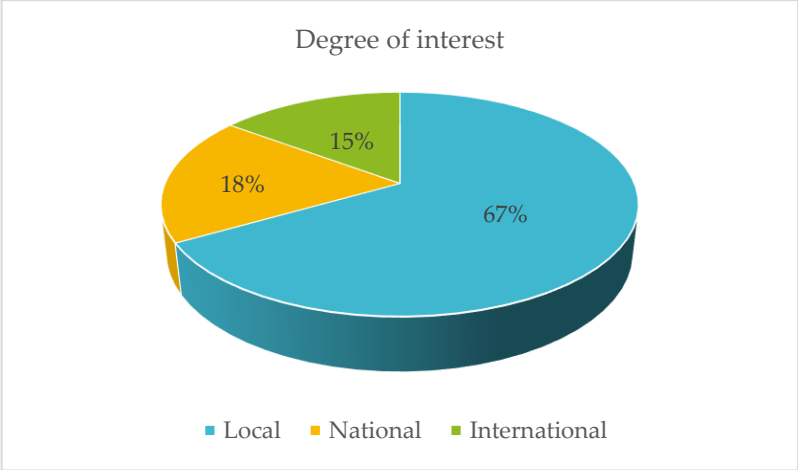


Figure 6.22: Graph showing the degree of interest of the 27 geosites in percentage.

GZ1 is the only sea arch of the Gozo island and it is the best-preserved one in the whole archipelago. Despite its rarity and high state of integrity, the arch was unknown from the scientific community and even from the population receiving attention only after the collapse of the Azure Window, the famous sea arch which stood in Dwejra area until 8th March 2017. For this reason, there are not any scientific papers on the geological importance of this site, except for a recently applied geology investigation conducted by Grechi and Martino (2019).

MT19 is a geosite mentioned in different scientific papers (Prampolini et al., 2017) and recognised as a geosite by Selmi et al. (2019).

MT32 is the only site on the study area that presents an outcrop of all the geological formations of the Maltese Islands. The site has national relevance and it has been mentioned as a geosite by Selmi et al. (2019) and by Pedley and Waugh (1974). The latter scientific paper describes in detail the best site itinerary to observe the outstanding outcrop of the Maltese Islands.

MT53, located at Ras Il-Pellegrin, is the only site of the islands that presents two spectacular marine caves cut in Globigerina Limestones. Despite the national importance of this geosite due to its scarcity in the country, it is not famous for its scientific relevance. It is mentioned in a few scientific papers (Pedley et al, 2002; Biolchi et al, 2016) but with any mention to its possible geoheritage value. From the touristic point of view, it is unspoilt by mass tourism and locals, mainly due to its difficult access.

MT 76 refers to Blue Grotto, a famous natural attraction that gathers a lot of tourists. It represents the widest karst complex in the island of Malta and is characterised by several coastal karst scenic features, such as sea caves, gorges, and sea arches.

The remaining geosites are examples of geological elements and features of the Maltese Islands and are important at local scale.

Almost all the geosites (85%) are inside an international protected area, but they are not all considered of international relevance due to the fact that the legal protection regards further ecological and biological elements (Figure 6.23).

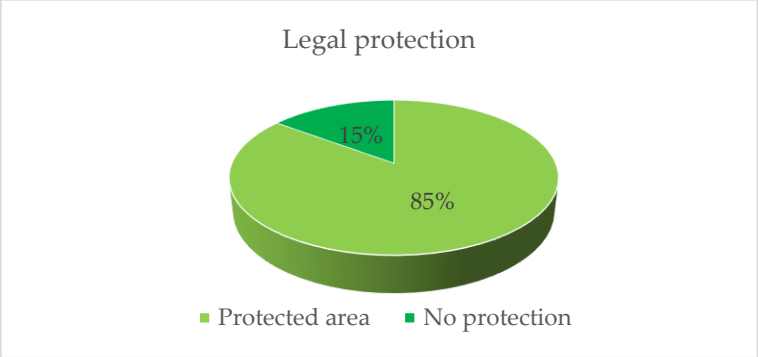
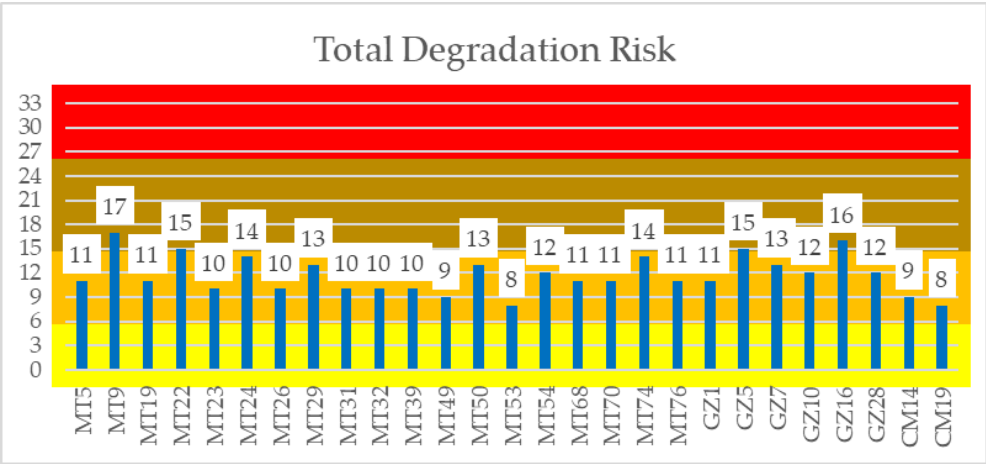


Figure 6.23: Legal protection and geosites: the 85% of the geosites are inside protected areas.

6.8 Degradation Risk assessment

The 27 geosites were assessed using the quantitative degradation risk methodology developed within this research and described in paragraph 5.7 (Annex 5).

The results are reported on Figure 6.24, where the graphs report the total value of degradation risk obtained.



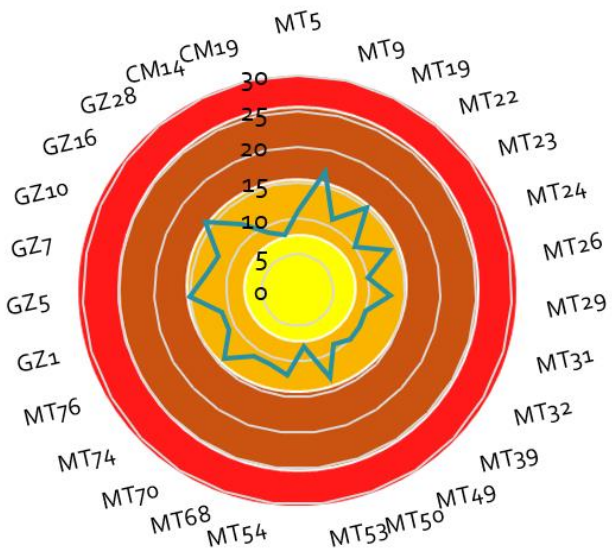


Figure 6.24: Total degradation risk result for each geosite: a) bar chart representation; b) radar representation.

Almost all the geosites have a medium risk of degradation, with only four geosites that reach the score equal or higher than 15 that means high risk of degradation.

The four geosites with high risk of degradation are: MT9 and GZ16, badland topography in Blue Clay slopes, located respectively at Blata l–Bajda and southeast Gozo; GZ5, mesa in Globigerina Limestone located at il-Qolla I-Bajda; MT22, area affected by rock spreading at Paradise Bay. For the three first mentioned geosites, the risk is given both by natural factors due to the soft and erodible lithologies involved, both by anthropogenic pressure, due to the areas are improperly frequented and used for uncontrolled recreational activities. Regarding the last geosite, MT22, the risk of degradation is entirely given by the high human pressure, with no recognition and attention to its geological value.

In general, analysing the different factors that contribute to the total score of degradation (Figure 6.25), anthropogenic vulnerability is almost absent except for MT31, the Lower Globigerina Limestone terrace, where fossils of echinoderms in perfect condition can be illegally collected by private individuals.

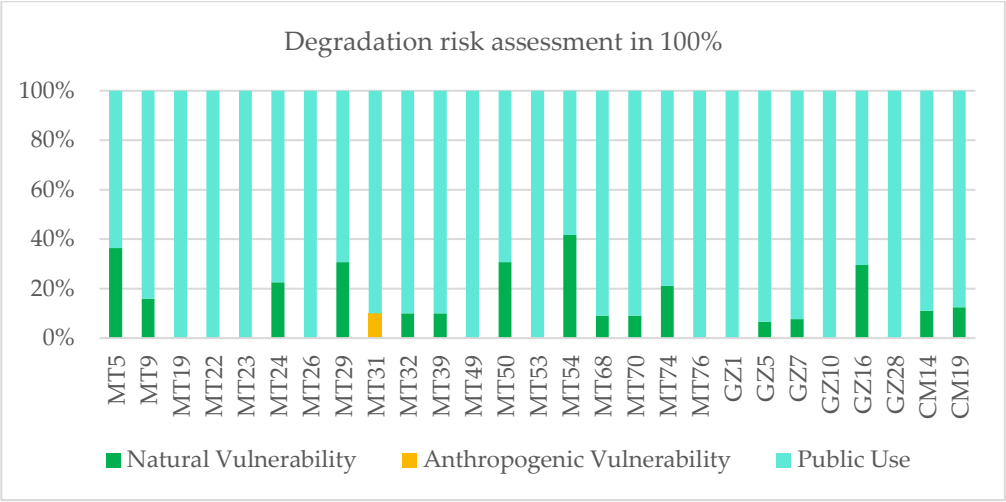


Figure 6.25: Degradation risk assessment showing the percentage of each geosite of natural vulnerability, anthropogenic vulnerability and public use.

The results in the study area show how the degradation risk of the geosites are mainly influenced by the public accessibility. Although humans are just one agent that causes degradation, their activities are very varied and cause a range of alterations similar or even more degrading than natural processes. The risk of degradation by public use usually progresses faster than natural ones, and sometimes, has a sudden component (Fuertes-Gutiérrez et al., 2016). The high score in public use is in most of the cases related

to negligence and lack of knowledge of the geological heritage that leads to incorrect public use of the geosites areas. Threats from public use include conflicts with other territorial uses as infrastructure construction, and possible conflicts with other types of natural or cultural heritages. It comprises also threats raised from incorrect educational and recreational uses of the geosites, as well as collecting and vandalism.

In all cases, the critical point remains the low awareness of the geological importance of the geosites of locals and tourists. Most of the geosites are in fact located along the coast, where the pressure of tourism and infrastructures are concentrated. Tourism could be a resource, but only if managed in a sustainable and responsible way.

The low knowledge and recognition of geological heritage, also on the legal framework, means that the geosites are not protected. The absence of protection, physical barriers or infrastructures that can reach the visitors, lead to the consequent absence of control of access and the increase of degradation risk. The uncontrolled presence of access on the geosites, the lack of knowledge on geoheritage's value and the absence of any preservation and safeguarding actions led to high risk of degradation of the geological heritage, with consequent deterioration of biodiversity with also irreversible loss of certain components of the entire ecosystem. In fact, the degradation risk on the geosites may also present threats to important habitats (flora and fauna). For this reason, care must be taken to prevent any disturbance that could, in the long term, affect the geoheritage and its biological and heritage quality.

For five geosites, the risk of degradation is influenced by natural vulnerability for more than 30% of the total score. The principal natural threat is the proximity of the geosites to the coast that make them more vulnerable to water and wind processes. The coastal erosion threats the degradation of geosites and the connected environments, with the resultant reduction of coastal biodiversity. Coastal erosion has also its socio-economical aspects: including loss of land with economic value, and damage of coastal infrastructure and tourism, sectors that play key role for the economy (Gül et al., 2019). Coastal areas are in fact complex environments more exposed to natural hazards and worst affected by effect of climate change (sea level rise, changes in coastal deposition

and erosion, increase of violent marine storms and tsunamis from near-field and far-field sources) (Rizzo et al., 2020).

Almost all the geosites are along the coast and hence exposed to natural hazards, but the different lithologies made some geosites at a higher risk of natural deterioration than others such as those made up of soft and erodible Globigerina Limestone and Blue Clay. On the contrary, geosites in Lower and Upper Coralline Limestone located along the coast report usually low or non-existent natural vulnerability.

In detail, the geosites that reach a high score on natural vulnerability are: MT29, MT50, GZ16 that are of badland topography in steep Blue Clay slopes, and are considered made up by the most erodible and softest formation of the limestone lithological sequence. The geosites are easily eroded at the bottom by sea water and rendered unstable at the top by wind erosion.

Geosite MT54, GSSP point for the Serravallian stage, reports 40% score in natural vulnerability being a cliff in Globigerina Limestone and Blue Clay exposed on the water erosion on the west coast of Malta.

In the same way, at MT5, the small shore in Globigerina Limestone is exposed to natural degradation, with possible negative impacts to the integrity of the site.

Several studies (e.g. IPCC, 2012; Petrakis et al., 2013; Antonioli et al., 2017) emphasized how possible sea level rise may threat coastlines and high wave energy beach zones. In the study area, as located in the Mediterranean region, the problem of future sea-level rise is particularly felt. According to the estimation of Galassi and Spada (2014), the sea level of the Mediterranean sub basin is going to rise from min 10.7 cm and max 25.8 cm**.** Low-elevation coastal zones, especially on the island of Comino and eastern region of the island of Malta, southwest of Gozo, are highly vulnerable to environmental events, like floods, which can directly or indirectly affect the economic activities and coastal communities. For this reason, it is important to monitor the natural vulnerability due to the continuing active natural evolution of the coast which may affect the value of such landforms classified as geosites (Gül et al., 2019).

Despite this, in the present state, the natural vulnerability is low in most of the geosites. Most of the natural processes acting on the geosites are involved in their construction

and evolution, and thus are considered in their fragility. The natural processes which are not involved in the creation and evolution of the geosites, but that affect them, are usually of minor importance. The extrinsic natural processes considered are the biological activity, the geological activity and the climate factors. The biological activity has no negative effect on the geosites. The activity by animals as trampling or burrowing is almost non-existent. The biological activity by plants related to root development or surface growth was recorded, but the level of activity and the area involved, do not lead to measurable impacts. The climate factors, such as the humidity, precipitation, wind, floods and freeze thaw cycle may concur to the natural vulnerability. In this case, the result of the assessment was based on the consideration that the climate factors had no made changes to the geosites in the times of the several field visits conducted in the three years of the research. A periodic or constant monitoring activity is suggested to have more data of the influence of the climatic factors though the time.

Regarding the assessment of the intrinsic factors, analysing the fragility, most of the geosites are under constant process-derived activity. The inactivity was assigned to the geosites with main stratigraphical and structural interest since the processes that led their creation are no longer active in the present morphoclimatic conditions. However, they may be affected by extrinsic active processes than did not lead to their creation, and thus are considered in the natural vulnerability. The potential loss of geological elements is zero or low for all the geosites. Regarding the type of the geosites, only few are linear, mainly the fault lines or the stratigraphic sections. Most of them are areal, as lateral spreading phenomena, or punctual, as sea caves, sea arches and sinkholes. Eleven geosites present an area between 1000 and 10000 m ^{2}. Five geosites extend for an area comprising between 10.000 and 100.000 and only three more than 100.000 m^2. Seven are small in size, with a total area less than 800 m^2.

In conclusion, the methodology of degradation risk assessment developed and applied combines anthropogenic pressure and natural factors. Most of the 27 geosites analysed present middle risk of degradation and thus they are not gravely endangered. Four

geosites were identified with high risk of degradation and a proper management plan is needed.

The degradation risk assessment gives an overview of the condition of the geosites and puts emphasis on the lack of protection, therefore the need for legal and effective protection of the sites. Due to the growing anthropogenic pressure and the active coastal processes, monitoring activities and protection measures are needed.

The assessment conducted is based on qualitative data, mainly collected through analysis of photos and past observation conducted in the fieldworks. Due to the ongoing pandemic, it was not possible to conduct new field visits and collect new data. Data on sea erosion or landslide movements are not present due to the absence of monitoring plans. The same, there is no control of access to the geosites and the precise number of tourists is not available. For a complete degradation risk analysis of the geosites it is important to compare and monitor their evolution over time and assess their degradation risk regularly to ensure the implementation of proper and effective protection strategies. Considering that the monitoring plan requires time and financial support, the present research identified the geosites with high risk of degradation that may form the subject of the first monitoring plan, with direct or indirect control.

Therefore, the application of the methodology in the study area is meant to be the first attempt to identify the main natural and anthropogenic processes that currently affect the geosites, in order to determine conservation needs and inform threat response and management planning. The results are extremely important to inform the stakeholders about the risk connected with geoheritage and to decide in which sites their resources should be applied. All the geosites have to be managed, enhanced and monitored, but with the degradation risk assessment, attention and money can be addressed to identify effective strategies of geoconservation and management of those geosites that resulted with high risk of degradation. The requirements of a proper management are in fact an active conservation and monitoring of geosite's conditions and threats.

The degradation risk analysis reveals where there is the need to introduce more focused attention for geoconservation, to put more regulations on geoheritage and to implement national management strategies.

CHAPTER 7. Conclusion

The principal research aims of this thesis dealt with the identification of a new methodological approach to select a unified geographical area of the Maltese Islands (central Mediterranean Sea) for its possible application as UNESCO Global Geopark and the identification and selection of sites of geological and geomorphological interest within its boundary. It also provides the development and application of a new degradation risk methodology of geoheritage.

Geoheritage has quickly emerged in the last thirty years, together with the development of inventory methods, qualitative and quantitative geosites assessment methodologies, the concept of geopark, geotourism activities and geoconservation strategies.
The domain of geoheritage is suitable for interdisciplinary approach and provides the cooperation between different fields of science.
Geoheritage inventories have the main goal of recording elements and landforms of geological importance, but additional ecological, biological, cultural and historical values are also considered. In this way, it is clear the interconnection between biotic and abiotic heritage. However, considerations of geoheritage are generally underrepresented in inventories of biodiversity or cultural-historical heritage, since geoheritage has not yet the same recognition. This disparity is also present in the legislation, where geoheritage is usually not mentioned in international documents and local decision-making protocols, mainly due to the lack of knowledge and the absence of geoheritage national inventories.

This work describes the first, most important phase of the inventorying, which consists of the development of concepts, principles, methods and classifications with the objectives of recognizing, selecting, and assessing sites of geological and geomorphological interest.
The research aimed to produce the first inventory of geological and geomorphological sites in a unified geographical area of the Maltese Islands, that could apply as UNESCO

Global Geopark. The research was conducted within the frame of the interest shown by the Maltese government, in particular the Ministry of Environment, Sustainable Development and Climate Change of Malta, to apply for possible inclusion of the Maltese Islands in the UNESCO Global Geoparks Network.

For this purpose, the study area was defined through the analysis of UNESCO guideline and application dossiers of insular geoparks in order to define the characteristics and requirements needed for a UNESCO Global Geopark. In addition, thematic maps of the Maltese Islands were analysed in order to define the environmental, administrative and legislative frameworks of the area.

Existing bibliography, thematic maps and aerial photos of the Maltese Islands were analysed and together with expert interviews and field surveys led to the recognition of 131 sites of geological and geomorphological interest, named potential geosites. Field surveys were essential to integrate the sites identified in literature and to collect site-specific information – i.e., state of conservation, accessibility and presence of services- relevant to the subsequent assessment.

The 131 potential geosites were analysed. The analysis provided for the identification of a series of parameters characterizing each potential geosites. These parameters were collected in descriptive cards including elements of textual description and pictorial data, referring to the scientific, additional, use and management value of the sites. The accurate characterisation of potential geosites aim to help the Maltese government administration become more aware of the sites of geological and geomorphological interest of the country, giving useful information for their effective management which includes both protection and geotourism actions (Selmi et al., 2019).

Subsequently, the 131 potential geosites were divided in categories of interest such as geomorphology, structural geology, palaeontology, stratigraphy and human activity. Four sub-categories were identified for geomorphology, based on the main processes: marine, fluvial, gravitational and karst. For each category the best potential geosites were selected considering their representativeness, rareness and integrity applying two criteria proposed by Reynard (2016): geohistory and geodiversity.

The preselection led to the identification of 55 potential geosites, which in turn were assessed applying two international quantitative methodologies (from Reynard et al., 2007 and Brilha, 2016) adapted to the study area.

The quantitative methodologies are generally preferred by the scientific community for their objectivity due to the use of a systematic and well-structured assessment with transparent criteria.

The two methodologies applied evaluate the scientific value and the additional value. The scientific value aims to reveal the importance of the sites for the geosciences and is assessed according to several parameters as rarity, representatives, scientific knowledge, integrity, key locality, geological diversity and paleogeographical model. It is the key value to consider a site a geosite, but additional values of the potential geosites were also assessed. The additional values are important in the view of educational and touristic activities and also for the connection of the geosites with natural and cultural heritage. The results from the two methodologies were compared and 27 geosites were finally selected due to their high scientific relevance. Considering the additional value, seven sites were identified as geodiversity sites due to their low scientific interest, but high potential for educational and touristic purpose.

In 2015, with the adoption of the designation UNESCO Global Geopark, the geopark must comprise at least one geosite of international relevance. In this regard, the 27 geosites were analysed and a classification into three categories of value has been made: international, national and local. In the study area four geosites were classified according to international interest, due to their rareness and exemplarity.

In general, the 27 geosites correspond to outstanding sites with high scientific interest, and usually relevant additional value, given mainly by their high ecological and aesthetical importance. Most of them are concentrated in coastal areas, where the main economic activity is tourism.

Human activities and natural processes may cause negative impacts that act directly or indirectly on geosites. In this regard, a methodology to assess the degradation risk related to the geosites was developed. The methodology includes the assessment of three main factors: natural vulnerability, anthropogenic vulnerability and public use.

The degradation risk assessment gave an overview of the condition of the geosites and provided precious information for a correct protection of the geological heritage and its management, with attention to the effects of climate change. The results in the study area shows that most of the geosites are at medium risk of degradation, mainly due to the lack of recognition by locals and tourists and by the resulting absence of protection. As already mentioned, most of the geosites are located along the coast, that is associated to a very sensitive environment, particularly vulnerable to disturbance and prone to change, where climate change impacts are very acute (Selmi et al., 2019). For this, the degradation risk analysis meant to be as a tool to prioritize the management of geosites, stressing the importance of constant monitor and measure of natural and anthropogenic vulnerability, to prevent and avoid future degradation and destruction of geoheritage.

The recognition, selection and assessment phases are fundamental to identify the geosites to protect. However, the inventory of geosites is not enough to ensure geoheritage protection. The conservation strategies and actions need the involvement of national and local administrations. In general, whilst most academic researchers involved in geoheritage issues have a far greater interest in recognition, selection and assessment of the geosites, those involved in conservation strategies intend to publish fewer papers (Reynard, 2018 and reference therein). This disparity is also given by the lack of legislation and policy drivers relating to geoheritage worldwide, as a requirement to conserve geosites means that plans and approaches as to how to achieve this are then needed (Reynard, 2018). For this purpose, greater effort to raise awareness of the importance of geoheritage is required.

Frameworks, conservation needs and legal actions on geoheritage will help to develop and evolve to respond to a changing world to take account of new threats and opportunities. Growing population and tourism pressure, changing attitudes to the natural environment, increasing development pressure and effects of climate change (Prosser et al., 2010) are all going to provide challenges and opportunities that will need to be accommodated in the way that geoheritage is conserved (Gordon et al., 2016).

To sum up, the research offers a new methodological approach to define the application of a unified geographical area as UNESCO Global Geopark, defining all the steps needed

from the identification of the study area to the recognition and assessment of geosites and their management.

This research confirms once again the presence of the rich geological heritage of the Maltese Islands, that need to be preserved and managed with sustainable geoconservation strategies. It has been compiled with also the intention of providing input for the Maltese government towards dedicated conservation strategies, that nowadays are more focused on the biological and ecological domain. Indeed, the research has the intent to carry out effective geoconservation strategies, with the inclusion of geoscience in tourism and educational activities which may be part of the national sustainable development plan.

7.1 Remarks on the application of the study area as UNESCO Global Geopark

In 2017 the Malta Geopark group was established by the Ministry of Environment, Sustainable Development and Climate Change in order to apply for possible inclusion of the Maltese Islands in the UNESCO Global Geopark Network. The Malta Geopark group was an advisor committee supporting the Malta National Commission for UNESCO on the details of the application. The Malta Geopark group consisted of different stakeholders from civil and private sectors which also included academic international researches willing to cooperate to submit a formal application as aspiring UNESCO Global Geopark. At the beginning of 2018 the expression of interest has been submitted to the UNESCO Global Geoparks council and the application of Malta as aspiring UNESCO Geopark has been presented on the 8th International Conference on UNESCO Global Geopark held in Madonna di Campiglio (8-14 September 2018). The Malta Geopark group has unfortunately been dissolved in 2019 due to the Geopark project has not registered any progress in the last two years, but the Finance Minister pledged that the government will keep working to establish the first Geopark in Malta (Scicluna, 2018). Future works will concern the implementation of the Management Plans of Natura 2000 sites and the legislative framework, with investment in other National Parks, including Majjistral and Inwadar (Scicluna, 2018).

The investigations conducted in this PhD project confirm the high potentiality of the Maltese Islands for the application as UNESCO Global Geopark. The Maltese Islands could benefit from the UNESCO recognition and could improve the natural protection and sustainable development.

The advantages and disadvantages related to the application of the study area as UNESCO Global Geopark, can be summarized by a basic SWOT analysis (Table 7.1) which is a widely used common tool for local development strategies (Kubalíková, 2019).

Table 7.1: Swot analysis of the possible UNESCO Global Geopark in Malta.

STRENGTHS	WEAKNESSES
Wide range of possible recreational activities	No bottom-up approach
Existence of historical and ancient heritage in the region	Weak partnership
Geosites of international geological significance	Not mentioned in media
Promotion of cultural heritage	Lack of guiding signs to attract tourism
Climate/suitable natural environment	Lack of panels and traffic signs
English speaking country	Lack of promotion of local food
Easy accessibility	
OPPORTUNITIES	**THREATS**
Booming nature, sports, adventure and sustainable tourism	Increasing popularity of mass tourism
Improvement of scientific knowledge	Increasing negligence and vandalism to the site
Willing of tourists to discover new destinations	Environmental pollution and destruction of the site by tourists
Willing of tourist to learn about the geology and natural heritage	
Increasing importance of safety	
Sustainable development	
Possibility to tourism educational activities	
Economy	
Development of eco-tourism	
Possibility of winter traveller's attraction	
Improvement of people's living standard	

The biggest **strength** of the proposed area as UNESCO Global Geopark is the rich natural and cultural heritage. The additional value of the geosites was already largely discussed in the previous chapter. In addition, the outstanding elements and landforms of the geological heritage are surrounded by a rich natural and cultural-historical heritage. In the study area there are several sites with cultural values, some of them already

comprised in the list of World Heritage Sites. The Mediterranean flora hosts endemic species, creating important ecological habitats and composing landscapes with high aesthetic relevance.

Inside the designed Geopark area, four geosites with international relevance have been assessed, as demonstrated on the assessment of paragraph. 6.6.

Another strength point is the English as official language of the Maltese archipelago: it can be helpful to have a wider range of tourists, worldwide, and it is helpful for understanding of the complex geological features that tourists can find in the area.

Data from the World Travel and Tourism Council (WTTC, 2017) show that the travel and tourism industry's total contribution to Malta's GDP stood at 27.1% in 2017. Leisure tourism remains the main purpose of visit for the vast majority of tourists' arrivals to the Maltese Islands, with a share of 85.3% of total inbound tourists in 2017 (WTTC, 2017). For this purpose, local companies already offer a wide choice of outdoor activities and the local conditions are ideal to practice both marine and land sports. The most practiced water sports are scuba diving, kayaking, river trekking, boating, fishing, diving, swimming, snorkelling, jet skiing and windsurfing. Land sports include trekking, running, rock climbing, caving, mountain biking and horse riding.

Another strong point is the typical Mediterranean climate, with warm and mild temperatures that attract many tourists throughout all the year.

A major **weakness** is that locals often are not aware about the importance of geoheritage, and therefore do not consider the potentiality of the islands as geotourism destination. The geopark proposal has to be truly community driven: while the concept of geopark is emerging within the academics, effective programs need to be developed at local level and community partnership.

A UNESCO Global Geopark is an area that has a plan for the sustainable development of the people who live there. Currently, the designed geopark area is far from the idea of a bottom-up approach, the latter considered a fundamental pillar of a UNESCO Global Geopark, which provides for the involvements of all the relevant local and regional stakeholders and authorities in order to empower local communities and to develop cohesive partnerships. For this reason, the designed geopark area does not present a

proper management and is not operated by a body having legal existence recognised under national legislation, as requested by the UNESCO guideline.

Therefore, the marketing of the geological heritage of the islands is non-existent. The different national parks and natural reserves of the Maltese Islands present their own websites with general information in English about the natural-cultural heritage, but with usually no mention to the geological heritage. The Majjistral Nature and History Park, first national park of the archipelago, has a structured website and Facebook page, easily findable and regularly updated with offers activities and visits to the tourists. Nevertheless, there is a strong and urgent need to start and improve activities that are essential for the networking. All stakeholders related to environment and culture will also have to make greater efforts to connect themselves to international research networks, programmes and activities (Tomaskinova and Tomaskin, 2018).

Many are the **opportunities**: first, the geopark will advance community-wide opportunities for scientific research and earth science education, while simultaneously fostering economic development and conservation of nature.

Due to the increasing development of eco and sustainable tourism worldwide, destination such as national parks and geoparks are gaining more importance. This led to many tourists nowadays preferring to experience soft adventures, more connected with nature, respecting the environment and far away from mass tourism (Kubalíková, 2013). The geopark is a big opportunity that covers geoheritage recognition, education, economic development and nature conservation. Together these pillars stand to help the Maltese community cultivate existing features in a sustainable way that ensure their preservation for future generations (Selmi et al., 2019). The geosites assessed can serve as a basis for the elaboration of national and local strategies for sustainable geotourism.

Geotourism, as a type of sustainable tourism, is key to protect the natural heritage from negative tourism development. It creates synergies between tourists and local community, respecting the nature and increasing economic prosperity. The geotourism is appreciated and accepted as a useful tool for promoting natural and cultural heritage and for fostering local and regional economic development, especially within rural areas. Geotourism will ensure benefits for travellers that will discover the geoheritage,

cultural heritage and traditions of the archipelago in an innovative and green way, respecting the environment and ensuring a sustainable economic growth.
Most importantly, geotourism will provide some evidence of diversification within the Maltese holiday product itself, which departs from the stereotypical image of the islands as a 'sun and sea' destination (Selmi et al., 2019).
In fact, the rich natural and cultural heritage of the designed geopark area is suitable for the ABC approach that means Abiotic-Biotic-Culture, that consider the geotourism as the tourism which sustains and enhances the identity of a territory, taking into consideration its geology, environment, culture, aesthetics, heritage and the well-being of its residents (Arouca declaration, 2011).

The **threats** are mainly related to a mismanagement of the geosites. Most of the geosites can be reached easily by the tourists: the promotion of the geosites without a proper control of access and legal protection may lead to mass tourism. The uncontrolled mass tourism can lead to irreversible damages to the geosites (e.g., vandalism, illegal picking) and compromises the natural heritage (e.g., environmental pollution, trash). Considering that most of the geosites are nowadays even known by locals, the promotion of geoheritage and that of a future geopark need to be properly managed.

7.2 Future recommendations

The results presented in this research are a starting point for other research questions aimed to promote the recognition and protection of the Maltese geoheritage.
The geosites identified are now known by the scientific community, but locals and national authorities are still not aware of geological heritage and its advantages. The geosites are thus not recognised, protected and promoted.
The first emerging research question is: how can be the geoheritage recognised at national level and protected?
As shown in Chapter 4, the Maltese legislation is detailed and rich about the protection of the natural heritage, but there is still no legislation created *ad hoc* to protect exclusively

the geological heritage. The abiotic nature is of secondary importance compared to biotic nature. National legislation has to be updated in order to implement management strategies for the protection of the abiotic nature. The protection of abiotic nature can also be considered as an intrinsic contribution to human wellbeing and protection of natural habitat for endemic species. Preserving natural heritage, including geoheritage and geosites containing some of the richest combinations of ecological and biological value, is a fundamental contribution to sustainable development.

Most of the geosites have also developed over time through mutual adaptation between humans and the environment, and thus demonstrate how, natural and cultural values interact with and affect one another in complex ways in a sort of co-evolutionary process. Geoheritage is also an important asset for economic development, by attracting investments and ensuring green jobs some of which may be related to geotourism. Thus, national regulatory initiatives aimed to implement management strategies for the protection of abiotic environments need to be combined with the recognition of geoheritage by locals and tourists. This reflection leads to a second research question: how can the geoheritage be enhanced and promoted?

The rich and remarkable geological and cultural heritage of the study area makes the Maltese archipelago an exemplary location to promote geotourism activities. The geosites can be the core of educational and geotourism activities in order to minimize the gap between experts and the general public, through an open and clear dialogue. As already mentioned before, the themes of geoconservation, education and economic development are intrinsically linked. These are three themes that can encourage the Maltese community to cultivate existing features in a sustainable way for future generations.

It is important to develop effective programs through creative pedagogy and community partnership at local level. This will advance community wide opportunities for Earth science education, while simultaneously fostering economic development. Locals and tourists will be afforded increased opportunity to be aware of the rich geoheritage of the islands and its connection with nature and culture. The interest in geoheritage from

locals will lead to geoconservation activities and will establish a truly community driven for a future application as UNESCO Global Geopark.

This research presents also the first attempt to assess the risk of degradation of geosites. The future research question to be investigated is how the geoheritage can be conserved. This question is a complex request that requires time and money: the need of protection of geosites can be identified only with a proper monitoring plan. Through months, years of monitoring data will be possible to have more precise and objective information to assess the risk of degradation. Regarding the public use, the monitoring plan will define the actual number of visitors of the geosites and will help to identify more accurately the degradation by public use. In the same way, proper monitoring plans have to be adopted for the natural vulnerability. For example, the rate of coastal erosion and sea level rise are fundamental to measure the impact of natural factors, also as part of climate change. The preservation of geoheritage is also significant in addressing risks related to natural and human-made disasters. The degradation of natural resources and neglected rural areas increase the vulnerability of degradation of natural heritage and the vulnerability to communities to disaster risks, especially on the coastal area.

Other important considerations that should be tackled in future initiatives in the Maltese Islands are:

- A detailed inventory of the whole Maltese Islands, using the methods applied in the present assessment. This research was conducted on the area defined as a possible UNESCO Global Geopark. The recognition of sites of geological and geomorphological interest and the selection of geosites can be implemented in all the archipelago, comprising also the area excluded from the designed Geopark's boundary. The proposed boundary was selected at the beginning of the research project. The environmental framework is changing rapidly. For example, what it is called 'dump site' and therefore excluded by the geopark boundary, it is now undergoing extensive landfill re-habilitation by WasteServ and turning into waste-to-energy plant by EcoHive Project (newsbook.com.mt). Such territorial extension

of the inventory would be especially valuable to confirm the potential of the whole archipelago as the application as UNESCO Global Geopark and to promote effective conservation strategy and action plan for natural heritage at national level.

- The identification of sites of geological and geomorphological interest underwater, through the adaptation of the methodological approach applied in the present work. Indeed, a range of surface geomorphic features may be recognized offshore, including drowned valleys and sinkhole, as well as landslide masses, nowadays under the sea level. This could help to understand the paleoenvironment present on the archipelago before the postglacial sea level rise. In addition, underwater sites could be the focus of new geotouristic routes, theme that are still underdeveloped, but which are important in order to bring innovation on geoheritage issues. The concept of marine geoconservation is only now beginning to advance (Prosser et al., 2013; Burek et al., 2013). By focusing on the geological underpinnings and advocating for the conservation of significant marine geosites, locals and tourists will be afforded increased opportunity to better understand the connection of the terrestrial environment through preservation and interpretation of the marine environment of the islands.

- The connection between geoheritage with natural and cultural heritage. Geoheritage, combined with the rich natural and cultural heritage of the Maltese Islands, could be considered as the heart of tourism and educational activities, with Malta's tourism direct contribution to GDP being among the highest in the EU (WTTC, 2017; Selmi et al, 2019). The Market Profile Survey (for 2017) undertaken by the Malta Tourism Authority's (2017) has in fact shown that the largest share of tourists (42.9%) chose Malta for its culture and heritage (Selmi et al., 2019). In view of this, the geosites should be evaluated for biodiversity importance (e.g., habitat for flora and fauna) and relevance to cultural heritage. Biodiversity and cultural importance are examined as additional values in the geosites assessment methodologies, but their detailed assessment should be carried out separately by appropriate experts. For this scope, it is fundamental the collaboration with experts

of other domains, such as tourism experts, biologist, historians, ecological and cultural managers and experts in territorial planning. In this way, the geosites can be an attraction for geotourism education, preserved and managed with sustainable and effective strategies concerned with raising environmental awareness and sustainable development.

All these research questions are fundamental to preserve the Maltese geoheritage and to move forward the application of the Maltese Islands as UNESCO Global Geopark.

7.3 Final remarks

As a concluding remark, the assessment of sites of geological and geomorphological interest has the potential to raise awareness of authorities on the conservation of geological elements and is a valuable opportunity to involve locals and tourists in the appreciation of the geological elements and features as integral parts of the natural heritage. Geoheritage is a nascent concept and not well-established in the Maltese Islands, the significance of the study area as a Geopark, coupled with effects upon education, economic growth and other as yet potentially unknown opportunities, is profound and far reaching.

The designed study area has a high natural and cultural potential to apply as a UNESCO Global Geopark and the strengths and opportunities are greater than weaknesses and threats. Despite this, several obstacles are still present to get to the application, mainly the lack of awareness on the geological heritage by locals and public institutions.

This work could contribute to the larger picture of geoconservation in practice, and the even more extended field of nature and culture protection, and add the important element of risk of degradation to geoheritage. The work is also supportive for future challenges and questions of geoheritage.

With this research, the geoheritage importance is shared with a growing community of colleagues, both nationally and internationally, who are working toward the advancement of geoheritage recognition and protection in the Maltese Islands.

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Appendix

The appendix of the thesis contains those supplementary materials that could not be placed into the core of dissertation due to length constraints.

Contents:

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General Data:

Date of visit	27.06.18	MT1
Compiler	Lidia Selmi	
Name of site	Area affected by rock spreading	
Location	coordinates	35°57'21.10"N 14°23'26.48"E
	inland	~~coastal~~
	municipality	San Pawl Il-Baħar
	city/community	Rdum Irxaw
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	
some deterioration with loss some minor elements	x
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	2
number of dissertations	2

Descriptive data

(lithology, geomorphology, active/inactive..)

The Upper Coralline Limestone plateau is heavily jointed and faulted, resulting from past tectonic activity. Fissures present in this rock formation play an important role in instability of the limestone cap rock, favoring processes of detachment and the subsequent displacement of the rock boulders. The site is entirely in Upper Coralline Limestone formation, with possible presence at the bottom of Blue Clay formation. In fact. lateral spreading phenomena occur within the Upper Coralline Limestone formation which overlies the Blue Clay formation, the latter being a softer and unconsolidated material. The process is active.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	x
	faunistic	x
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	x

Used value

Accessibility	
easy ~~moderate~~ difficult	
Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services: bus stop, bars, shops	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		
there is the possibility of deterioration of secondary geological elements by anthropic activity		x
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	26.06.18	MT2
Compiler	Lidia Selmi	
Name of site	Sinkhole	
Location	coordinates	35°57'23.40"N 14°23'24.64"E
	~~inland~~	coastal
	municipality	San Pawl il-Baħar
	city/community	Ix-Xagħra tal-Kortin
Type	punctiform	
	linear	
	areal	x
Size area	2.100 m²	
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	
some deterioration with loss some minor elements	x
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	2
number of dissertations	2

Descriptive data

(lithology, geomorphology, active/inactive..)

Quaternary sinkhole formed by collapse of underlying caves, inherited site in Upper Coralline Limestone formation.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	x
	faunistic	x
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility	
~~easy~~ moderate difficult	
Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services: bus stop, shops, main road, beach	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	x
good for all relevant features	
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection	
Natura 2000	
National park	
Bird sanctuary	x
Special Area of Conservation (SAC)	x
World heritage site	
no protection	
other	
need for protection yes	no
Proximity to areas/activities with potential to cause degradation	
no degradation risk	x
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	
Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	
there is the possibility of deterioration of secondary geological elements by anthropic activity	x
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References/Notes

The site is now colonized by Aleppo pine. This species is protected through national legislation, while habitats characterised by this species are considered of importance under EU legislation. There is the possibility to go inside.

Terrestrial Natura 2000 site, Special Area of Conservation (SAC): Ix-Xagħra tal-Kortin

Presence of human activity and garbage.

General Data:

Date of visit	26.06.2018	MT3
Compiler	Lidia Selmi	
Name of site	Area affected by lateral spreading	
Location	coordinates	35°57'37.08"N 14°23'42.14"E
	inland	~~coastal~~
	municipality	Mellieha
	city/community	Rdum il-Bies
Type	punctiform	
	linear	
	areal	x
Size area	14.000 m²	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	
5-10 examples	x
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	2

Descriptive data

(lithology, geomorphology, active/inactive..)

Lateral spreading phenomena that occurs within the Upper Coralline Limestone fm. The process is active. Upper Coralline Limestone blocks sliding and lateral spreading constantly expanding towards the sea.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	x
	vertical development	x

Used value

Accessibility			
~~easy~~	moderate	difficult	
Access to the site			
direct access via national roads			
direct access via local roads			
< 1km from a vehicle path			x
> 1 km from a vehicle path			
no direct accessibility			
only by permission			
Services			
good facilities of services < 1 km			
incomplete services < 5 km			x
absence of services < 10 km			
type of services:			
Visibility			
very difficult or not visible at all			
can only be viewed using special equipment			
limited by trees or lower vegetation			
good but need to move around for a complete observation			
good for all relevant features			x
Safety			
site with safety facilities (fence, stairs, handrails, ecc..)			
mobile coverage			x
equipper for people with physical deficit, elderly and infants			

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References/Notes

General Data:

Date of visit	26.06.18	MT4
Compiler	Lidia Selmi	
Name of site	Sea cave	
Location	coordinates	35°57'50.13"N 14°23'56.21"E
	inland	~~coastal~~
	municipality	San Pawl
	city/community	
Type	punctiform	
	linear	
	areal	
Property	private	
	public	x*
	association	

*Access to the island is only permissible between sunrise and sunset and then only against an entry permit obtainable from the ERA

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology		x				
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
Scientific notoriety	
number of articles	
number of dissertations	2

Descriptive data

(lithology, geomorphology, active/inactive..)

Sea caves Upper Coralline Limestone Fm. Active site.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	x
	touristic	x
ecological	botanic	x
	faunistic	x
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	x
	vertical development	

Used value

Accessibility		
easy	moderate	~~difficult~~

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	x
only by permission	

Services	
good facilities of services < 1 km	
incomplete services < 5 km	
absence of services < 10 km	x
type of services:	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
Other Nature Reserve		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	x
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	x
there is the possibility of deterioration of secondary geological elements by anthropic activity	
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References/Notes

The site's heritage importance is emphasised by its multiple designations, including its status as a Nature Reserve (Legal Notice 25 of 1993), a Bird Sanctuary (Legal Notice 41 of 2003) and its inclusion in the list of Scheduled Properties in terms of Section 81 of the Environment Protection, Act 2016 as a Level 1 Area of Ecological Importance (AEI), a Level 1 Site of Scientific Importance (SSI) for its ecology and a Level 2 Site of Scientific Importance (SSI) for its geomorphology (GN 827 of 2002). The islets are located within a Marine Special Area of Conservation of International Importance (MT0000105 – IlGrigal ta' Malta) and a Natura 2000 site.

These islands have been a declared nature reserve since 1993, where all flora and fauna is protected. It has interesting coastal garrigue communities, with the sub-endemic Maltese Toadflax (plant) and Pygmy Groundsel (plant), and an endemic wall lizard confined to these islands.

General Data:

Date of visit	26.06.18	MT5
Compiler	Lidia Selmi	
Name of site		St. Paul's Islands fault
Location	coordinates	35°57'54.08"N 14°23'56.60"E
	inland	coastal
	municipality	
	city/community	
Type	punctiform	
	linear	x
	areal	
Property	private	
	public	x*
	association	

*Access to the island is only permissible between sunrise and sunset and then only against an entry permit obtainable from the ERA

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy	x					
marine geology						
mineralogy						
geoarchaeology						
geomorphology		x				
hydrogeology						
paleontology						
petrography						
structural geology	x					

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
medium	
Scientific notoriety	
number of articles	1
number of dissertations	2

Descriptive data

(lithology, geomorphology, active/inactive..)

A direct fault across the island has brought the Upper Coralline Limestone in juxtaposition with Upper Globigerina Limestone. The Upper Coralline Limestone is predominant on the surface and represents the entire surface morphology of the islets; the Upper Globigerina Limestone outcrops as a small cliff with a narrow shore platform at the base. The coast of islets also features a number of marine caves. The islets are a Level 2 Site of Scientific Importance (SSI) for its geomorphology (GN 827 of 2002). Several sea caves are present along the coastline.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	x
	artistic	x
	touristic	
ecological	botanic	x
	faunistic	x
	protected site	x
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	moderate	~~difficult~~
Access to the site		
direct access via national roads		
direct access via local roads		
< 1km from a vehicle path		
> 1 km from a vehicle path		
no direct accessibility	x	
only by permission	x	
Services		
good facilities of services < 1 km		
incomplete services < 5 km		
absence of services < 10 km		
type of services: Access to the islets is only permissible between sunrise and sunset and then only against an entry permit obtainable from the Environment and Resource Authority (ERA).		
Visibility		
very difficult or not visible at all		
can only be viewed using special equipment		
limited by trees or lower vegetation		
good but need to move around for a complete observation		
good for all relevant features	x	
Safety		
site with safety facilities (fence, stairs, handrails, ecc..)		
mobile coverage		
equipper for people with physical deficit, elderly and infants		

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	x
	artistic	x
	touristic	
ecological	botanic	x
	faunistic	x
	protected site	x
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	moderate	~~difficult~~
Access to the site		
direct access via national roads		
direct access via local roads		
< 1km from a vehicle path		
> 1 km from a vehicle path		
no direct accessibility	x	
only by permission	x	
Services		
good facilities of services < 1 km		
incomplete services < 5 km		
absence of services < 10 km		
type of services: Access to the islets is only permissible between sunrise and sunset and then only against an entry permit obtainable from the Environment and Resource Authority (ERA).		
Visibility		
very difficult or not visible at all		
can only be viewed using special equipment		
limited by trees or lower vegetation		
good but need to move around for a complete observation		
good for all relevant features	x	
Safety		
site with safety facilities (fence, stairs, handrails, ecc..)		
mobile coverage		
equipper for people with physical deficit, elderly and infants		

General Data:

Date of visit	26.06.18	MT6
Compiler	Lidia Selmi	
Name of site	Salt pans	
Location	coordinates	35°57'54.60"N 14°23'45.31"E
	inland	~~coastal~~
	municipality	Mellieħa
	city/community	
Type	punctiform	
	linear	
	areal	x
Size area	12.000 m²	
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	
some deterioration with loss some minor elements	x
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	2

Descriptive data

(lithology, geomorphology, active/inactive..)

Shore platform in Globigerina Limestone characterised by a chequerboard of rock-cut saltpans protruding into the sea. The site is related to huma activity.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	x
	historic	x
	artistic	x
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Concervation (SAC)		x
world heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		
site located less than 50 m of a potential degradation area/activity		x
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		
there is the possibility of deterioration of secondary geological elements by anthropic activity		x
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	26.06.18	MT6
Compiler	Lidia Selmi	
Name of site	Salt pans	
Location	coordinates	35°57'54.60"N 14°23'45.31"E
	inland	~~coastal~~
	municipality	Mellieha
	city/community	Salini
Type	punctiform	
	linear	
	areal	x
Size area	9.500 m²	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	
some deterioration with loss some minor elements	x
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	2

Descriptive data

(lithology, geomorphology, active/inactive..)

Shore platform in Globigerina Limestone characterised by a chequerboard of rock-cut saltpans protruding into the sea. The site is antropogenic. Inactive salinas.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	x
	historic	x
	artistic	x
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Concervation (SAC)		x
world heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		
site located less than 50 m of a potential degradation area/activity		x
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		
there is the possibility of deterioration of secondary geological elements by anthropic activity		x
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

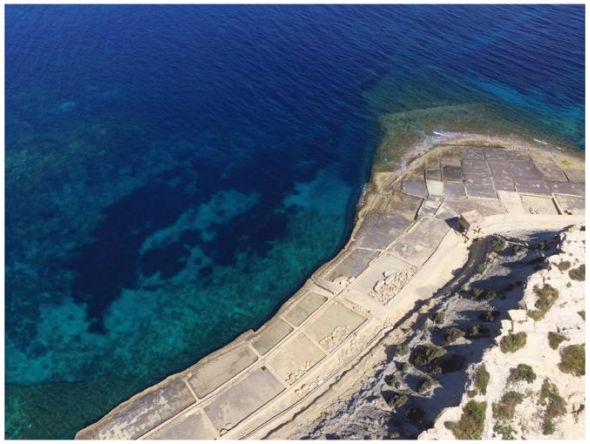
References

Selmi et al., 2019

General Data:

Date of visit	26.06.18	MT8
Compiler	Lidia Selmi	
Name of site	Salt pans	
Location	coordinates	35°57'54.60"N 14°23'45.31"E
	inland	~~coastal~~
	municipality	Mellieha
	city/community	Salini
Type	punctiform	
	linear	
	areal	x
Size area	6.500 m²	
Property	private	
	public	x
	association	

Picture of the site



Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	
some deterioration with loss some minor elements	x
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	2

Descriptive data

(lithology, geomorphology, active/inactive..)

Site in Globigerina Limestone. The shore platform is characterised by a chequerboard of rock-cut saltpans protruding into the sea. The site has anthropogenic origin. Inactive salinas.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	x
	historic	x
	artistic	x
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Concervation (SAC)		x
world heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		
site located less than 50 m of a potential degradation area/activity		x
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		
there is the possibility of deterioration of secondary geological elements by anthropic activity		x
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Selmi et al., 2019

General Data:

Date of visit		MT9
Compiler	Lidia Selmi	
Name of site	Badland topography in Blue Clay slopes	
Location	coordinates	35°58'0.82"N 14°23'29.72"E
	inland	coastal
	municipality	Mellieha
	city/community	Tal Blata
Type	punctiform	
	linear	
	areal	x
Size area	3.500 m²	
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	X
some deterioration with loss some minor elements	x
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Badland topography in Blue Clay formation consists of sequences of alternating paleo-grey and dark-grey banded marls, with lighter bands containing a higher proportion of carbonate. The formation in this site outcrops as gentle slopes occasionally covered by soil and generally affected by mass movements, in particular earth flows and earth slides.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	x
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	x
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		
there is the possibility of deterioration of secondary geological elements by anthropic activity		x
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References/Notes

The site is used by locals to practice recreational activities as mountain bike, quad or motocross.

Selmi et al., 2019

General Data:

Date of visit		MT10
Compiler		
Name of site	Quaternary features	
Location	coordinates	35°58'39.20"N 14°21'23.95"E
	inland	coastal
	municipality	Mellieha
	city/community	Ta' L-Imgħarrqa
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	2
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

The site represents the finest late Quaternary (Tyrrhenian) natural section in the island. The tyrrhenian deposits lie directly on a wave cut plutform and consist of a basal paleosol bed covered by intertidal sands.

Quaternary section lies on the eastern side of the bay. The sequence, which commences close to sea level, lies on eroded Upper Coralline Limestone which is capped unconformably by dark brown paleosol containing brecciated limestone clasts. Horizontally bedded brown packstones with occasional pubble horizons are developed above the soil.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	x
	naturalness	x
	vertical development	

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	x
good for all relevant features	
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		
Other Area of Ecological Impostance		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References/Notes

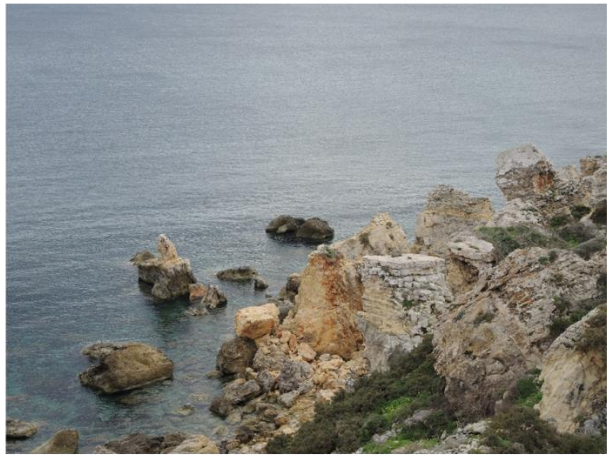
The site is Area of Ecological Importance DPA - GN 400/96

Pedley and Clarke, 2002

General Data:

Date of visit	28.01.19	MT11
Compiler	Lidia Selmi	
Name of site	Area affected by lateral spreading	
Location	coordinates	35°58'54.90"N 14°21'49.20"E
	inland	~~coastal~~
	municipality	Mellieħa
	city/community	L-Aħrax tal-Madonna
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Picture of the site



Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	
5-10 examples	x
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

The edge of the structural platform is characterised by faults and fractures, widened by chemical weathering and rock spreading. Fissures present in this rock formation play an important role in instability of the limestone cap rock, favoring processes of detachment and the subsequent displacement of the rock boulders. The site is entirely in Upper Coralline Limestone formation, with possible presence at the bottom of Blue Clay formation. The process is active.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	x
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	x
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	x
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	

Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	x
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	x
there is the possibility of deterioration of secondary geological elements by anthropic activity	
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References

Selmi et al., 2019

General Data:

Date of visit	15/07/2018	MT12
Compiler	Selmi Lidia	
Name of site	Badland topography in Blue Clay slopes	
Location	coordinates	35°59'1.92"N 14°21'51.26"E
	inland	~~coastal~~
	municipality	Mellieha
	city/community	
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Badland topography in Blue Clay Fm. The site consists of sequences of alternating paleo-grey and dark-grey banded marls, with lighter bands containing a higher proportion of carbonate.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	x
	naturalness	x
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	x
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	

Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	x
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	x
there is the possibility of deterioration of secondary geological elements by anthropic activity	
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References

Selmi et al., 2019

General Data:

Date of visit	Selmi Lidia	MT13
Compiler	17/07/18	
Name of site	Rock fall	
Location	coordinates	35°59'4.15"N 14°21'55.93"E
	inland	~~coastal~~
	municipality	Mellieha
	city/community	Rdum il-Ħmar
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Rock fall, active site. Upper Coralline Limestone formation. Separation occurs along discontinuities such as fractures, joints, and bedding planes, and movement occurs by free-fall, bouncing, and rolling. Falls are strongly influenced by gravity, mechanical weathering, and the presence of interstitial water.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	x
	faunistic	x
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	x
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	14/07/2018	MT14
Compiler	Selmi Lidia	
Name of site	Area affected by lateral spreading	
Location	coordinates	35°59'9.19"N 14°22'15.01"E
	inland	~~coastal~~
	municipality	Mellieħa
	city/community	Il-Marbat
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	
5-10 examples	x
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Active site in Upper Coralline Limestone Fm..

Lateral spreading of Upper Coralline blocks on fine-grained Blue Clay slopes.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	x
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	x
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	

Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	x
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	x
there is the possibility of deterioration of secondary geological elements by anthropic activity	
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References

General Data:

Date of visit	22/06/2018	MT15
Compiler	Selmi Lidia	
Name of site	Rock topple	
Location	coordinates	35°59'18.58"N 14°22'32.55"E
	inland	~~coastal~~
	municipality	Mellieha
	city/community	Rdum tal-Madonna
Type	punctiform	
	linear	
	areal	x
Size area	1.200 m²	
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

The process is active. Site in Upper Coralline Limestone, Mtarfa Member.

Toppling failures of Upper Coralline Limestone blocks are distinguished by the forward rotation of a unit or units about some pivotal point, below or low in the unit, under the actions of gravity and forces exerted by adjacent units or by fluids in cracks.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	x
	artistic	x
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	x
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	

Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	x
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	x
there is the possibility of deterioration of secondary geological elements by anthropic activity	
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References/Notes

The site is included in the Natura 2000 Management Plan (SAC/SPA) - L-Inħawi tar-Ramla tat-Torri u tal-Irdum tal-Madonna

General Data:

Date of visit	12/07/2018	MT16
Compiler	Lidia Selmi	
Name of site	Rock fall	
Location	coordinates	35°59'24.64"N 14°22'27.21"E
	inland	~~coastal~~
	municipality	Mellieħa
	city/community	
Type	punctiform	
	linear	
	areal	x
Size area	3.250 m²	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Rock fall in Upper Coralline Limestone plateau, Mtarfa Member. Separation occurs along discontinuities such as fractures, joints, and bedding planes, and movement occurs by free-fall, bouncing, and rolling. Falls are strongly influenced by gravity, mechanical weathering, and the presence of interstitial water.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	
	naturalness	x
	vertical development	x

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	

Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	x
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	x
there is the possibility of deterioration of secondary geological elements by anthropic activity	
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References

General Data:

Date of visit	15/06/2018	MT17
Compiler	Lidia Selmi	
Name of site	Sea cave	
Location	coordinates	35°59'35.21"N 14°22'19.38"E
	inland	~~coastal~~
	municipality	Mellieħa
	city/community	
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	2
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

Sea cave in Upper Coralline Limestone formation

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	x
	faunistic	x
	protected site	
aestetical	panoramic quality	x
	colour diversity	
	naturalness	x
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	x
good for all relevant features	
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Biolchi et al., 2016

Prampolini et al., 2017

General Data:

Date of visit	02/07/2018	MT18
Compiler	Lidia Selmi	
Name of site	Karst landform	
Location	coordinates	35°59'46.87"N 14°22'8.18"E
	inland	~~coastal~~
	municipality	Mellieħa
	city/community	Rdum l-Aħmar
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Coralline Limestone terrain is very sensible to dissolution due to its content of calcium carbonate and high fissure density, karstification is well developed in the area. The most widespread karstic feature is the surface of plareaus characterised by highly irregular and rugged shapes, resulting from dissolution processes.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	x
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Paskoff and Sanlaville, 1978

Coratza et al., 2011

General Data:

Date of visit	04/02/2018	MT19
Compiler	Lidia Selmi	
Name of site	Dragonara sinkhole	
Location	coordinates	35°59'52.06"N 14°22'3.84"E
	inland	~~coastal~~
	municipality	Mellieħa
	city/community	Aħrax point
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
medium	
Scientific notoriety	
number of articles	2
number of dissertations	3

Descriptive data

(lithology, geomorphology, active/inactive..)

Subsidence structure created as a result of the corrosive action of rainwater with limestone which enlarges a cave to an extent where the cave's roof becomes unstable and collapsed.

This unique site is connected with the sea and it is place of interest for diving and kayaking. It is also a panoramic view point, where is possible to see all the Marfa peninsula, Gozo and Comino.

Entirely Upper Coralline Limestone

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	x
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Biolchi et al., 2016

Prampolini et al., 2017

General Data:

Date of visit	28/01/2019	MT20
Compiler	Selmi Lidia	
Name of site	Tsunami deposit	
Location	coordinates	35°59'44.34"N 14°21'44.10"E
	inland	~~coastal~~
	municipality	Mellieħa
	city/community	Il-Fliegu ta'Kemmuna
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	1
number of dissertations	2

Descriptive data

(lithology, geomorphology, active/inactive..)

Imbricated limestone boulder deposit (Upper Coralline Limestone, Mtarfa Member), ranging from a few decimeters to meters in size. The occurrence of encrusted marine shells and bio forms on the boulder proves their marine origin. The deposit is about 100 m wide and situated at an altitude ranging between 0m and 5m above sea level.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	x
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Furlani et al., 2011

Biolchi et al., 2014, 2016

General Data:

Date of visit	11/07/2018	MT21
Compiler	Lidia Selmi	
Name of site	Cart ruts	
Location	coordinates	35°59'13.44"N 14°20'30.61"E
	~~inland~~	coastal
	municipality	Mellieħa
	city/community	Il Plazz Tal-Marfa
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology	x					
geomorphology		x				
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	
some deterioration with loss some minor elements	x
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Inherited anthropogenic features on Upper Coralline Limestone.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	x
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	x
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	

Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		x
other		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	
site located less than 50 m of a potential degradation area/activity	x
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	
there is the possibility of deterioration of secondary geological elements by anthropic activity	x
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References

General Data:

Date of visit	02/07/2018	MT22
Compiler	Lidia Selmi	
Name of site	Paradise Bay	
Location	coordinates	35°58'59.00"N 14°20'1.94"E
	inland	~~coastal~~
	municipality	Mellieha
	city/community	Ir-Ramla taċ-Ċirkewwa
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	
5-10 examples	x
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	1
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

Site affected by lateral spreading phenomena. Presence of a pocket beach used by tourists.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	x

Used value

Accessibility		
~~easy~~	moderate	difficult
Access to the site		
direct access via national roads		x
direct access via local roads		
< 1km from a vehicle path		
> 1 km from a vehicle path		
no direct accessibility		
only by permission		
Services		
good facilities of services < 1 km		x
incomplete services < 5 km		
absence of services < 10 km		
type of services: bars, bus stop, bus station, public services.		
Visibility		
very difficult or not visible at all		
can only be viewed using special equipment		
limited by trees or lower vegetation		
good but need to move around for a complete observation		
good for all relevant features		x
Safety		
site with safety facilities (fence, stairs, handrails, ecc..)		
mobile coverage		x
equipper for people with physical deficit, elderly and infants		

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		
site located less than 50 m of a potential degradation area/activity		x
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		
there is the possibility of deterioration of secondary geological elements by anthropic activity		x
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Selmi et al., 2019

General Data:

Date of visit	02/08/2018	MT23
Compiler	Selmi Lidia	
Name of site	Area affectd by lateral spreading	
Location	coordinates	35°58'48.10"N 14°19'45.95"E
	inland	~~coastal~~
	municipality	Mellieħa
	city/community	Ta' Qassisu
Type	punctiform	
	linear	
	areal	x
Size area	45.000 m²	
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	
5-10 examples	x
> 10 examples	
Representativeness	
High	
Scientific notoriety	
number of articles	1
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

The Upper Coralline Limestone plateau is heavily jointed and faulted, resulting from past tectonic activity. Chemical weathering, especially solution processes, have produced a karst terrain which aids in further widening the joints and faults and allows deeper infiltration of rainwater and wind erosion. The site is entirely in Upper Coralline Limestone formation, with possible presence at the bottom of Blue Clay formation.

Lateral spreading phenomena occur within the Upper Coralline Limestone formation which overlies the Blue Clay formation, the latter being a softer and unconsolidated material. The process is active.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	

Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	x
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	x
there is the possibility of deterioration of secondary geological elements by anthropic activity	
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References

Selmi et al., 2019

General Data:

Date of visit	02/08/2018	MT24
Compiler	Lidia Selmi	
Name of site	Ghajn Tuta sinkhole	
Location	coordinates	35°58'38.68"N 14°19'43.10"E
	~~inland~~	coastal
	municipality	Mellieħa
	city/community	Il-Latnija
Type	punctiform	x
	linear	
	areal	
Size area	1280.45 m²	
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
medium	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Inland cave with a surface area of 1280.45 m². It is one of the most extensive cave formations in the area and is made up of a globular chamber. This cave formation looks like a collapsed doline, yet the roof area has not collapsed entirely resulting in the formation of a cave within the sheltered area. This cave is situated at an altitude of 65 meters above sea level and has an entrance which is 8 meters high. This formation also presents some remnants of calcification in the form of flow stone. Evidence of past anthropogenic use in this cave can be seen in the form of rubble wall partitioning.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	x
	artistic	
	touristic	
ecological	botanic	x
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	x
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	x
good but need to move around for a complete observation	
good for all relevant features	
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		
there is the possibility of deterioration of secondary geological elements by anthropic activity		x
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References/Notes

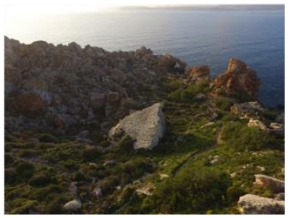
The site is surrounded by rocky pavement with some pockets of soils formed in karst landscape. It is highly affected by human activities such as rock climbing, night barbeque and recreation. Most of the vegetation inside the doline is destroyed except for some plants around big rocks on the sides of the entrance.

Saliba, 2008

General Data:

Date of visit	02/08/2018	MT25
Compiler	Selmi Lidia	
Name of site	Area affected by lateral spreading	
Location	coordinates	35°58'36.26"N 14°19'33.70"E
	inland	~~coastal~~
	municipality	Mellieħa
	city/community	Ta'Qassisu
Type	punctiform	
	linear	
	areal	x
Size area	62.000 m²	
Property	private	
	public	x
	association	

Pictures of the site



Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	
5-10 examples	x
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Upper Coralline Limestone plateau characterised by faults and fractures, widened by chemical weathering and rock spreading. Fissures present in this rock formation play an important role in instability of the limestone cap rock, favoring processes of detachment and the subsequent displacement of the rock boulders.

The site is entirely in Upper Coralline Limestone formation, with possible presence at the bottom of Blue Clay formation. In fact. lateral spreading phenomena occur within the Upper Coralline Limestone formation which overlies the Blue Clay formation, the latter being a softer and unconsolidated material.

The process is active.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	x
	protected site	
aestetical	panoramic quality	x
	colour diversity	
	naturalness	
	vertical development	x

Used value

Accessibility		
~~easy~~	moderate	difficult
Access to the site		
direct access via national roads		
direct access via local roads		x
< 1km from a vehicle path		
> 1 km from a vehicle path		
no direct accessibility		
only by permission		
Services		
good facilities of services < 1 km		
incomplete services < 5 km		x
absence of services < 10 km		
type of services:		
Visibility		
very difficult or not visible at all		
can only be viewed using special equipment		
limited by trees or lower vegetation		
good but need to move around for a complete observation		
good for all relevant features		x
Safety		
site with safety facilities (fence, stairs, handrails, ecc..)		
mobile coverage		x
equipper for people with physical deficit, elderly and infants		

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Selmi et al., 2019

General Data:

Date of visit	02/08/2018	MT26
Compiler	Lidia Selmi	
Name of site	Area affected by lateral spreading	
Location	coordinates	35°58'27.20"N 14°19'29.57"E
	inland	~~coastal~~
	municipality	Mellieħa
	city/community	Rdum il-Qawwi
Type	punctiform	
	linear	
	areal	x
Size area	53.000 m²	
Property	private	
	Public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	
5-10 examples	x
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Upper Coralline Limestone Plateau affected by later spreading phenomena. The site is active.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	
	naturalness	x
	vertical development	x

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	

Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	x
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	x
there is the possibility of deterioration of secondary geological elements by anthropic activity	
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References

Selmi et al., 2019

General Data:

Date of visit	02/08/2018	MT27
Compiler	Lidia Selmi	
Name of site	Badland topography in Blue Clay slope	
Location	coordinates	35°58'19.01"N 14°19'18.78"E
	inland	~~coastal~~
	municipality	Mellieħa
	city/community	Rdum il-Qawwi
Type	punctiform	
	linear	
	areal	x
Size area	2.900 m²	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
medium	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

The site consists of sequences of alternating paleo-grey and dark-grey banded marls, with lighter bands containing a higher proportion of carbonate. The formation in this site outcrops as gentle slopes occasionally covered by soil and generally affected by mass movements, in particular earth flows and earth slides.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	x
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	moderate	~~difficult~~

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	x
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Selmi et al., 2019

General Data:

Date of visit	14/07/2018	MT28
Compiler	Lidia Selmi	
Name of site	Shore platform	
Location	coordinates	35°58'17.65"N 14°19'10.03"E
	inland	coastal
	municipality	Mellieħa
	city/community	Ras il-Qammieħ
Type	punctiform	
	linear	
	areal	x
Size area	8.000 m²	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Shore platform in Globigerina Limestone

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	x
	vertical development	

Used value

Accessibility		
easy	moderate	~~difficult~~

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	x
no direct accessibility	
only by permission	

Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	x
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	x
there is the possibility of deterioration of secondary geological elements by anthropic activity	
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References

General Data:

Date of visit	07/07/2018	MT29
Compiler	Lidia Selmi	
Name of site	Badland topography in Blue Clay slopes	
Location	coordinates	35°58'11.26"N 14°19'21.87"E
	inland	~~coastal~~
	municipality	Mellieħa
	city/community	Rdum il-Qammieħ
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
medium	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Thesite shows an outcrop of Blue Clay, gently corrugated, set between Upper Coralline limestone and Globigerina Limestone. The site is active.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	x
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	moderate	~~difficult~~

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	x
no direct accessibility	
only by permission	

Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	x
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	x
there is the possibility of deterioration of secondary geological elements by anthropic activity	
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References

Selmi et al., 2019

General Data:

Date of visit	02/08/2018	MT30
Compiler	Lidia Selmi	
Name of site	Karst landform	
Location	coordinates	35°58'7.76"N 14°19'20.62"E
	inland	~~coastal~~
	municipality	Mellieħa
	city/community	Rdum il-Qammieħ
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Karst features on Globigerina Limestone terrace.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
easy	moderate	~~difficult~~

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	x
no direct accessibility	
only by permission	

Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	x
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	x
there is the possibility of deterioration of secondary geological elements by anthropic activity	
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References

Selmi et al., 2019

General Data:

Date of visit	03/07/2018	MT31
Compiler	Lidia Selmi	
Name of site	Terrace in Globigerina Limestone	
Location	coordinates	35°58'11.35"N 14°19'43.92"E
	inland	~~coastal~~
	municipality	Mellieħa
	city/community	Rdum il-Qammieħ
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy		x				
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology	x					
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Terrace in Globigerina Limestone Fm extended to 1 km. Chemical weathering is the main process shaping the surface of the platform and forming small solution holes, known as honeycombs structures. High scientific value and high aesthetic value being the unique terrace in northern Malta, spectacularly flat and yellow coloured.

The site conserves a substantial number of fossils: the intensive network of fossilized burrowing channels over the surface of the Lower member of the Globigerina Limestone Formation, scallop shells especially within the Lower Conglomerate bed, and the fossils of Echinoids species that are exposed at the surface.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	x
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	x
	vertical development	

Used value

Accessibility		
easy	moderate	~~difficult~~

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	x
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	02/08/2018	MT32
Compiler	Lidia Selmi	
Name of site	Il-Qammieħ fault	
Location	coordinates	35°58'13.20"N 14°20'3.07"E
	inland	~~coastal~~
	municipality	Mellieħa
	city/community	Il-Qammieħ
Type	punctiform	
	linear	x
	areal	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy	x					
marine geology						
mineralogy						
geoarchaeology						
geomorphology		x				
hydrogeology						
paleontology		x				
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

The site is the only striking geological feature of the study area which exposes the entire Oligo-Miocene Maltese lithological sequence – also greensand formation.

Inactive site.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	x
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	x
only by permission	

Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	x
good for all relevant features	

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	x
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	x
there is the possibility of deterioration of secondary geological elements by anthropic activity	
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References

General Data:

Date of visit	02/08/2018	MT33
Compiler	Lidia Selmi	
Name of site	Caves	
Location	coordinates	35°58'4.24"N 14°20'12.47"E
	inland	coastal
	municipality	Mellieħa
	city/community	Ic-Cumnija
Type	punctiform	x
	linear	
	areal	
Size area		
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology	x					
geomorphology						
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	
some deterioration with loss some minor elements	x
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Active site in Upper Coralline Limeston Fm. The site is shaped my sea erosion and gravity.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	x
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	

Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	
site located less than 50 m of a potential degradation area/activity	x
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	
there is the possibility of deterioration of secondary geological elements by anthropic activity	x
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References

General Data:

Date of visit	08/02/2018	MT34
Compiler	Lidia Selmi	
Name of site	Badland topography in Blue Clay slopes	
Location	coordinates	35°57'17.43"N 14°20'30.65"E
	inland	~~coastal~~
	municipality	Mellieħa
	city/community	
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
medium	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Active site in Blue Clay slopes. The slopes are usually affected by gully erosion and partially covered by vegetation .

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility			
~~easy~~	moderate	difficult	
Access to the site			
direct access via national roads			x
direct access via local roads			
< 1km from a vehicle path			
> 1 km from a vehicle path			
no direct accessibility			
only by permission			
Services			
good facilities of services < 1 km			x
incomplete services < 5 km			
absence of services < 10 km			
type of services:			
Visibility			
very difficult or not visible at all			
can only be viewed using special equipment			
limited by trees or lower vegetation			
good but need to move around for a complete observation			
good for all relevant features			x
Safety			
site with safety facilities (fence, stairs, handrails, ecc..)			
mobile coverage			
equipper for people with physical deficit, elderly and infants			

Management value

Legal protection		
Natura 2000		x
National park		x
Bird sanctuary		
Special Area of Concervation (SAC)		x
world heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	14/07/18	MT35
Compiler	Lidia Selmi	
Name of site	Dry valley	
Location	coordinates	35°57'13.18"N 14°20'40.55"E
	~~inland~~	coastal
	municipality	Mellieħa
	city/community	Wied ta'Rdum
Type	punctiform	
	linear	
	areal	x
Property	private	x
	public	
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology		x				
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

V-shape small dry valley in the Upper Coralline Limestone; It is relict of former pluvial conditions and extensive groundwater sapping.

The site is currently converted to agricultural land and terraced field.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	x
	faunistic	x
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	x
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	x
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	x
good but need to move around for a complete observation	
good for all relevant features	
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		x
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		
there is the possibility of deterioration of secondary geological elements by anthropic activity		x
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Coratza et al., 2011

General Data:

Date of visit	07/07/2018	MT36
Compiler	Lidia Selmi	
Name of site	Sinkhole	
Location	coordinates	35.953744° 14.346956°
	~~inland~~	coastal
	municipality	Mellieħa
	city/community	
Type	punctiform	
	linear	
	areal	x
Size area	3.100 m²	
Property	private	x
	public	
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	
some deterioration with loss some minor elements	x
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	2
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

Inherited site.

Quaternary sinkhole, natural depression caused by karst processes. Closed sub-circular depression with well defined margins that are linked to a post-Miocene karst system mainly developed in the Upper Coralline Limestone Formation. It is considered a solution sinkhole: a relatively shallow closed depression covered by soil, usually *terra rossa*, with its central part being the most favoured for cultivation. This solution sinkhole was probably generated by differential corrosional lowering of the ground surface where karst rocks are exposed at the surface.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	x
	artistic	
	touristic	
ecological	botanic	x
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	x
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	x
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	x
good but need to move around for a complete observation	
good for all relevant features	
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		x
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Pedley et al., 1975

Tonelli et al., 2012

General Data:

Date of visit	05/07/2018	MT37
Compiler	Lidia Selmi	
Name of site	Dry valley	
Location	coordinates	35.954781° 14.348478°
	~~inland~~	coastal
	municipality	Mellieħa
	city/community	Il-Wied tal-Hanżira
Type	punctiform	
	linear	
	areal	x
Size area	45.000 m²	
Property	private	x
	public	
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Inherited site in Upper Coralline Limestone Formation.

V-shape small dry valley, currently covered to agricultural land or terrace fields. This site is a relict of former pluvial condition and extensive groundwater sapping.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	x
	faunistic	x
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	x
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	x
good but need to move around for a complete observation	x
good for all relevant features	
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		x
other		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	x
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	
Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	
there is the possibility of deterioration of secondary geological elements by anthropic activity	x
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References

Coratza et al., 2011

General Data:

Date of visit	07/07/2018	MT38
Compiler	Lidia Selmi	
Name of site	Sinkhole	
Location	coordinates	35.955803° 14.350739°
	~~inland~~	coastal
	municipality	Mellieħa
	city/community	
Type	punctiform	
	linear	
	areal	
Size area	3.500 m²	
Property	private	x
	public	
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	
some deterioration with loss some minor elements	x
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
medium	
Scientific notoriety	
number of articles	2
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

Quaternary sinkhole, natural depression caused by karst processes.

Closed sub-circular depression with well defined margins that are linked to a post-Miocene karst system mainly developed in the Upper Coralline Limestone Formation. It is considered a solution sinkhole: a relatively shallow closed depression covered by soil, usually *terra rossa*, with its central part being the most favoured for cultivation. This solution sinkhole was probably generated by differential corrosional lowering of the ground surface where karst rocks are exposed at the surface.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	x
	artistic	
	touristic	
ecological	botanic	x
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	x
	vertical development	

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		x
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		
there is the possibility of deterioration of secondary geological elements by anthropic activity		x
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Pedley et al., 1975

Tonelli et al., 2012

General Data:

Date of visit	18/01/2019	MT39
Compiler	Lidia Selmi	
Name of site	Dissolution structure	
Location	coordinates	35.951328° 14.341389°
	inland	~~coastal~~
	municipality	Mellieħa
	city/community	Rdum id-Delli
Type	punctiform	x
	linear	
	areal	
Size area	5.000 m²	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
medium	
Scientific notoriety	
number of articles	2
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

Natural depression caused by karst processes.

Closed sub-circular depression with well defined margins that are linked to a post-Miocene karst system mainly developed in the Upper Coralline Limestone Formation. It is considered a solution sinkhole: a relatively shallow closed depression covered by soil, usually *terra rossa*. This solution sinkhole was probably generated by differential corrosional lowering of the ground surface where karst rocks are exposed at the surface.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	x
	touristic	x
ecological	botanic	x
	faunistic	x
	protected site	x
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	x
good for all relevant features	
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		x
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Pedley et al.,, 1975

Coratza et al., 2011

Tonelli et al., 2012

General Data:

Date of visit	09/08/2018	MT40
Compiler	Lidia Selmi	
Name of site	Area affected by lateral spreading	
Location	coordinates	35.951089° 14.339914°
	inland	~~coastal~~
	municipality	Mellieħa
	city/community	Rdum id-Delli
Type	punctiform	
	linear	
	areal	x
Size area	15.000 m²	
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	
5-10 examples	x
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Upper Coralline Limestone Formation, active site.

Landslide located along the coast and favoured by the overposition of the Upper Coralline Limestone on the Blue Clay. The site is an exemplary case and is the result of the key processes that provide a comprehensive undestanding of the geomorphological evolution of the rocky coastal areas.

The site is an exemplary case and is the result of the key processes that provide a comprehensive undestanding of the geomorphological evolution of the rocky coastal areas.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	x
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult
Access to the site		
direct access via national roads		
direct access via local roads		
< 1km from a vehicle path		x
> 1 km from a vehicle path		
no direct accessibility		
only by permission		
Services		
good facilities of services < 1 km		
incomplete services < 5 km		x
absence of services < 10 km		
type of services:		
Visibility		
very difficult or not visible at all		
can only be viewed using special equipment		
limited by trees or lower vegetation		
good but need to move around for a complete observation		
good for all relevant features		x
Safety		
site with safety facilities (fence, stairs, handrails, ecc..)		
mobile coverage		x
equipper for people with physical deficit, elderly and infants		

Management value

Legal protection		
Natura 2000		x
National park		x
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Coratza et al., 2011

General Data:

Date of visit	03/08/2018	MT41
Compiler	Lidia Selmi	
Name of site	Area affected by lateral spreading	
Location	coordinates	35.946422° 14.337461°
	inland	~~coastal~~
	municipality	Mellieħa
	city/community	Rdum id-Delli
Type	punctiform	
	linear	
	areal	x
Size area	50.000 m²	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	
5-10 examples	x
> 10 examples	
Representativeness	
High	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Upper Coralline Limestone Formation, active site.

Landslide located along the coast favoured by the overposition of the Upper Coralline Limestone on the Blue Clay.

The site is an exemplary case and is the result of the key processes that provide a comprehensive undestanding of the geomorphological evolution of the rocky coastal areas.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	x
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		x
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Coratza et al., 2011

General Data:

Date of visit	03/08/2018	MT42
Compiler	Selmi Lidia	
Name of site	Area affected by lateral spreading	
Location	coordinates	35.942906° 14.332131°
	Inland	~~coastal~~
	municipality	Mellieħa
	city/community	Rdum id-Delli
Type	punctiform	
	linear	
	areal	x
Size area	55.000 m²	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	
5-10 examples	x
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Upper Coralline Limestone Formation, active site.

The landslide is favoured by the overposition of the Upper Coralline Limestone on the Blue Clay. The site is an exemplary case and is the result of the key processes that provide a comprehensive undestanding of the geomorphological evolution of the rocky coastal areas.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	x
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		x
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Coratza et al., 2011

General Data:

Date of visit	03/08/2018	MT43
Compiler	Lidia Selmi	
Name of site	Karst landform	
Location	coordinates	35.941525° 14.331822°
	inland	~~coastal~~
	municipality	Mellieħa
	city/community	
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	
5-10 examples	x
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Upper Coralline Limestone Formation, active site.

The surface of the plateau is characterised by highly irregular and rugged shapes, resulting from dissolution processes.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	x
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		x
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Coratza et al., 2011

General Data:

Date of visit	08/08/2018	MT44
Compiler	Selmi Lidia	
Name of site	Area affected by lateral spreading	
Location	coordinates	35.941844° 14.331086°
	inland	coastal
	municipality	Mellieħa
	city/community	Ras Il-Waħx
Type	punctiform	
	linear	
	areal	x
Size area	40.000 m²	
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	
5-10 examples	x
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Upper Coralline Limestone Formation, active site.

Lateral spreading phenomena from the edge of Upper Coralline Limestone plateau.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	x
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		x
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Coratza et al., 2011

General Data:

Date of visit	17/07/2018	MT45
Compiler	Lidia Selmi	
Name of site	Area affected by lateral spreading	
Location	coordinates	35°56'26.56"N 14°19'50.83"E
	inland	~~coastal~~
	municipality	Mellieħa
	city/community	
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	
5-10 examples	x
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Upper Coralline Limestone plateau affected by landslide phenomena. Rock fall and lateral spreading.
Active site.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	x
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		x
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	07/07/2018	MT46
Compiler	Lidia Selmi	
Name of site	Badland topography in Blue Clay slopes	
Location	coordinates	35°56'19.30"N 14°19'55.48"E
	inland	~~coastal~~
	municipality	Mellieħa
	city/community	Rdum Majjiesa
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

The site consists of sequences of alternating paleo-grey and dark-grey banded marls, with lighter bands containing a higher proportion of carbonate. The formation in this site outcrops as gentle slopes occasionally covered by soil and generally affected by mass movements, in particular earth flows and earth slides.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	x
	naturalness	
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		x
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	07/07/2018	MT47
Compiler	Lidia Selmi	
Name of site	Karst landform	
Location	coordinates	35°56'26.24"N 14°20'16.36"E
	~~inland~~	coastal
	municipality	Mellieħa
	city/community	Ix-Xagħra tal-Majjiesa
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Upper Coralline Limeston Fm., active site.
The Upper Coralline Limestone pavement is sensible to dissolution due to its content of calcium carbonate and high fissure density, karstification is well developed in the area.
The surface of the plateau is characterised by highly irregular and rugged shapes, resulting from dissolution processes.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	x
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		x
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Coratza et al., 2011

General Data:

Date of visit	07/07/2018	MT48
Compiler	Lidia Selmi	
Name of site	Dry valley	
Location	coordinates	35°56'22.50"N 14°20'26.30"E
	~~inland~~	coastal
	municipality	Mellieħa
	city/community	
Type	punctiform	
	linear	
	areal	x
Size area	10.000 m²	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Upper Coralline Limestone Formation, inherited.

V-shape small dry valley, currently covered to agricultural land or terrace fields. This site is a relict of former pluvial condition and extensive groundwater sapping.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	x
	faunistic	x
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	x
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	x
good but need to move around for a complete observation	x
good for all relevant features	
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		x
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		
there is the possibility of deterioration of secondary geological elements by anthropic activity		x
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Coratza et al., 2011

General Data:

Date of visit	03/98/2018	MT49
Compiler	Selmi Lidia	
Name of site	Il-Qarraba	
Location	coordinates	35°55'38.45"N 14°20'24.94"E
	inland	~~coastal~~
	municipality	Mgarr
	city/community	Il-Qarraba
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology	x					
geomorphology						
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	5
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Upper Coralline Limestone plateau remodelled by coastal erosion and gravitational processes.

The edges of the structural platforms is characterised by faults and fractures, widened by chemical weathering and rock spreading. Fissures present in this rock formation play an important role in instability of the limestone cap rock, favouring processes of detachment and the subsequent displacement of the rock boulders.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	x
	faunistic	x
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Pedley and Waugh. 1974

General Data:

Date of visit	10/08/2018	MT50
Compiler	Lidia Selmi	
Name of site	Badland topography in Blue Clay slopes	
Location	coordinates	35°55'36.35"N 14°20'38.70"E
	inland	~~coastal~~
	municipality	Mgarr
	city/community	
Type	punctiform	
	linear	
	areal	x
Size area	15.000 m²	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Slopes of alternating paleo-grey and dark-grey banded marls, with lighter bands containing a higher proportion of carbonate. The formation in this site outcrops as gentle slopes occasionally covered by soil and generally affected by mass movements, in particular earth flows and earth slides.
Active site.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	x
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	

Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services: bus stop, car park, bar, public services	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	x
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	x
there is the possibility of deterioration of secondary geological elements by anthropic activity	
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References

General Data:

Date of visit	07/08/2018	MT51
Compiler	Lidia Selmi	
Name of site	Shore platform	
Location	coordinates	35°55'31.88"N 14°20'35.50"E
	inland	~~coastal~~
	municipality	Mgarr
	city/community	
Type	punctiform	
	linear	
	areal	x
Size area	2.600 m²	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Shore platform in Globigerina Limestone Fm.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	

Used value

Accessibility		
easy	moderate	~~difficult~~

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	x
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	06/08/2018	MT52
Compiler	Lidia Selmi	
Name of site	Badland topography in Blue Clay slopes	
Location	coordinates	35°55'5.43"N 14°20'1.95"E
	inland	~~coastal~~
	municipality	Mgarr
	city/community	Il-Qala
Type	punctiform	
	linear	
	areal	x
Size area	16.000 m²	
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
medium	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Badland topography in Blue Clay slopes.

The sequence of alternating paleo-grey and dark-grey banded marls is visible.
The formation in this site outcrops as gentle slopes occasionally covered by soil and generally affected by mass movements, in particular earth flows and earth slides.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	moderate	~~difficult~~

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	x
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	26/07/2018	MT54
Compiler	Lidia Selmi	
Name of site	cave	
Location	coordinates	35.917913°, 14.333107°
	Inland	~~coastal~~
	municipality	Mgarr
	city/community	Il-Qala
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Sea caves in Globigerina Limestone Fm.

Active site.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	x
	vertical development	

Used value

Accessibility		
easy	moderate	~~difficult~~

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	x
good for all relevant features	
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

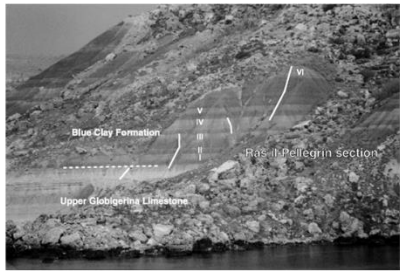
References/Notes

No direct accessibility, only by boat or kayak

General Data:

Date of visit	26/07/2018	MT54
Compiler	Lidia Selmi	
Name of site	GSSP	
Location	coordinates	35.913889° 14.336111°
	Inland	~~coastal~~
	municipality	Mgarr
	city/community	
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Pictures of the site



Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy	x					x
marine geology						
mineralogy						
geoarchaeology						
geomorphology		x		x		
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	2
number of dissertations	/

Descriptive data

(lithology, geomorphology, active/inactive..)

The boundary between the Globigerina Limestone and the Blue Clay Formation coincides with the major step in the middle Miocene global cooling and provides a level suitable for placing the physical reference point for the Langhian/Serravallian boundary.

Inactive and rare site, it represents the Langhian/Serravallian boundaries.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	x
	faunistic	x
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	moderate	~~difficult~~

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	x
no direct accessibility	
only by permission	

Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	x
good for all relevant features	

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
Other		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	x
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	x
there is the possibility of deterioration of secondary geological elements by anthropic activity	
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References

Abels et al., 2005.

General Data:

Date of visit	24/01/2019	MT55
Compiler	Lidia Selmi	
Name of site	Badland topography in Blue Clay slopes	
Location	coordinates	35°54'29.27"N 14°20'27.17"E
	inland	~~coastal~~
	municipality	Mgarr
	city/community	Il-Bajja ta' Fomm Ir-Rih
Type	punctiform	
	linear	
	areal	x
Size area	1.300 m²	
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
Medium	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Badland topography in Blue Clay slopes. Huge boulders detached from the Upper Coralline Limestone plateau above are frequent.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	x
	faunistic	x
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	moderate	~~difficult~~

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	x
no direct accessibility	
only by permission	

Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	
site located less than 50 m of a potential degradation area/activity	x
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	
there is the possibility of deterioration of secondary geological elements by anthropic activity	x
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References

General Data:

Date of visit	26/07/2018	MT56
Compiler	Lidia Selmi	
Name of site	Victoria Lines fault	
Location	coordinates	35.905847° 14.340567°
	Inland	~~coastal~~
	municipality	Mgarr
	city/community	Fomm ir-Rih
Type	punctiform	
	linear	x
	areal	
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy		x				
marine geology						
mineralogy						
geoarchaeology						
geomorphology						
hydrogeology						
paleontology						
petrography						
structural geology	x					

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

The Victoria Lines Fault forms a bold fault scarp which is the most striking topographic feature of the island. A full succession of the Lower Globigerina Limestone is exposed near the cliff-top at this locality. The yellow, coarse bioclastic limestones contain abundant bryozoans, bivalves and thalassinoidean burrows. Views to the north show excellent sections in the Blue Clay and Upper Coralline Limestone in the cliffs of Fomm ir-Rih Bay.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	x
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	x
good for all relevant features	
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Pedley H.M., 1990

General Data:

Date of visit	04/11/2018	MT57
Compiler	Lidia Selmi	
Name of site	Marine cave	
Location	coordinates	35°54'9.91"N 14°19'53.08"E
	inland	~~coastal~~
	municipality	Rabat
	city/community	
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
medium	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Sea cave in Lower Coralline Limestone Fm.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
easy	moderate	~~difficult~~

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	x
good for all relevant features	
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	16/01/2019	MT58
Compiler	Lidia Selmi	
Name of site	Fossil record	
Location	coordinates	35°54'5.09"N 14°19'52.87"E
	~~inland~~	coastal
	municipality	Rabat
	city/community	
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy		x				
marine geology						
mineralogy						
geoarchaeology						
geomorphology		x				
hydrogeology						
paleontology	x					
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Globigerina Limestone terrace rich in fossils: sharks teeth are common in these pelagic limestone and can be quite large. Their presence is a further indicator that the water in which the muds were deposited was a deep and open sea.

Lots of burrowing heart shaped sea urchins are also found.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	x
	historic	
	artistic	x
	touristic	
ecological	botanic	
	faunistic	x
	protected site	
aestetical	panoramic quality	
	colour diversity	x
	naturalness	x
	vertical development	

Used value

Accessibility		
easy	moderate	~~difficult~~

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	x
no direct accessibility	
only by permission	

Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	x
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		
World heritage site		
no protection		
other		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	x
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	
there is the possibility of deterioration of secondary geological elements by anthropic activity	
there is the possibility of deterioration of main geological elements by anthropic activity	x
there is the possibility of deterioration of all geological elements by anthropic activity	

References

General Data:

Date of visit	27/01/2019	MT59
Compiler	Lidia Selmi	
Name of site	Chert nodules	
Location	coordinates	35°54'5.25"N 14°19'52.76"E
	~~inland~~	coastal
	municipality	Rabat
	city/community	
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy	x					
marine geology						
mineralogy		x				
geoarchaeology						
geomorphology						
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Chert nodules, irregularly-shaped masses of siliceous limestone occurring in the Middle Globigerina Limestone formation. This rock is arised by the deposition of silica rendered insoluble by the action of marine organisms.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	23/01/2019	MT60
Compiler	Selmi Lidia	
Name of site	Globigerina Limestone cliff	
Location	coordinates	35°53'59.75"N 14°19'53.54"E
	~~inland~~	coastal
	municipality	Rabat
	city/community	
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy		x				
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology		x				
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Spectacular cliffs in Globigerina Limestone located inland. The site is active and it is under erosion by wind and rain.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	moderate	~~difficult~~

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	

Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	x
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	x
there is the possibility of deterioration of secondary geological elements by anthropic activity	
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References

General Data:

Date of visit	30/01/2019	MT61
Compiler	Lidia Selmi	
Name of site	Cart ruts	
Location	coordinates	35°54'00.8"N 14°22'34.1"E
	~~inland~~	coastal
	municipality	Rabat
	city/community	Santi
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology	x					
geomorphology						
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	
some deterioration with loss some minor elements	x
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Numerous ruts in several directions, dated 7,200 years ago.

Ruts are small-scale erosional landforms incised into surface bedrock outcrops, Upper Coralline Limestone. They occur as paired grooves of remarkable parallelism incised into bedrock, and extending up to several hundred metres in length.

The cross-section form of the ruts is the footprint of the vehicle and provides significant clues regarding the morphology of the vehicular component which carved them.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	x
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility	
~~easy~~ moderate difficult	
Access to the site	
direct access via national roads	
direct access via local roads	x
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	x
good for all relevant features	
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		
Other No trapping zone, except cultivated agricultural land officially registered with the Department of Agriculture prior to end July 2014 (this exemption does not apply to Bird Sanctuaries or Protected Beaches		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	31/01/2019	MT62
Compiler	Selmi Lidia	
Name of site	Cart ruts	
Location	coordinates	35°54'0.81"N 14°22'34.05"E
	~~inland~~	coastal
	municipality	Rabat
	city/community	Santi
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology	x					
geomorphology						
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	
some deterioration with loss some minor elements	x
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Numerous ruts in several directions, 7,200 years ago.

Ruts are small-scale erosional landforms incised into surface bedrock outcrops, Upper Coralline Limestone. They occur as paired grooves of remarkable parallelism incised into bedrock.

The cross-section form of the ruts is the footprint of the vehicle and provides significant clues regarding the morphology of the vehicular component which carved them.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	x
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult
Access to the site		
direct access via national roads		
direct access via local roads		x
< 1km from a vehicle path		
> 1 km from a vehicle path		
no direct accessibility		
only by permission		
Services		
good facilities of services < 1 km		x
incomplete services < 5 km		
absence of services < 10 km		
type of services:		
Visibility		
very difficult or not visible at all		
can only be viewed using special equipment		
limited by trees or lower vegetation		
good but need to move around for a complete observation		x
good for all relevant features		
Safety		
site with safety facilities (fence, stairs, handrails, ecc..)		
mobile coverage		x
equipper for people with physical deficit, elderly and infants		

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		
Other No trapping zone, except cultivated agricultural land officially registered with the Department of Agriculture prior to end July 2014 (this exemption does not apply to Bird Sanctuaries or Protected Beaches		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	18/01/2019	MT63
Compiler	Selmi Lidia	
Name of site	Dry valley	
Location	coordinates	35.903344° 14.378901°
	~~Inland~~	coastal
	municipality	Rabat / Mgarr
	city/community	Binġemma
Type	punctiform	
	linear	
	areal	x
Size area	18.000 m²	
Property	private	x
	public	
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology		x				
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

V-shape small dry valley, currently covered by vegetation. This site is a relict of former pluvial condition and extensive groundwater sapping.

Additional value

cultural	archaeological	x
	architectonic	
	geohistorical	
	historic	x
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	x
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	x
good but need to move around for a complete observation	
good for all relevant features	
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	x
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		x
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	18/01/2019	MT64
Compiler	Selmi Lidia	
Name of site	Inland caves	
Location	coordinates	35.903706° 14.378252°
	~~Inland~~	coastal
	municipality	Rabat / Mgarr
	city/community	Binġemma
Type	punctiform	x
	linear	
	areal	
Property	private	x
	public	
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	
some deterioration with loss some minor elements	x
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Inland caves in Upper Coralline Limestone.

The caves show anthropogenic disturbance in the form of rubble walls and small chambers hewn in the rock. However the physical features have not been altered and identification of the primary processes of formation is still possible. The site host a series of thirty burial chambers that vary in surface area from less than 10 m² to about 50 m ² or more.

Additional value

cultural	archaeological	
	architectonic	x
	geohistorical	x
	historic	
	artistic	x
	touristic	x
ecological	botanic	x
	faunistic	x
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	x

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	x
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	

Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	x
good for all relevant features	

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection	
Natura 2000	
National park	
Bird sanctuary	
Special Area of Conservation (SAC)	
World heritage site	
no protection	x
other	

need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	x
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	
there is the possibility of deterioration of secondary geological elements by anthropic activity	x
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

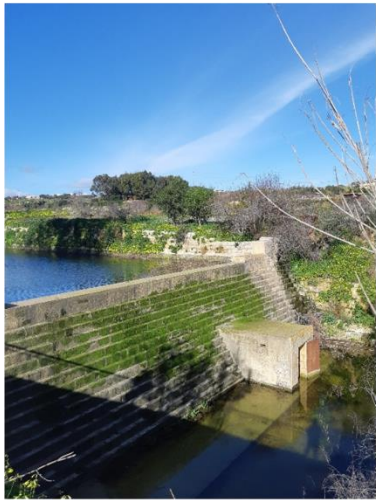
References

Saliba, 2008

General Data:

Date of visit	19/01/2019	MT65
Compiler	Selmi Lidia	
Name of site	Chadwick lake	
Location	coordinates	35.891614° 14.386330°
	~~Inland~~	coastal
	municipality	Rabat
	city/community	Marfa
Type	punctiform	
	linear	x
	areal	
Property	private	
	public	x
	leased governament	

Pictures of the site



Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology		x				
hydrogeology	x					
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Chadwick Lakes are temporary ponds formed as a result of the damming of the Qliegha Valley. These Lakes are filled with water only during the rainy season and dry up completely in the summer. The Wied il Ghasel valley system is characterised by these different geological layers, which give rise to various landforms with their respective rates of weathering. Muscat (1993) attributes the system formation to river passage when the Maltese Islands were still in Pleistocene Period. As the river passed through this system it created a meandering course at Wied il-Qlejgha, which is indicative of the mature stage of the river. Yet the occurrence of the Lower Coralline Limestone at Wid il-Ghasel, the morphology of the valley changed considerably. This gives rise to steep, vertical cliff-faces and gorge-like valley with a deeply incised meander, whose inside has a gentler slope and some deposition features.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	x
	faunistic	x
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	x
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	x
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		x
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		
there is the possibility of deterioration of secondary geological elements by anthropic activity		x
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Anthony Mifsud (2003)

M. Zammit Lucia thesis (1971)

General Data:

Date of visit	06.02.19	MT66
Compiler	Lidia Selmi	
Name of site	Ghar Lapsi	
Location	coordinates	35°49'39.59"N 14°25'36.53"E
	inland	coastal
	municipality	Siggiewi
	city/community	
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	2
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

High caves in the Upper Coralline Limestone cliff above Ghar Lapsi. They formation may be either land caves opened by rainfall solution or, perhaps more likely the eroded remnants of sea caves created when this cliff was at sea level some time in the Pliocene or early Pleistocene.

The earlier and longer part of the Quaternary era (the Pleistocene Period) saw many sudden changes in sea level brought about by variations in the amount of water locked up as land ice during glacial periods. A few of these eustatuc sea-level fluctuations potentially could have left their mark on areas of the island. Examples of what may be elevated former sea caves. At Ghar Lapsi the coast rises in a series of at least two steps. This probably reflects periods of sea erosion as the lands became uplifted in stages through Pliocene and Quaternary time. The Upper caves may well be sea caves developed at an early stage of the uplift.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	
	naturalness	
	vertical development	x

Used value

Accessibility			
~~easy~~	moderate	difficult	
Access to the site			
direct access via national roads			
direct access via local roads			
< 1km from a vehicle path			x
> 1 km from a vehicle path			
no direct accessibility			
only by permission			
Services			
good facilities of services < 1 km			x
incomplete services < 5 km			
absence of services < 10 km			
type of services: bars, bus stop, restaurant			
Visibility			
very difficult or not visible at all			
can only be viewed using special equipment			
limited by trees or lower vegetation			
good but need to move around for a complete observation			
good for all relevant features			x
Safety			
site with safety facilities (fence, stairs, handrails, ecc..)			
mobile coverage			x
equipper for people with physical deficit, elderly and infants			

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		
there is the possibility of deterioration of secondary geological elements by anthropic activity		x
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Pedley et al., 2002.

General Data:

Date of visit	06.02.19	MT67
Compiler	Lidia Selmi	
Name of site	Quaternary deposit	
Location	coordinates	35°49'35.56"N 14°25'50.40"E
	inland	~~coastal~~
	municipality	Qrendi
	city/community	
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy	x					
marine geology						
mineralogy						
geoarchaeology						
geomorphology						
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	
some deterioration with loss some minor elements	x
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Quaternary deposits outcrops along the coast. It was reported the presence of fossils, also from macrofauna. The site is mainly eroded by the sea.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility	
easy ~~moderate~~ difficult	
Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	x
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	X
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	X
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		
there is the possibility of deterioration of secondary geological elements by anthropic activity		X
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Pedley et al., 2002

General Data:

Date of visit	06.02.19	MT68
Compiler	Lidia Selmi	
Name of site	Magħlaq fault	
Location	coordinates	35°49'31.65"N 14°26'6.30"E
	inland	~~coastal~~
	municipality	Qrendi
	city/community	
Type	punctiform	
	linear	x
	areal	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology						
hydrogeology						
paleontology						
petrography						
structural geology	x					

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Segment of major fault visible along the southern Malta coast, known as Magħlaq fault. The fault carries Upper Coralline Limestone (Tal-Pitkal Member) down againt Lower Coralline Limestone (Attard Member)

Most spectacular tensional fracture with NW-SE trend within the Maltese Islands.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	x
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult
Access to the site		
direct access via national roads		
direct access via local roads		
< 1km from a vehicle path		
> 1 km from a vehicle path		x
no direct accessibility		
only by permission		
Services		
good facilities of services < 1 km		
incomplete services < 5 km		x
absence of services < 10 km		
type of services:		
Visibility		
very difficult or not visible at all		
can only be viewed using special equipment		
limited by trees or lower vegetation		
good but need to move around for a complete observation		
good for all relevant features		x
Safety		
site with safety facilities (fence, stairs, handrails, ecc..)		
mobile coverage		
equipper for people with physical deficit, elderly and infants		

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	17/01/2019	MT69
Compiler	Lidia Selmi	
Name of site	Arch	
Location	coordinates	35°49'21.14"N 14°26'18.77"E
	inland	~~coastal~~
	municipality	Qrendi
	city/community	Ras Il-Hamrija
Type	punctiform	x
	linear	
	areal	
Property	private	x
	public	
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology	x					
geomorphology						
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	
some deterioration with loss some minor elements	x
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Sea arch in Upper Coralline Limestone Fm. The site is active and under costanct erosion by the sea.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	
	naturalness	x
	vertical development	

Used value

Accessibility	
easy ~~moderate~~ difficult	
Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	x
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	X
absence of services < 10 km	
type of services: bus stop	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	X
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		X
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	6.02.19	MT70
Compiler	Lidia Selmi	
Name of site	Magħlaq fault	
Location	coordinates	35°49'24.26"N 14°26'22.55"E
	inland	~~coastal~~
	municipality	Qrendi
	city/community	
Type	punctiform	
	linear	x
	areal	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology						
hydrogeology						
paleontology						
petrography						
structural geology	x					

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Segment of major fault visible along the southern Malta coast, known as Magħlaq fault. In this segment is exposed Lower Coralline Limestone Fm.

The NW-SE-trending Il Magħlaq fault, exposed on the coast of SW Malta, throws in excess 210 m and is located on the periphery of the Pantelleria Rift. Only the Maghlaq Fault at Ghar Lapsi illustres the north-west trending faults well.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	x
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	
	naturalness	x
	vertical development	x

Used value

Accessibility	
easy ~~moderate~~ difficult	
Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	x
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Pedley et al., 1976; 2002.

General Data:

Date of visit	06/02/2019	MT71
Compiler	Lidia Selmi	
Name of site	Filfla island	
Location	coordinates	35°47'14.01"N 14°24'35.42"E
	inland	~~coastal~~
	municipality	
	city/community	
Type	punctiform	
	linear	
	areal	x
Size area	25.000 m²	
Property	private	
	public	x
	leased government	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

The island of Filfla is just 5 kilometers from Malta. It is a plateau entirely in Upper Coralline Limestone Fm. The edge of the plareau is affected by rock fall and rock spreading.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	x
	historic	x
	artistic	
	touristic	
ecological	botanic	x
	faunistic	x
	protected site	x
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility	
easy moderate ~~difficult~~	
Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	x
only by permission	x
Services	
good facilities of services < 1 km	
incomplete services < 5 km	
absence of services < 10 km	x
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	x
limited by trees or lower vegetation	
good but need to move around for a complete observation	x
good for all relevant features	
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
Other Nature Reserve		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References/Notes

The killing, capture, collection, trapping, maintaining in captivity, taxidermy, commercial exploitation, as well as picking and hunting of any species of flora and fauna in or from the Filfla nature reserve is prohibited.

Access to the Filfla nature reserve shall be by permission to be granted by the Minister for educational and scientific purposes. Filfla island became a bird sanctuary in 1980 and on 1st June 1988 through the Filfla Natural Reserve Act became a natural reserve for all plants and animals resident or migratory which exist in the wild state on the island.

Within a natural mile around the island fishing is also prohibited.

General Data:

Date of visit	17/07/20	MT72
Compiler	Lidia Selmi	
Name of site	Cart ruts	
Location	coordinates	35°51'8.94"N 14°23'50.21"E
	inland	coastal
	municipality	Siggiewi
	city/community	Għar il-Kbir
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology	x					
geomorphology						
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Ruts in Upper Coralline Limestone Fm.. The site has anthropogenic origin.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	x
	historic	x
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	x
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	

Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		x
other		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	x
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	
there is the possibility of deterioration of secondary geological elements by anthropic activity	x
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References

General Data:

Date of visit	18/01/19	MT73
Compiler	Lidia Selmi	
Name of site	Salt pans	
Location	coordinates	35°53'44.44"N 14°19'47.72"E
	inland	~~coastal~~
	municipality	Rabat
	city/community	
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology						
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Globigerina Limestone platform with salinas produced by anthropogenic activity.

The salinas are not active.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	x
	artistic	x
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
easy	moderate	~~difficult~~

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	x
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	x
good for all relevant features	
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	04/07/2018	MT74
Compiler	Lidia Selmi	
Name of site	Il-Maqluba sinkhole	
Location	coordinates	35°49'50.22"N 14°27'28.50"E
	~~inland~~	coastal
	municipality	Qrendi
	city/community	Il-Maqluba
Type	punctiform	x
	linear	
	areal	
Size area	5.400 m²	
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology						
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive)

Quaternary collapse sinkhole located in the Globigerina Limestone formation.

Il-Maqluba is the only onshore Quaternary collapse that has its roots in the Lower Coralline Limestone. This sinkhole indicates that large cavities were also developed within the Lower Coralline Limestone formation.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	x
	faunistic	x
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	x
	vertical development	x

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	x
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	x
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
Other No trapping zone S.L. 504.71 TPA Tree Protection Area L.N. 200 of 2011 & G.N. 473 of 2011		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Tonelli PhD Thesis, 2014

General Data:

Date of visit	12/08/18	MT75
Compiler	Lidia Selmi	
Name of site	Wied Babu	
Location	coordinates	35°49'26.98"N 14°27'36.09"E
	inland	~~coastal~~
	municipality	Zurrieq
	city/community	
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Dry valley with walls in Lower Coralline Limestone

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	x
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	x
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
Other No trapping zone S.L. 504.71		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		
there is the possibility of deterioration of secondary geological elements by anthropic activity		x
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	13/02/2018	MT76
Compiler	Selmi Lidia	
Name of site	Blue Grotto	
Location	coordinates	35°49'15.52"N 14°27'24.23"E
	inland	~~coastal~~
	municipality	
	city/community	
Type	punctiform	
	linear	
	areal	
Property	private	
	public	
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..

Blue Grotto includes an impressive cave and arch eroded along fault silvers that have the same alignment as the Magħlaq Fault.

The entire cliff in in Lower Coralline Limestone, hard and resist erosion, but the Magħlaq Fault created weaker zones that can be excavated by water action.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	x
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	

Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	x
mobile coverage	
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
Other No trapping zone S.L. 504.71		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	x
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	x
there is the possibility of deterioration of secondary geological elements by anthropic activity	
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

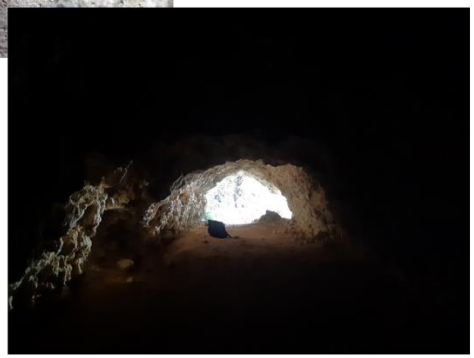
References

Pedley et al, 2002

General Data:

Date of visit	12/11/2018	MT77
Compiler	Lidia Selmi	
Name of site	Cave	
Location	coordinates	35°52'53.32"N 14°20'40.41"E
	~~inland~~	coastal
	municipality	Rabat
	city/community	
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Pictures of the site



Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology		x				
paleontology		x				
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	
some deterioration with loss some minor elements	x
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

The inland cave presents an unusual type of solution present only in this zone. It is a phreatic tube with an elliptical shape that extends for more than 200 meters after which further access is dangerous due to lack of space and oxygen. The entrance of this cave presents scalloping features that are similar to wave patterns forming on the walls of the cave. Scallops are a result of mechanical abrasion induced by turbulent flows. Stalactite formations and bedrock collapse were also identified. This cave has an entrance height of 2.11 meters which is relatively small compared to the inland depth. Another series of caves consisting of more than 10 formations is situated at the cliff face and occur in the proximity of this cave.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	x
	faunistic	x
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	x
	vertical development	

Used value

Accessibility		
easy	moderate	~~difficult~~

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	x
good but need to move around for a complete observation	x
good for all relevant features	
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
Other No trapping zone S.L. 504.71		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	06.08.2018	GZ1
Compiler	Lidia Selmi	
Name of site	Wied il Mielaħ	
Location	coordinates	36° 4'46.28"N 14°12'45.89"E
	inland	~~coastal~~
	municipality	Gharb
	city/community	It-Tieqa
Type	punctiform	x
	linear	
	areal	
Size area	600 m²	
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Natural arch in Lower Coralline Limestone Formation, Xlendi Member; it has formed by growth of an initial cave, developed along a line of rock weakness, which has cut through the limestone, resulting in the arch being formed. Wied il-Mielah is situated in the middle of the area beteween Wied I-Ghasri and San Dimitri Point in the north-west corner of Gozo. It is characterised by high and steep cliffs and narrow valleys. Despite its natural values, the site is not included in the Natura 2000 network of protected areas.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	x
	protected site	
aestetical	panoramic quality	x
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	x
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		x
Other S.L. 504.71 No trapping zone		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		
there is the possibility of deterioration of secondary geological elements by anthropic activity		x
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

Notes/References

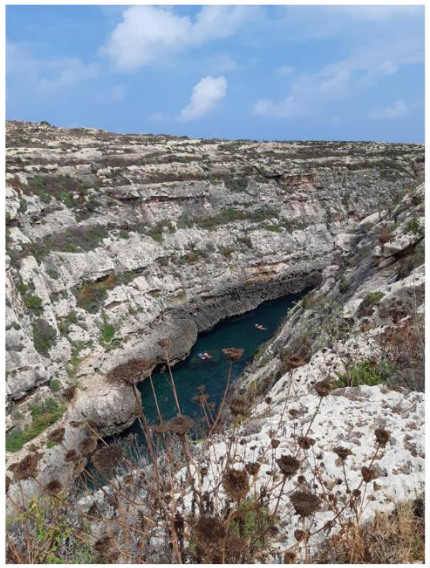
Site used by rock climbers

Cliff areas appear to be a suitable breeding habitat for Yelkouan Shearwater

General Data:

Date of visit	06.08.2018	GZ2
Compiler	Lidia Selmi	
Name of site	Wied il-Ghasri	
Location	coordinates	36.079521° 14.212746°
	inland	~~coastal~~
	municipality	Ghasri
	city/community	Il Sikkina tal-Qortin
Type	punctiform	
	linear	
	areal	x
Size area	13.000 m²	
Property	private	
	public	x
	association	

Picture of the site



Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology		x				
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

L-Ghasri valley is a deep gorge-like valley with very high cliffs carved into the Lower Coralline Limestone and the overlying Globigerina Limestone.

The meandering stream pattern was producted first by a continuous water flow and secondly the gradient of the stream bed must be low and allow the water flow to contort the stream channel in sinous curves across a relative flat surface. That land surface must have been at around the level of the present top of the gorge and at that time close to sea level. Once the meander pattern had become established there must then have been a rapid uplift of the land or a fall of the sea to cause the continuously running stream to cut down through the hard Lower Coralline Limestone and make the gorge on the same meander pattern.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	x
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	x

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	x
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		x
Other	S.L. 504.71 No trapping zone	
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		
there is the possibility of deterioration of secondary geological elements by anthropic activity		x
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	06.08.2018	GZ3
Compiler	Lidia Selmi	
Name of site	Salt pan	
Location	coordinates	36° 4'51.61"N 14°14'18.53"E
	inland	~~coastal~~
	municipality	Zebbug (Ghawdex)
	city/community	Salini
Type	punctiform	
	linear	
	areal	x
Size area	10.000 m²	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

Man made salt pans to collect marine water, engraved in Lower Globigerina Limestone Member.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	x
	artistic	x
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	x
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		x
Other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	06.08.2018	GZ4
Compiler	Lidia Selmi	
Name of site	Salt pans	
Location	coordinates	36° 4'45.90"N 14°14'48.29"E
	inland	~~coastal~~
	municipality	Zebbug (Ghawdex)
	city/community	Salini
Type	punctiform	
	linear	
	areal	x
Size area	13.000 m²	
Property	private	x
	public	
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

The site consist of a shore platform in Lower Globigerina Limestone extend more than 3 km on the north of Marsalforn, on the north coast of Gozo island.

The accessible nature from both sea and land and the flat morphology of shore platform attracted the extraction of salt through sea water insolation and intensive manual labour.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	x
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	x
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services: hotels, bars, public transport	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection	
Natura 2000	
National park	
Bird sanctuary	
Special Area of Conservation (SAC)	
World heritage site	
no protection	x
other	

need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	x
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	
Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	x
there is the possibility of deterioration of secondary geological elements by anthropic activity	
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References/Notes

The geosite is considered the largest and most impressive system of salt harvesting on an industrial scale and underlines the strict relation with geology and land use development.

Gauci and Inkpen (2019)

General Data:

Date of visit	06.08.2018	GZ5
Compiler	Lidia Selmi	
Name of site	Dome	
Location	coordinates	36° 4'46.65"N 14°14'59.10"E
	inland	coastal
	municipality	Zebbug
	city/community	Il-Qolla I-Bajda
Type	punctiform	x
	linear	
	areal	
Size area	170 m²	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy		x				
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	
some deterioration with loss some minor elements	x
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

The conical shape of il-Qolla I-Bajda is the result of sub-aerial erosional processes which have acted on the island for the past five million years. This particular shape is due to the resistance properties of the limestone. Water permeaters the Upper Coralline Limestone mostly through its fault planes, finding its way to the Ble Clay layer. When the clay minerals come into contact with water they sent to expand due to the forces of repulsion between the particles, causing structural weakness in the layer of upper coralline limestone above it. These processes lead to the development of cracks in this top geological stratum and the detachment of sizable limestone blocks that slide down the valley sides towards the sea. In the meantime the layers of Globigerina Limestone below the Blue Clay, are also eroded by flowing water. Thus, these rounded cone-like structures exhibit all the layers on the stratigraphic succession.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	x
	vertical development	x

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	x
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	

Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services: bus stop, bars, all facilities	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		x
Other S.L. 504.71 No trapping zone		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	
site located less than 50 m of a potential degradation area/activity	x
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	
there is the possibility of deterioration of secondary geological elements by anthropic activity	x
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References

Pedley et al., 2002

General Data:

Date of visit	06.08.18	GZ6
Compiler	Lidia Selmi	
Name of site	Cart ruts	
Location	coordinates	36° 3'15.61"N 14°11'23.04"E
	inland	~~coastal~~
	municipality	San Lawrenz
	city/community	
Type	punctiform	x
	linear	
	areal	
Size area	600 m²	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology	X					
geomorphology		X				
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Human made features on Lower Coralline Limestone. Inactive site.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	x
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	06.08.2018	GZ7
Compiler	Lidia Selmi	
Name of site	Blue Hole	
Location	coordinates	36° 3'10.70"N 14°11'18.68"E
	inland	~~coastal~~
	municipality	San Lawrenz
	city/community	
Type	punctiform	x
	linear	
	areal	
Size area	450 m²	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology	x					
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservationlow	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Small rounded dissolution feature named Blue Hole, at Dwejra North bay. This feature contributes to the geomorphological diversity of the Dwejra coastline and is strictly related to the sinkholes and dissolution pans present in the area. This round Blue Hole is about 15 meters wide. It seems carved into the surrounding rocks, but an underwater arch located 10 meters below the surface actually connects it to the open sea.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	
	naturalness	x
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	x
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	06.08.18	GZ8
Compiler	Lidia Selmi	
Name of site	Fungus rock	
Location	coordinates	36° 2'48.37"N 14°11'20.22"E
	inland	coastal
	municipality	San Lawrence
	city/community	Ġebla tal-Ġeneral
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

The Fungus rock is a large isolated massive block, 60 metres high, bounding Dwejra Bay westwards. It was originally the external wall of the paleosinkhole in which the bay originated. Marine erosion then removed part of the wall, taking advantage of the structural weakness of faulted and fractured areas, and the present impressive feature was originated.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	x
	artistic	
	touristic	
ecological	botanic	x
	faunistic	x
	protected site	x
aestetical	panoramic quality	
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	x
only by permission	

Services	
good facilities of services < 1 km	
incomplete services < 5 km	
absence of services < 10 km	
type of services:	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
Other Nature reserve		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	x
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	x
there is the possibility of deterioration of secondary geological elements by anthropic activity	
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References/Notes

The rock owes its name to the presence at its top of a plant which was considered to have medical properties during the time of the Medieval Knights of St. John. The rock, in fact, supports many endemic and rare garigue and rupestral species, two of the more important ones being *cynomorium coccineum* and *podarcis filfolensis* generalensis. The rock takes its name from a phallic-shaped plant (in the past mistakenly thought to be a fungus) which has been protected since the 15th century when it was then considered by the Hospitalier Military Order to have medicinal properties.

Coratza et al., 2016

General Data:

Date of visit	08/08/2018	GZ9
Compiler	Selmi Lidia	
Name of site	Tunnel	
Location	coordinates	36° 3'17.60"N 14°11'25.79"E
	inland	coastal
	municipality	San Lawrence
	city/community	
Type	punctiform	
	linear	x
	areal	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology		x				
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Narrow karstic channel that connects the Qawra Sinkhole with the open sea.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	x
	vertical development	

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Coratza et al, 2016

General Data:

Date of visit	06.08.2018	GZ10
Compiler	Lidia Selmi	
Name of site	Qawra sinkhole	
Location	coordinates	36° 3'13.84"N 14°11'28.14"E
	inland	coastal
	municipality	San Lawrence
	city/community	Qawra – Il Bajja tad-Dwejra
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	3
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Qawra is a steep-sided erosional depression controlled by an annular fault around 350 m in diameter. The depression has a small semicircular lagoon on its northern sector. Although the basin is surrounded by scarps or steep slopes along its whole perimeter, the lagoon is connected to the open sea through a fault-controlled cave more than 100 m long developed in the Lower Coralline Limestone. The size of the cave is large enough to allow navigation with boats. The margins of the paleosinkhole consist of Lower Coralline Limestone and Lower Globigerina, whereas the rocks exposed within the collapse are Blue Clay and Upper Globigerina Limestone.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	x
	naturalness	x
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	x
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Tonelli et al., 2012

General Data:

Date of visit	06.08.18	GZ11
Compiler	Lidia Selmi	
Name of site	L-Ghadira ta'Sarraflu	
Location	coordinates	36° 2'11.66"N 14°11'56.38"E
	~~inland~~	coastal
	municipality	Kercem
	city/community	
Type	punctiform	
	linear	
	areal	x
Size area	930 m²	
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology						
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

The sire is a semi-artificial depression supporting an important freshwater community and is quite popular with locals and visitors. It is also scheduled as an Area of Ecological Importance and is protected also within the approved Qawra/Dwejra Heritage Park Action Plan (2005)

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	x
	faunistic	x
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	x
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		
Other Area of Ecological Importance DPA - GN 288/95 No trapping zone S.L. 504.71		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		
there is the possibility of deterioration of secondary geological elements by anthropic activity		x
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	20/01/19	GZ12
Compiler	Selmi Lidia	
Name of site	Xlendi Sinkhole	
Location	coordinates	36° 1'54.83"N 14°13'1.28"E
	inland	~~coastal~~
	municipality	Munxar
	city/community	Is-Sidra
Type	punctiform	
	linear	
	areal	x
Size area	112.171 m²	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

The Xlendi paleosinkhole is an isolated subsidence structure located in the southwestern coast of Gozo. It shows a N-S trending elongated shape in plan-view, with its southern sector significantly wider than the northern one. The margins of the structure are mainly underlain by resistant Lower Coralline Limestone, whereas the foundered sediments preserved in the downthrown block correspond to softer Globigerina Limestone.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	x
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	x
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	x
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	x
good for all relevant features	
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		
site located less than 50 m of a potential degradation area/activity		x
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		
there is the possibility of deterioration of secondary geological elements by anthropic activity		x
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Tonelli, 2014

General Data:

Date of visit	27.01.2019	GZ13
Compiler	Lidia Selmi	
Name of site	Globigerina terrace	
Location	coordinates	36° 1'37.77"N 14°12'47.15"E
	inland	coastal
	municipality	Munxar
	city/community	It-Torri Tax-Xlendi
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology		x				
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Terrace in hard Lower Globigerina Limestone, with presence of ancient inactive salt pans at Ras il-Bajda point.

This section mainly comprises fine grained limestones full of planktonic fossils which shows that it was originally deposites in deeper water below the action of waves. Scallop shells, burrowing heart shaped urchins and fossil Sharks Teeth are common. Their presence is a further indicator that the water in which the muds were deposited was deep and open sea.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	x
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	x
	naturalness	x
	vertical development	

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
Other Legislation S.L. 504.71: No trapping zone		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		
there is the possibility of deterioration of secondary geological elements by anthropic activity		x
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Pedley et al., 2002

General Data:

Date of visit	18/01/2019	GZ14
Compiler	Selmi Lidia	
Name of site		Mgarr ix-Xini harbour
Location	coordinates	36° 1'13.61"N 14°16'15.64"E
	inland	~~coastal~~
	municipality	Sannat
	city/community	Wied ta'Mgarr ix-Xini
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology		x				
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Dry valley in Lower Coralline Limestone Fm. The landscape is dominated southwards by what the Maltese term 'Rdum', (a boulder strewn area) and several carob groves and abandoned fields lead down to the coast. On looking eastwards, many river interfluves can be observed in which a few scattered houses stand on the hilltops. The view to the north is mainly obscured by housing developments.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	x
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	x
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		x
Other No trapping zone S.L. 504.71		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	18/01/2019	GZ15
Compiler	Lidia Selmi	
Name of site	Salt pan	
Location	coordinates	36° 1'6.52"N 14°17'13.63"E
	inland	~~coastal~~
	municipality	Ghajnsielem
	city/community	
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology						
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Salinas in Lower Globigerina Limestone. Anthropogenic origin, inactive.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	x
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		x
Other No trapping zone S.L. 504.71		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	18/01/2019	GZ16
Compiler	Selmi Lidia	
Name of site	Badland topography in Blue Clay slopes	
Location	coordinates	36° 1'11.76"N 14°17'27.19"E
	inland	~~coastal~~
	municipality	Ghajnsielem
	city/community	Xatt l-Ahmar
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy		x				
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
medium	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Badland topography in Blue Clay slopes. Marked banded colour due to the difference in carbon content.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	x
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	x
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		x
Other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	18/01/2019	GZ17
Compiler	Selmi Lidia	
Name of site	Salt pans	
Location	coordinates	36° 1'6.49"N 14°17'27.55"E
	inland	coastal
	municipality	Ghajnsielem
	city/community	Il-Ponta tal-Mellieħa
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology	X					
geomorphology		x				
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Globigerina Limestone terrace with ancient salinas.

Anthropogenic site, inactive.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	x
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		x
Other No trapping zone S.L. 504.71		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	18/01/2019	GZ18
Compiler	Selmi Lidia	
Name of site	Cave	
Location	coordinates	
	inland	coastal
	municipality	Nadur
	city/community	
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	
some deterioration with loss some minor elements	x
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Inland cave in Upper Coralline Limestone. It is made up by Mtarfa Member and Tal-Pitkal Member. Gravitational activity still ongoing.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	x
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	

Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		x
other		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	
site located less than 50 m of a potential degradation area/activity	x
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	
there is the possibility of deterioration of secondary geological elements by anthropic activity	x
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References

General Data:

Date of visit	18/01/2019	GZ19
Compiler	Lidia Selmi	
Name of site	Cave	
Location	coordinates	36° 3'4.93"N 14°15'52.94"E
	~~inland~~	coastal
	municipality	Xragha
	city/community	
Type	punctiform	
	linear	
	areal	
Property	private	x
	public	
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology		x				
geomorphology	x					
hydrogeology						
paleontology		x				
petrography						
structural geology		x				

State of conservation	
well preserved, no deterioration	
some deterioration with loss some minor elements	x
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Inland cave in Upper Coralline Limestone

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	x
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	x
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	

Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	x
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		X
Other		
need for protection	yes	No

Proximity to areas/activities with potential to cause degradation	
no degradation risk	X
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	X
there is the possibility of deterioration of secondary geological elements by anthropic activity	
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References

General Data:

Date of visit	18/01/2019	GZ20
Compiler	Lidia Selmi	
Name of site	Cave	
Location	coordinates	36° 3'4.50"N 14°15'40.91"E
	~~inland~~	coastal
	municipality	Xragha
	city/community	
Type	punctiform	
	linear	
	areal	
Property	private	x
	public	
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy		x				
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology		x				
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	
some deterioration with loss some minor elements	x
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Inland cave in Upper Coralline Limestone Fm.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	x
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	x
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	x
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		x
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		
site located less than 50 m of a potential degradation area/activity		x
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	18/01/2019	GZ21
Compiler	Lidia Selmi	
Name of site	Dry valley	
Location	coordinates	36° 1'54.73"N 14°13'22.56"E
	inland	coastal
	municipality	Munxar
	city/community	Wied Xlendi
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	
some deterioration with loss some minor elements	x
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Dry valley in Lower Coralline Limestone. The valley is filled in with sediments and vegetation.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	x
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	x
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	x
good but need to move around for a complete observation	
good for all relevant features	
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protectionx		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		x
Other No trapping zone S.L. 504.71		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		X
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	02/08/2018	GZ22
Compiler	Lidia Selmi	
Name of site	Globigerina sequence	
Location	coordinates	36° 2'58.79"N 14°19'2.45"E
	Inland	~~coastal~~
	Municipality	Qala
	city/community	Daħlet Qorrot
Type	Punctiform	x
	Linear	
	Areal	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy	x					
marine geology						
mineralogy						
geoarchaeology						
geomorphology		x				
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
Low	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Globigerina Limestone pavement with both Upper and Lower main phosphorite conglomerate beds.

The beds are disturbed by a series of joints which penetrate the LMPCB and cause buckling and disruption. Many of the joints are infilled by phosphorite conglomerate and there is a marginal alteration of the fracture walls.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	
	naturalness	
	vertical development	x

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	x
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		x
Other Environment protection ALT_170		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Pedley et al., 2002

General Data:

Date of visit	06/08/2018	GZ23
Compiler	Selmi Lidia	
Name of site	Quaternary deposits	
Location	coordinates	36° 3'39.57"N 14°16'57.92"E
	inland	~~coastal~~
	municipality	Xaghra
	city/community	Tar-Ramla
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy	x					
marine geology						
mineralogy						
geoarchaeology						
geomorphology		x				
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

The site contains the largest aeolian deposit in the islands and consists of a carbonate sand dune area which extends several hundred meters up the valley from the present day beach. The dunes are barely active today but have partly buried remains of Roman age near the beach.

Additional value

cultural	archaeological	x
	architectonic	
	geohistorical	
	historic	x
	artistic	
	touristic	x
ecological	botanic	x
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	x
	naturalness	
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	x
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
Other Environment protection DPA - GN 7/95		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		
site located less than 50 m of a potential degradation area/activity		x
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		
there is the possibility of deterioration of secondary geological elements by anthropic activity		x
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Pedley et al., 2002

General Data:

Date of visit	06/08/2018	GZ24
Compiler	Lidia Selmi	
Name of site	Globigerina point	
Location	coordinates	36° 4'46.01"N 14°12'45.42"E
	inland	~~coastal~~
	municipality	
	city/community	
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy	x					
marine geology						
mineralogy						
geoarchaeology						
geomorphology		x				
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

The vertical cliffs here expose cross stratified Xlendi Member of the Lower Coralline Limestone Fm. There is also an opportunity here to see the contact between the Lower Coralline Limestone Fm and the Lower Globigerina Limestone. It is marked by a rapid transition from cross-stratified Xlendi Member composed of coarse grained brownish, bioclastic limestone to brownish cream, finer grained limestones.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	x
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		x
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Pedley et al., 2002

General Data:

Date of visit	06/08/2018	GZ25
Compiler	Selmi Lidia	
Name of site	Collapse contortion	
Location	coordinates	36° 2'53.92"N 14°12'28.90"E
	inland	coastal
	municipality	Kercem
	city/community	Ghajn Abdul
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy	x					
marine geology						
mineralogy						
geoarchaeology						
geomorphology						
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	
some deterioration with loss some minor elements	x
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

On the flanks of the Ghajn Abdul collapse structure some of the outcrops of the Upper Coralline Limestone show very contorted bedding. Lithified pieces of rim wall which fell into the unconsolidated sediments accumulating in the collapse structure are responsible for these deformation features. Miocene debris which collapsed into the sea floor depressions from the edges of the collapse shafts and slumping causing soft sediment contortion. All this visible evidence must imply that the Miocene sea floor collapsed into a void.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	x
	vertical development	

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	x
good for all relevant features	
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		x
Other No trapping zone S.L. 504.71		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		
site located less than 50 m of a potential degradation area/activity		x
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		x
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Pedley et al., 2002

General Data:

Date of visit		GZ26
Compiler	Lidia Selmi	
Name of site	Reqqa point	
Location	coordinates	36° 4'51.87"N 14°14'12.39"E
	inland	~~coastal~~
	municipality	Zebbug
	city/community	Il-Ponta ta-Reqqa
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy	x					
marine geology						
mineralogy						
geoarchaeology						
geomorphology		x				
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

The site provides total exposure of the Globigerina Limestone Members.

The Glogiberina Limestone is divided into three by two hard phosphatic conglomerate layers (the lower denoted as C1 and the upper as C2) which form distinctive benches in this view and throuhout the islands of Malta and Gozo.

The basal bench with the salt pans lies at the top of the hard Lower Coralline Limestone.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	x
	naturalness	x
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	x
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		x
Other No trapping zone S.L. 504.71		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Pedley et al., 2002

General Data:

Date of visit	18/01/2019	GZ27
Compiler	Lidia Selmi	
Name of site	Weathering	
Location	coordinates	36° 1'8.12"N 14°17'29.64"E
	inland	coastal
	municipality	Ghajnsielem
	city/community	Il-Ponta tal-Mellieħa
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy	x					
marine geology						
mineralogy						
geoarchaeology						
geomorphology						
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

The inhomogeneous texture in the rock created this burrow fabric also affects the weathering properties of the limestone and can produce a very characteristic honeycomb surface.

Weathering on the vertical surface of heavily burrowed Globigerina Limestone often produces a very characteristic honeycombed surface. Such weathering of burrow systems on old buildings can enhance their appearance and has even been copied by masons on the Old Opera House, valletta.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	x
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	x
	naturalness	x
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		x
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

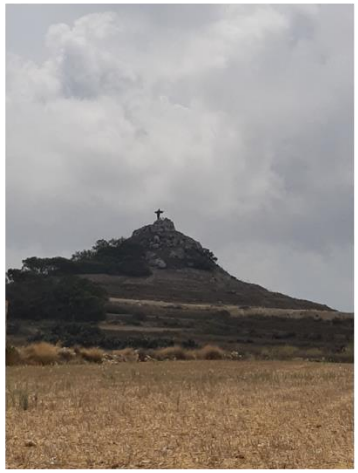
References

Pedley et al., 2002

General Data:

Date of visit	06/08/2018	GZ28
Compiler	Selmi Lidia	
Name of site	Tas-Salvatur	
Location	coordinates	36° 3'59.16"N 14°15'15.98"E
	~~inland~~	coastal
	municipality	Zebbug
	city/community	
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Picture of the site



Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	4
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

The site emerges from the surrounding landscape as a 65 m high hill. Where the rocks capping the collapsed rock are more resistant than the country rock, rounded buttes or mesas are created due to differential erosion. Upper Coralline Limestone (Gebel Imbark Member, Tal-Pitkal Member).

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	x
	artistic	x
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		
Other No trapping zone S.L. 504.71		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Coratza et al., 2012

General Data:

Date of visit	06/08/2018	GZ29
Compiler	Lidia Selmi	
Name of site	Ghajn Abdul sinkhole	
Location	coordinates	36° 2'51.36"N 14°12'26.77"E
	~~inland~~	coastal
	municipality	Kercem
	city/community	Ghain Abdul
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	x
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	4
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

Ghajn Abdul is a sinkhole showing positive relief. The site is a large calcareous mesa emerging from the surroinding clays. Its scientific value is due to the presence of well-exposed sedimentary infill.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	x
	faunistic	x
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	x
only by permission	

Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	x
good for all relevant features	

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		
World heritage site		
no protection		
Other No trapping zone S.L. 504.71		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	
there is the possibility of deterioration of secondary geological elements by anthropic activity	
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References/Notes

Historical value: the site is thought that the people who first colonised Gozo in the Neolithic period lived in caves on Ghajn Abdul.

Coratza et al., 2012

General Data:

Date of visit	18/08/18	CM1
Compiler	Selmi Lidia	
Name of site	Arch and window	
Location	coordinates	36° 1'11.87"N 14°20'16.93"E
	inland	~~coastal~~
	municipality	Ghanjnsielem
	city/community	
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

Rock arch and window in Upper Coralline Limestone.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	

Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services: services only in touristic season	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	~~no~~

Proximity to areas/activities with potential to cause degradation	
no degradation risk	
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	
there is the possibility of deterioration of secondary geological elements by anthropic activity	
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References

General Data:

Date of visit	08/08/2018	CM2
Compiler	Selmi Lidia	
Name of site	deposit	
Location	coordinates	36° 1'6.94"N 14°20'23.15"E
	inland	~~coastal~~
	municipality	Għajnsielem
	city/community	
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
Medium	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

In the area is possible to note the scarp of the coastline with several joints and detached of boulders. The detached boulders are evidence of high-energy wave impacts. The application of both run-up and boulder detachments have led the deposition of Upper Coralline Limestone boulders on le coastline. The distribution of clast size, the shape and density contain information about the process of their formation

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services: service only in touristic season	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Mottershead et al., 2019

General Data:

Date of visit	23/07/2018	CM3
Compiler	Selmi Lidia	
Name of site	Steep-sided narrow cleft	
Location	coordinates	36° 1'9.48"N 14°20'19.33"E
	inland	coastal
	municipality	Ghajnsielem
	city/community	
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
medium	
Scientific notoriety	
number of articles	
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

Site of geological interest along the coast, in Upper Coralline Limestone

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services: service only in touristic season	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	17/07/2018	CM4
Compiler	Selmi Lidia	
Name of site	Tsunami deposits	
Location	coordinates	36° 1'6.94"N 14°20'23.15"E
	inland	~~coastal~~
	municipality	Ghajnsielem
	city/community	
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
medium	
Scientific notoriety	
number of articles	
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

In the area is possible to note the scarp of the coastline with several joints and detached of boulders. The detached boulders are evidence of high-energy wave impacts. The application of both run-up and boulder detachments have led the deposition of Upper Coralline Limestone boulders on le coastline. The distribution of clast size, the shape and density contain information about the process of their formation

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	x
aestetical	panoramic quality	
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services: service only in touristic season	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Mottershead et al., 2019

General Data:

Date of visit	08/08/2018	CM5
Compiler	Selmi Lidia	
Name of site		Multiple-mouthed cave
Location	coordinates	36° 1'6.57"N 14°20'24.84"E
	inland	~~coastal~~
	municipality	Ghajnsielem
	city/community	
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

Multiple-mouthed cave in Upper Coralline Limestone.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	x
	protected site	x
aestetical	panoramic quality	
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services: service only in touristic season	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	08/08/2018	CM6
Compiler	Selmi Lidia	
Name of site	Sea caves	
Location	coordinates	36° 1'3.26"N 14°20'25.17"E
	inland	~~coastal~~
	municipality	Ghajnsielem
	city/community	
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	
5-10 examples	x
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

Sea caves in Upper Coralline Limestone, different range of shapes and sizes.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	x
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	

Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services: service only in touristic season	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	x
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	x
there is the possibility of deterioration of secondary geological elements by anthropic activity	
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References

General Data:

Date of visit	08/08/2018	CM7
Compiler	Selmi Lidia	
Name of site	Sea cave	
Location	coordinates	36° 1'1.10"N 14°20'24.81"E
	inland	~~coastal~~
	municipality	Ghajnsielem
	city/community	
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	
5-10 examples	x
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

Sea cave in Upper Coralline Limestone

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	x
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services: service only in touristic season	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	16/07/2018	CM8
Compiler	Lidia Selmi	
Name of site	Elephant rock	
Location	coordinates	
	inland	~~coastal~~
	municipality	Ghanjnsielem
	city/community	Id-Darsa
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology		x				
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Site in Upper Coralline Limestone. Active site due to the constant action of sea water and gravity.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	x
aestetical	panoramic quality	x
	colour diversity	
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	moderate	~~difficult~~

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	x
only by permission	
Services	
good facilities of services < 1 km	
incomplete services < 5 km	x
absence of services < 10 km	
type of services:	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	x
good for all relevant features	
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	16/07/2018	CM9
Compiler	Selmi Lidia	
Name of site	Natural arch and blowhole	
Location	coordinates	36° 0'22.58"N 14°20'50.26"E
	inland	~~coastal~~
	municipality	Ghajnsielem
	city/community	
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

Small natural arch in Upper Coralline Limestone and small depression (blow hole) inland.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	x
aestetical	panoramic quality	
	colour diversity	
	naturalness	x
	vertical development	

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	

Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services: service only in touristic season	

Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x

Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no

Proximity to areas/activities with potential to cause degradation	
no degradation risk	x
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	

Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	x
there is the possibility of deterioration of secondary geological elements by anthropic activity	
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References

General Data:

Date of visit	16/07/2018	CM10
Compiler	Selmi Lidia	
Name of site	Il-Mistika cave	
Location	coordinates	36° 0'23.99"N 14°20'43.68"E
	inland	~~coastal~~
	municipality	Ghajnsielem
	city/community	
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

Caves in Upper Coralline Limestone. Their formation is connected with gravitational processes and sea erosion.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	x
	faunistic	x
	protected site	x
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services: service only in touristic season	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	16/07/2018	CM11
Compiler	Selmi Lidia	
Name of site	Blowhole	
Location	coordinates	36° 0'18.16"N 14°20'12.83"E
	~~inland~~	coastal
	municipality	Għajnsielem
	city/community	
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

Small collapsed structure inland, totally in Upper Coralline Limestone. The site was formed by both karstic processes and gravitational processes.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	x
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services: service only in touristic season	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	~~no~~
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	16/07/2018	CM12
Compiler	Selmi Lidia	
Name of site	Steep-sided narrow cleft	
Location	coordinates	36° 0'14.94"N 14°19'30.20"E
	~~inland~~	coastal
	municipality	Għajnsielem
	city/community	
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
medium	
Scientific notoriety	
number of articles	
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

Feature in Upper Coralline Limestone Fm.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	x
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult
Access to the site		
direct access via national roads		
direct access via local roads		
< 1km from a vehicle path		x
> 1 km from a vehicle path		
no direct accessibility		
only by permission		
Services		
good facilities of services < 1 km		x
incomplete services < 5 km		
absence of services < 10 km		
type of services: service only in touristic season		
Visibility		
very difficult or not visible at all		
can only be viewed using special equipment		
limited by trees or lower vegetation		
good but need to move around for a complete observation		
good for all relevant features		x
Safety		
site with safety facilities (fence, stairs, handrails, ecc..)		
mobile coverage		x
equipper for people with physical deficit, elderly and infants		

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	~~no~~
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	16/07/18	CM13
Compiler	Selmi Lidia	
Name of site	Karst landform - view point	
Location	coordinates	36° 0'20.87"N 14°19'37.90"E
	inland	~~coastal~~
	municipality	Ghajnsielem
	city/community	
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	x
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

Karst landform in Upper Coralline Limestone pavement. The feature is one of the best view points of the island. From there is possible to admire the south of Gozo, northern Malta (Marfa Ridge) and Comino.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services: service only in touristic season	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	08/08/2018	CM14
Compiler	Lidia Selmi	
Name of site	L-Ghar ta' Bla Saqaf	
Location	coordinates	36° 0'35.12"N 14°19'46.04"E
	inland	~~coastal~~
	municipality	Ghajnsielem
	city/community	
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology		x				
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	
some deterioration with loss some minor elements	x
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	X
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

A huge sinkhole cuts the watercourse at Il-Wied ta' Skalanova into two. The sinkhole was formed by the craving into of the surface above a subterranean cavern. It is evident that both terrestrial erosion (valley flow) and marine erosion (wave action) have played a part in shaping it. Two alternative explanations being plausible as genetic pathways:

1) the formation of an 'inland' subterranean hollow by purely terrestrial factors was followed by collapse to from a concave-sided doline. Cliff retreat at Taht il-Mazz (due to marine erosion) brought the cavity within the reach of wave action, which finally pierced its seaward side to form a large arch;

2) the formation of a large sea cave and the incision of a moderately deep watercourse on the land surface above it occurred ad independent events. As the sea cave was enlarged by violent wave action and/or the valley was deepened by water flow, the two features eventually pierced each other when the cave roof and the valley bed met. More likely, the cave roof grew too thin and weak when at two features almost met, and thus collapsed.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	x
aestetical	panoramic quality	
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	x
< 1km from a vehicle path	
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services: services only in summer season	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	x
good for all relevant features	
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		X
National park		
Bird sanctuary		X
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	~~no~~
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Debono H., 1996 (unpublished dissertation).

General Data:

Date of visit	08/08/2018	CM15
Compiler	Selmi Lidia	
Name of site	Arch	
Location	coordinates	36° 0'36.79"N 14°19'37.38"E
	inland	~~coastal~~
	municipality	Ghajnsielem
	city/community	
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Pictures of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

Rock arch in Upper Coralline Limestone. Its formation is related to karstic processes, marine erosion and possible ancient fluvial activity. The site is located on a tilted stack close to the coast.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services: service only in touristic season	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	~~no~~
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	08/08/18	CM16
Compiler	Selmi Lidia	
Name of site	Arch	
Location	coordinates	36° 0'38.50"N 14°19'31.85"E
	inland	~~coastal~~
	municipality	Ghajnsielem
	city/community	
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..

Rock arch in Upper Coralline Limestone. Its formation is related to karstic processes, marine erosion and possible ancient fluvial activity. The site is located on a tilted stack close to the coast.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	x
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services: service only in touristic season	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	08/08/18	CM17
Compiler	Selmi Lidia	
Name of site	Arch	
Location	coordinates	36° 0'45.30"N 14°19'18.08"E
	inland	~~coastal~~
	municipality	Ghajnsielem
	city/community	
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

Natural cave in Upper Coralline Limestone. The site is located on the island of Cominotto.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	x
aestetical	panoramic quality	
	colour diversity	x
	naturalness	x
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services: service only in touristic season	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	08/08/2018	CM18
Compiler	Selmi Lidia	
Name of site	Pocket beach	
Location	coordinates	36° 0'47.65"N 14°19'20.77"E
	inland	~~coastal~~
	municipality	Għajnsielem
	city/community	
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

Pocket beach located on the island of Cominotto. The sand is composed by yellowish Upper Coralline Limestone.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	x
aestetical	panoramic quality	
	colour diversity	x
	naturalness	x
	vertical development	

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services: service only in touristic season	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	08/08/2018	CM19
Compiler	Lidia Selmi	
Name of site	Tsunami deposits	
Location	coordinates	36° 0'51.28"N 14°19'5.32"E
	inland	~~coastal~~
	municipality	Għajnsielem
	city/community	
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x		x			
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
Medium	
Scientific notoriety	
number of articles	1
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

In the area is possible to note the scarp of the coastline with several joints and detached of boulders. The detached boulders are evidence of high-energy wave impacts. The application of both run-up and boulder detachments have led the deposition of Upper Coralline Limestone boulders on le coastline. The distribution of clast size, the shape and density contain information about the process of their formation.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	
	faunistic	
	protected site	x
aestetical	panoramic quality	x
	colour diversity	x
	naturalness	
	vertical development	

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services: services only in touristic season	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	~~no~~

Proximity to areas/activities with potential to cause degradation	
no degradation risk	x
site located less than 50 m of a potential degradation area/activity	
site located less than 200 m of a potential degradation area/activity	
site located less than 500 m of a potential degradation area/activity	
site located less than 1 km of a potential degradation area/activity	
Vulnerability	
the geolocial elements of the site present no possible deterioration by anthropic activity	x
there is the possibility of deterioration of secondary geological elements by anthropic activity	
there is the possibility of deterioration of main geological elements by anthropic activity	
there is the possibility of deterioration of all geological elements by anthropic activity	

References

Mottershead et al., 2019

General Data:

Date of visit	08/07/2018	CM20
Compiler	Selmi Lidia	
Name of site	Swell deposit	
Location	coordinates	36° 1'3.72"N 14°19'23.21"E
	inland	~~coastal~~
	municipality	Ghajnsielem
	city/community	
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

Upper Coralline Limestone deposits. Possible tsunami origin

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services: service only in touristic season	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	06/07/2018	CM21
Compiler	Lidia Selmi	
Name of site	Sea cave	
Location	coordinates	36° 1'6.68"N 14°19'26.61"E
	inland	~~coastal~~
	municipality	Ghajnsielem
	city/community	
Type	punctiform	x
	linear	
	areal	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

Sea cave in Upper Coralline Limestone, active site.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services: service only in touristic season	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	06/07/2018	CM22
Compiler	Selmi Lidia	
Name of site		Multiple-mouthed cave
Location	coordinates	36° 1'4.89"N 14°19'28.50"E
	Inland	~~coastal~~
	Municipality	Għajnsielem
	city/community	
Type	Punctiform	x
	Linear	
	Areal	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

Marine cave in Upper Coralline Limestone Fm. The cave has multiple entrance. Active site.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	
	naturalness	
	vertical development	x

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services: service only in touristic season	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	06/07/2018	CM23
Compiler	Selmi Lidia	
Name of site	Collapsed cave	
Location	coordinates	36° 1'8.04"N 14°19'40.77"E
	Inland	~~coastal~~
	Municipality	Għajnsielem
	city/community	
Type	Punctiform	x
	Linear	
	Areal	
Property	private	
	public	x
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

Sea cave collapsed by sea erosion and gravity. Inactive geosite. Several boulders of the ancient roof of the cave are found on the site.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services: service only in touristic season	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

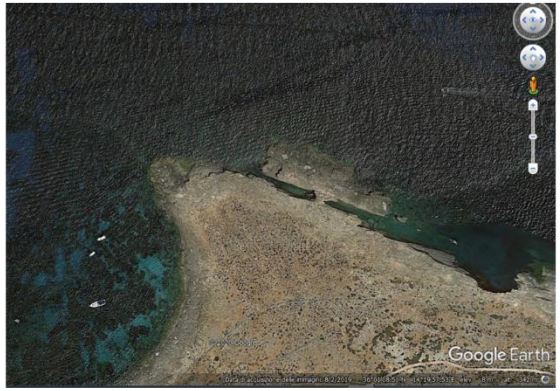
Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	06/07/2018	CM24
Compiler	Selmi Lidia	
Name of site	Natural arch and tunnel	
Location	coordinates	36° 1'9.61"N 14°19'56.60"E
	Inland	~~coastal~~
	Municipality	Ghajnsielem
	city/community	
Type	Punctiform	x
	Linear	
	Areal	
Property	private	
	public	x
	association	

Picture of the site



Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	x
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	
2-4 examples	x
5-10 examples	
> 10 examples	
Representativeness	
high	
Scientific notoriety	
number of articles	
number of dissertations	1

Descriptive data

(lithology, geomorphology, active/inactive..)

Tunnel in Upper Coralline Limestone Fm. A small rock arch is located in the middle of the tunnel.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	x
ecological	botanic	
	faunistic	
	protected site	
aestetical	panoramic quality	x
	colour diversity	
	naturalness	
	vertical development	

Used value

Accessibility		
easy	~~moderate~~	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	x
> 1 km from a vehicle path	
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	x
incomplete services < 5 km	
absence of services < 10 km	
type of services: service only in touristic season	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	x
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		x
National park		
Bird sanctuary		x
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
other		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		x
site located less than 50 m of a potential degradation area/activity		
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

General Data:

Date of visit	06/07/2018	CM25
Compiler	Selmi Lidia	
Name of site	Dry Valley	
Location	coordinates	36° 0'55.67"N 14°20'11.07"E
	inland	coastal
	municipality	Għajnsielem
	city/community	
Type	punctiform	
	linear	
	areal	x
Property	private	
	public	X
	association	

Picture of the site

Scientific value

Scientific interest			Level			
	P	S	L	R	N	I
stratigraphy						
marine geology						
mineralogy						
geoarchaeology						
geomorphology	x					
hydrogeology						
paleontology						
petrography						
structural geology						

State of conservation	
well preserved, no deterioration	
some deterioration with loss some minor elements	
deteriorate through some human actions which hide part of the features	X
numerous human actions which deteriorate the character of the site	
character of the site destroyed	
Rareness: relative abundance in the region	
1 example	X
2-4 examples	
5-10 examples	
> 10 examples	
Representativeness	
low	
Scientific notoriety	
number of articles	
number of dissertations	

Descriptive data

(lithology, geomorphology, active/inactive..)

Dry valley in Upper Coralline Limestone Fm.

Additional value

cultural	archaeological	
	architectonic	
	geohistorical	
	historic	
	artistic	
	touristic	
ecological	botanic	x
	faunistic	
	protected site	
aestetical	panoramic quality	
	colour diversity	x
	naturalness	x
	vertical development	

Used value

Accessibility		
~~easy~~	moderate	difficult

Access to the site	
direct access via national roads	
direct access via local roads	
< 1km from a vehicle path	
> 1 km from a vehicle path	X
no direct accessibility	
only by permission	
Services	
good facilities of services < 1 km	X
incomplete services < 5 km	
absence of services < 10 km	
type of services: bars and transport only in summer season	
Visibility	
very difficult or not visible at all	
can only be viewed using special equipment	
limited by trees or lower vegetation	
good but need to move around for a complete observation	
good for all relevant features	X
Safety	
site with safety facilities (fence, stairs, handrails, ecc..)	
mobile coverage	x
equipper for people with physical deficit, elderly and infants	

Management value

Legal protection		
Natura 2000		X
National park		
Bird sanctuary		
Special Area of Conservation (SAC)		x
World heritage site		
no protection		
Other TPA Tree Protection Area L.N. 200 of 2011 & G.N. 473 of 2011		
need for protection	yes	no
Proximity to areas/activities with potential to cause degradation		
no degradation risk		
site located less than 50 m of a potential degradation area/activity		X
site located less than 200 m of a potential degradation area/activity		
site located less than 500 m of a potential degradation area/activity		
site located less than 1 km of a potential degradation area/activity		
Vulnerability		
the geolocial elements of the site present no possible deterioration by anthropic activity		x
there is the possibility of deterioration of secondary geological elements by anthropic activity		
there is the possibility of deterioration of main geological elements by anthropic activity		
there is the possibility of deterioration of all geological elements by anthropic activity		

References

Annex 2a: Geosites assessment with the methodology of Reynard et al. (2007)

	Scientific Value					Ecological value			Aesthetic value			Cultural value					Economic value		TOTAL
Site	Integrity	Representativeness	Rareness	Paleogrographical value	TOTAL	ecological impact	protected site	Total ECOL	view points	vertical development	Total AEST	religious importance	historical importance	artistic and literature importance	geohistorical importance	Total CULT	economic products	Total ECON	TOTAL
MT1	1	1	0	0	0,56	0,75	0,75	0,75	0,75	1	0,88	0	0	0	0	0,5	0,5	0,5	0,66
MT5	1	1	1	1	0,88	1	1	1,00	0,75	1	0,88	0,5	0,5	0,25	0,3	0,38	0	0	0,56
MT7	1	1	0	0	0,38	0,5	0,5	0,50	0,75	0,75	0,75	0	0,5	0,5	0	0,25	0,5	0,5	0,50
MT8	1	1	0	0	0,50	0,5	0,5	0,50	1	1	1,00	0	0,5	0,5	0	0,5	0,5	0,5	0,63
MT9	1	1	0	0	0,63	0,5	0,5	0,50	1	1	1	0	0	0,5	0	0,13	0,75	0,75	0,59
MT19	1	1	1	0	0,81	0,75	0,75	0,75	1	1	1,00	0	0	0,5	0	0,13	1	1	0,72
MT22	1	1	0	0	0,63	0,75	0,75	0,75	0,5	1	0,75	0	0	0	0	0,00	0	0	0,38
MT23	1	1	0	0	0,63	0,75	0,75	0,75	0,5	1	0,75	0	0	0	0	0,00	0	0	0,38
MT24	1	1	1	0	0,75	0,75	0,75	0,75	0,5	1	0,75	0	0,3	0	0	0,06	0,5	0,5	0,52
MT25	1	1	0	0	0,56	0,75	0,75	0,75	0,5	1	0,75	0	0	0	0	0,00	0	0	0,38
MT26	1	1	0	0	0,63	0,75	0,75	0,75	0,5	1	0,75	0	0	0	0	0,00	0	0	0,38
MT29	1	1	1	0	0,63	0,75	0,75	0,75	0,5	1	0,75	0	0	0	0	0,00	0	0	0,38
MT32	1	1	1	0	0,63	0,75	0,75	0,75	0,75	1	0,88	0	0	0	0	0,00	0	0	0,41
MT34	1	1	1	0	0,63	0,75	0,75	0,75	0,5	1	0,75	0	0	0	0	0,00	0,5	0,5	0,50
MT39	1	1	1	0	0,69	0,75	0,75	0,75	1	0,75	0,88	0	0	0,25	0	0,00	0,5	0,5	0,53
MT42	1	1	0	0	0,56	0,75	0,75	0,75	1	1	1,00	0	0,3	0	0	0,06	0,5	0,5	0,58
MT44	1	1	0	0	0,56	0,75	0,75	0,75	1	1	1,00	0	0,3	0	0	0,06	0,5	0,5	0,58
MT45	1	1	0	0	0,56	0,75	0,75	0,75	1	1	1,00	0	0,3	0	0	0,06	0,5	0,5	0,58
MT49	1	1	0	0	0,63	0,75	0,75	0,75	1	1	1,00	0	0	1	0	0,25	1	1	0,75
MT50	1	1	0	0	0,63	0,75	0,75	0,75	1	1	1,00	0	0	0,5	0	0,13	0,75	0,75	0,66
MT53	1	1	1	0	0,75	0,75	0,75	0,75	0,75	1	0,88	0	0	0,25	0	0,06	0,5	0,5	0,55
MT54	1	0	1	1	0,69	0,75	0,75	0,75	0,5	0,75	0,63	0	0	0	0,8	0,19	0	0	0,39
MT55	1	1	0	0	0,44	0,75	0,75	0,75	0,25	1	0,63	0	0	0	0	0,00	0	0	0,34
MT58	1	1	0	0	0,63	0,75	0,75	0,75	0,25	0,25	0,25	0	0	0	0	0,00	0	0	0,25
MT59	1	1	0	0	0,56	0,75	0,75	0,75	0,25	0,25	0,25	0	0	0	0	0,00	0	0	0,25
MT64	1	1	0	0	0,56	0,75	0	0,38	1	1	1,00	0,5	1	0,75	0	0,56	0,5	0,5	0,61
MT65	1	0	1	0	0,44	1	0	0,50	0,75	0,75	0,75	0	0,5	0,75	0	0,31	1	1	0,64
MT66	1	1	0	0	0,56	0,75	0,75	0,75	1	1	1,00	0	0	0,25	0	0,06	1	1	0,70
MT67	1	1	1	0	0,56	0,75	0,75	0,75	0,5	0,25	0,38	0	0	0	0	0,00	0,25	0,25	0,34
MT68	1	1	1	0	0,69	0,75	0,75	0,75	0,75	1	0,88	0	0	0,25	0	0,06	0,75	0,75	0,61
MT70	1	1	1	0	0,69	0,75	0,75	0,75	0,75	1	0,88	0	0	0,25	0	0,06	0,75	0,75	0,61
MT72	1	1	0	0	0,31	1	0	0,50	1	0,5	0,75	0,5	1	1	0	0,63	0,75	0,75	0,66
MT74	1	1	1	0	0,69	1	1	1,00	1	1	1,00	0	0	0,5	0	0,13	1	1	0,78

MT75	1	1	0	0	0,50	1	0,75	0,88	1	1	1,00	0	0	1	0	0,25	0,5	0,5	0,66
MT76	1	1	1	0	0,69	0,75	0,75	0,75	1	1	1,00	0	0	0,5	0	0,13	1	1	0,72
GZ1	1	1	1	0	0,63	0	0	0,00	1	1	1,00	0	0	0,25	0,3	0,13	1	1	0,53
GZ2	1	1	1	0	0,69	1	0	0,50	1	1	1,00	0	0,3	0,5	0	0,19	0,75	0,75	0,61
GZ4	1	1	0	0	0,50	0,5	0	0,25	1	0,75	0,88	0	0,5	0,75	0	0,31	1	1	0,61
GZ5	1	1	1	0	0,69	0	0	0,00	1	1	1,00	0	0	0,5	0	0,13	0,75	0,75	0,47
GZ6	1	1	0	0	0,50	0,25	0	0,13	1	0,5	0,75	0	0	0,5	0	0,13	0,75	0,75	0,44
GZ7	1	1	1	0	0,63	0,25	0,75	0,50	1	1	1,00	0	0	0,5	0	0,13	1	1	0,66
GZ8	1	1	1	0	0,56	1	1	1,00	1	1	1,00	0	1	1	0	0,50	0,25	0,25	0,69
GZ9	1	1	1	0	0,56	0	0,5	0,25	0,5	0	0,25	0	0	0	0	0,00	0,25	0,25	0,19
GZ10	1	1	1	0	0,75	0,25	0,5	0,38	1	1	1,00	0	0	0,5	0	0,13	0,75	0,75	0,56
GZ15	1	1	0	0	0,50	0,5	0	0,25	1	1	1,00	0	1	1	0	0,50	0,75	0,75	0,63
GZ16	1	1	0	1	0,63	0	0	0,00	0,75	1	0,88	0	0	0,5	0	0,13	0,5	0,5	0,38
GZ17	1	1	0	0	0,50	0,5	0,5	0,50	1	1	1,00	0	1	1	0	0,50	0,5	0,5	0,63
GZ18	1	1	0	0	0,56	0,5	0	0,25	1	1	1,00	0	1	1	0	0,50	0,75	0,75	0,63
GZ28	1	1	1	0	0,63	0	0	0,00	1	1	1,00	1	0,5	0,75	0	0,56	0,5	0,5	0,52
CM1	1	1	0	0	0,50	0,75	1	0,88	0,5	0,5	0,50	0	0	0	0	0,00	0,25	0,25	0,41
CM5	1	1	0	0	0,50	1	1	1,00	0,75	1	0,88	0	0	0,75	0	0,19	0,5	0,5	0,64
CM8	1	1	1	0	0,56	0,75	1	0,88	0,25	1	0,63	0	0	0	0	0,00	0,25	0,35	0,46
CM14	1	1	1	0	0,69	0,75	1	0,88	1	1	1,00	0	0	0	0	0,00	0,5	0,5	0,59
CM15	1	1	0	0	0,56	1	1	1,00	1	1	1,00	0	0	0	0	0,00	0,5	0,5	0,63
CM18	1	1	0	0	0,44	0,75	1	0,88	0,75	0,75	0,75	0	0	0	0	0,00	1	1	0,66
CM19	1	1	0	0	0,63	0,75	1	0,88	0,25	0,25	0,25	0	0	0	0	0,00	0	0	0,28
CM20	1	1	0	0	0,63	0,75	1	0,88	0,25	0,25	0,25	0	0	0	0	0,00	0,25	0,25	0,34
CM23	1	1	0	0	0,38	0,75	1	0,88	0,75	1	0,88	0	0	0,75	0	0,19	0,5	0,5	0,61
CM24	1	1	0	0	0,44	0,75	1	0,88	0,5	0,75	0,63	0	0	0	0	0,00	0,25	0,25	0,44

Annex 2b: Geosites assessment with the methodology of Brilha (2016)

		Weight	MT1	MT5	MT8	MT9	MT19	MT22	MT23	MT24	MT25	MT26	MT29	MT31	MT32	MT34	MT39	MT42	MT44	MT45	MT49	MT50	MT53	MT54	MT55	MT58	MT59
Scientific value	Representativeness	30	15	15	15	15	30	15	15	30	7,5	15	15	30	30	7,5	30	7,5	7,5	7,5	30	30	30	30	7,5	7,5	7,5
	Key location	20	5	10	5	10	5	10	10	10	5	10	15	10	10	5	10	10	10	10	10	5	5	20	5	5	5
	integrity	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	7,5	15	15	15	15	15	15	15	15	15	15
	rarity	15	3,75	15	3,75	7,5	15	3,75	3,75	7,5	3,75	3,75	3,75	15	15	3,75	15	3,75	3,8	3,75	15	3,75	15	15	3,8	3,8	3,75
	use limitation	10	10	2,5	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
	geological diversity	5	1,25	1,25	1,25	2,5	1,25	2,5	2,5	1,25	1,25	2,5	1,25	2,5	1,3	1,25	1,25	1,25	1,3	1,25	1,25	1,25	1,3	1,25	1,3	1,3	1,25
	scientific knowledge	5	1,25	5	0	5	2,5	5	5	2,5	1,25	5	2,5	5	5	5	5	5	5	1,25	1,25	0	5	0	0	0	0
	Total SV	100	51,25	63,8	50	65	78,8	61,3	61,3	76,3	43,75	61,3	62,5	87,5	86	47,5	78,8	52,5	53	48,8	82,5	65	81	91,3	43	43	42,5
Total Educational-Touristic value	Vulnerability	10	10	10	10	7,5	10	10	10	7,5	10	10	10	10	10	10	10	10	10	10	7,5	7,5	10	10	10	10	10
	Accessibility	10	2,5	2,5	2,5	2,5	7,5	2,5	2,5	2,5	2,5	2,5	2,5	2,5	2,5	7,5	2,5	2,5	2,5	2,5	7,5	7,5	2,5	2,5	2,5	2,5	5
	Use limitation	5	5	1,25	5	5	5	5	5	5	5	5	5	1,25	5	5	5	5	5	5	5	5	5	5	5	5	5
	Safety	10	5	2,5	5	5	5	5	5	5	5	5	5	2,5	5	5	5	5	5	5	5	5	2,5	2,5	2,5	2,5	5
	Logistics	5	5	0	5	5	5	5	5	5	5	5	5	0	5	5	5	5	5	5	5	5	5	5	5	5	5
	Density of population	5	5	0	3,75	3,8	3,75	3,75	3,75	3,75	3,75	3,75	3,75	0	3,8	3,75	3,75	3,75	3,8	3,75	2,5	2,5	2,5	2,5	2,5	2,5	2,5
	Association with other values	5	5	5	5	5	2,5	1,25	1,25	1,25	1,25	1,25	1,25	5	1,3	1,25	1,25	1,25	1,3	1,25	1,25	1,25	1,3	1,25	1,3	1,3	1,25
	Scenary	5	1,25	0	1,25	0	5	0	0	1,25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Uniqueness	5	1,25	2,5	1,25	1,3	3,75	1,25	1,25	2,5	1,25	1,25	1,25	2,5	3,8	1,25	3,75	1,25	1,3	1,25	3,75	1,25	3,8	5	1,3	1,3	1,25
	Observation conditions	10	10	10	10	7,5	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
	geological diversity	10	2,5	5	5	5	2,5	2,5	2,5	5	2,5	2,5	2,5	5	5	2,5	2,5	2,5	2,5	2,5	5	5	5	5	2,5	2,5	2,5
	interpretative potential	10	7,5	7,5	10	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5
	Proximity of recreational areas	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	Didactical potentia	5	1,25	1,25	5	1,3	1,25	1,25	1,25	1,25	1,25	1,25	1,25	1,25	1,3	1,25	1,25	1,25	1,3	1,25	1,25	1,25	1,3	1,25	1,3	1,3	1,25
	Total EDU-TOUR	100	66,25	52,5	73,8	61	73,8	60	60	62,5	60	60	60	52,5	65	65	62,5	60	60	60	66,3	63,8	61	62,5	56	56	61,3

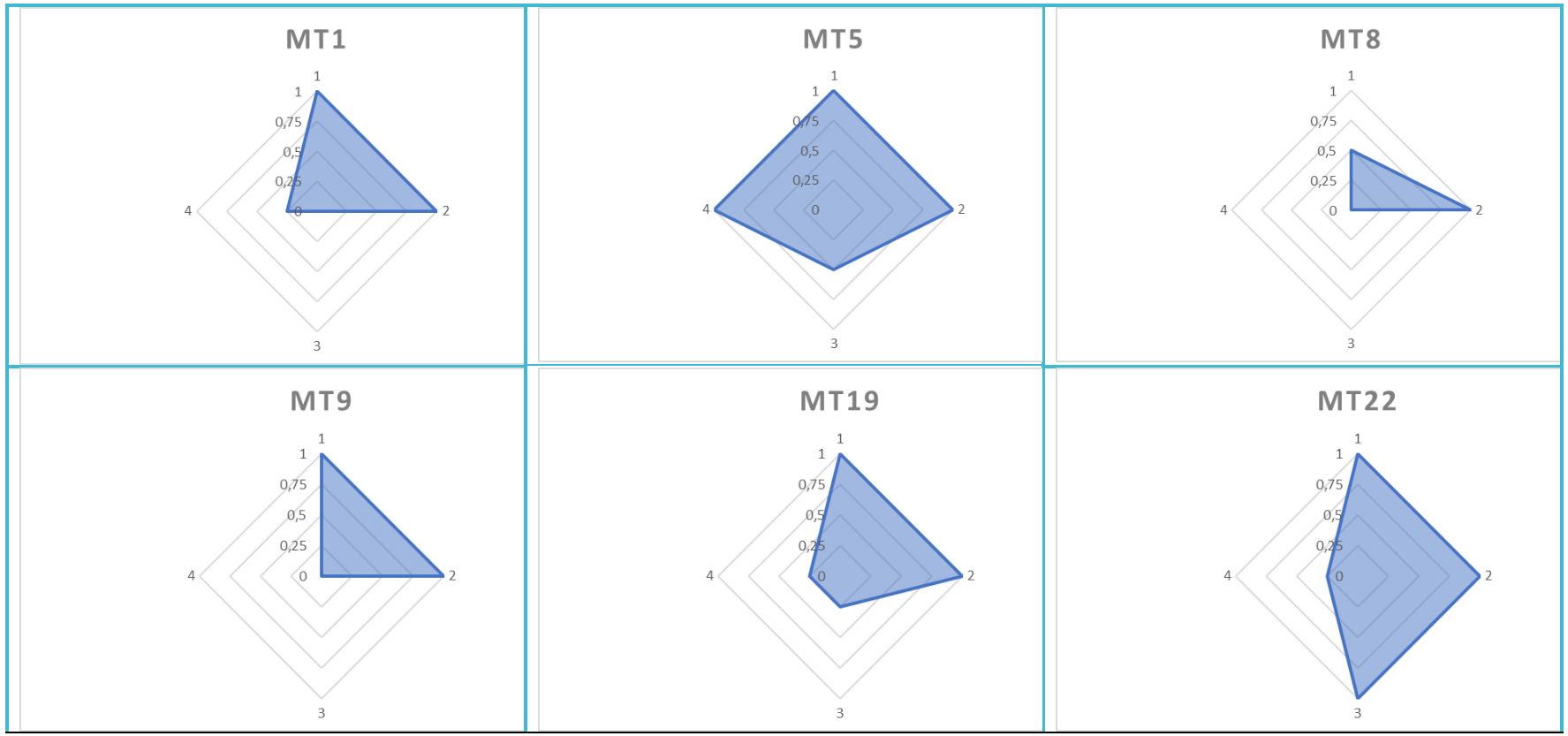
Annex 2b: Geosites assessment with the methodology of Brilha (2016)

MT64	MT65	MT66	MT67	MT68	MT70	MT72	MT74	MT75	MT76	GZ1	GZ2	GZ4	GZ5	GZ6	GZ7	GZ8	GZ9	GZ10	GZ15	GZ16	GZ17	GZ18	GZ28
30	15	15	15	30	30	30	30	15	30	30	15	15	30	7,5	30	30	15	30	15	30	15	30	30
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	10	5	5	10	10	5	5	5
15	7,5	15	15	15	15	15	15	15	15	15	15	15	7,5	7,5	15	7,5	3,75	15	15	15	15	7,5	15
3,75	7,5	3,75	3,8	7,5	7,5	3,8	7,5	7,5	15	3,8	3,75	3,8	15	7,5	7,5	7,5	15	15	3,75	7,5	3,75	3,75	15
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	2,5	10	10	10	10	10	10	10
1,25	1,25	1,25	1,3	1,25	1,25	1,3	1,3	1,3	1,25	1,3	1,25	1,3	1,3	1,25	1,25	1,25	1,25	2,5	1,25	2,5	1,25	1,25	1,25
1,25	1,25	1,25	1,3	1,25	1,25	1,3	5	1,3	5	1,3	1,25	0	1,3	0	5	5	0	5	0	0	0	0	1,25
66,3	47,5	51,3	51	70	70	66	74	55	81,3	66	51,3	50	70	38,8	73,8	63,8	50	82,5	55	75	50	57,5	77,5
7,5	7,5	10	7,5	10	10	10	10	10	10	10	10	10	7,5	10	10	10	10	7,5	10	10	10	7,5	7,5
2,5	7,5	7,5	2,5	2,5	2,5	5	10	10	10	10	10	10	10	10	10	2,5	2,5	10	7,5	7,5	7,5	7,5	10
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	1,25	2,5	5	5	5	5	5	5
5	5	5	5	5	5	5	10	5	7,5	5	5	7,5	5	5	5	5	5	5	5	5	5	5	5
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	3,75	5	5	5	5	5	5	5
3,75	3,75	3,75	3,8	3,75	3,75	3,8	3,8	3,8	3,75	3,8	3,75	3,8	3,8	2,5	2,5	2,5	2,5	2,5	3,75	3,8	3,75	3,75	3,75
2,5	1,25	0	0	1,25	1,25	0	2,5	2,5	1,25	3,8	3,75	3,8	3,8	2,5	3,75	3,75	3,75	3,75	2,5	2,5	2,5	2,5	3,75
2,5	0	0	0	0	0	0	0	0	5	2,5	1,25	1,3	1,3	1,25	5	1,25	1,25	5	1,25	1,3	1,25	5	5
1,25	2,5	1,25	1,3	2,5	2,5	1,3	3,8	1,3	3,75	0	1,25	1,4	3,8	0	2,5	3,75	1,25	2,5	1,25	1,3	1,25	1,25	1,25
10	10	10	10	10	10	10	10	10	10	10	10	10	10	7,5	7,5	10	7,5	10	10	10	10	10	10
2,5	2,5	2,5	5	2,5	2,5	2,5	2,5	5	5	5	2,5	2,5	5	0	2,5	5	2,5	2,5	2,5	2,5	2,5	2,5	2,5
7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	10	7,5	5	7,5	7,5	7,5	7,5	10	7,5	10	7,5	7,5
5	5	5	5	5	5	5	5	5	5	3,8	3,75	3,8	3,8	3,75	5	5	5	5	5	5	5	5	5
1,25	1,25	1,25	1,3	1,25	1,25	1,3	1,3	1,3	1,25	1,3	1,25	0	1,3	1,25	1,25	1,25	1,25	1,25	0	0	0	1,25	1,25
61,3	63,75	63,8	59	61,3	61,3	61	76	71	80	73	70	74	73	58,8	72,5	62,5	57,5	72,5	68,8	66	68,75	68,75	72,5

Annex 2b: Geosites assessment with the methodology of Brilha (2016)

CM1	CM5	CM8	CM14	CM15	CM18	CM19	CM20	CM23	CM24
15	30	15	30	30	30	30	15	15	15
5	0	0	0	0	0	0	0	0	0
15	15	15	15	15	15	15	15	15	15
7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5
10	10	10	10	10	10	5	10	10	10
1,25	1,25	1,25	2,5	1,25	1,25	1,25	1,25	1,25	1,25
0	0	0	0	0	0	2,5	2,5	0	0
53,75	63,75	48,75	65	63,75	63,75	61,25	51,25	48,75	48,75
10	10	10	10	10	10	10	10	10	10
7,5	7,5	2,5	7,5	2,5	0	0	2,5	2,5	2,5
5	5	5	5	5	2,5	2,5	5	5	5
5	5	5	5	5	2,5	2,5	5	5	5
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
1,25	1,25	1,25	1,25	1,25	1,25	1,25	1,25	0	0
0	1,25	0	1,25	0	0	0	0	0	0
1,25	3,75	1,25	2,5	2,5	1,25	1,25	1,25	2,5	2,5
10	10	10	10	10	10	10	10	10	10
2,5	2,5	2,5	5	2,5	2,5	5	5	5	5
10	2,5	10	7,5	7,5	7,5	7,5	7,5	7,5	7,5
5	5	5	5	5	5	5	5	5	5
0	1,25	1,25	1,25	1,25	0	1,25	1,25	1,25	1,25
57,5	55	53,75	61,3	52,5	42,5	46,25	53,75	53,75	53,75

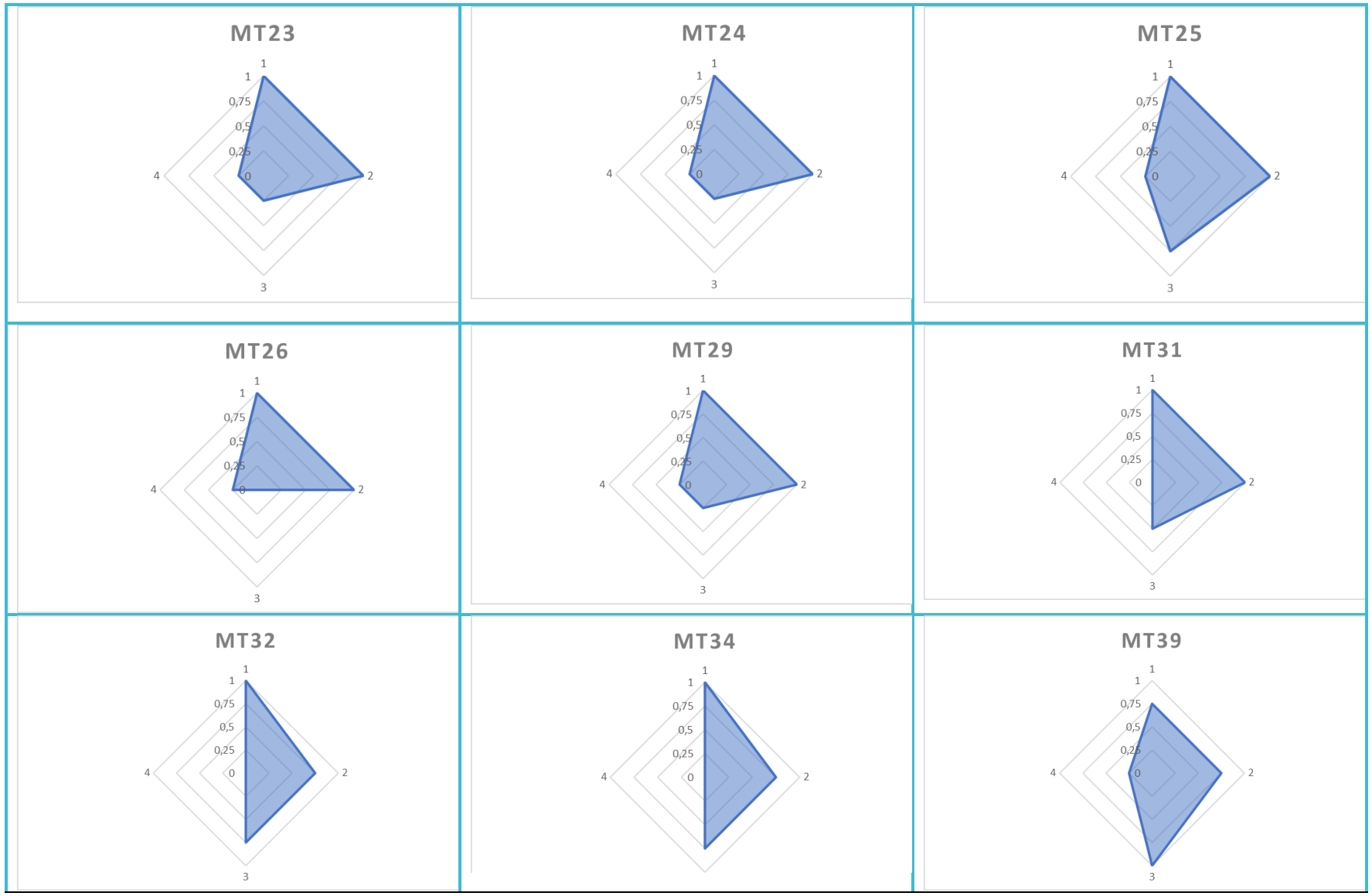
Annex 3a: Representation of the scientific value of the potential geosites by radar graphs (Reynard et al. 2007)



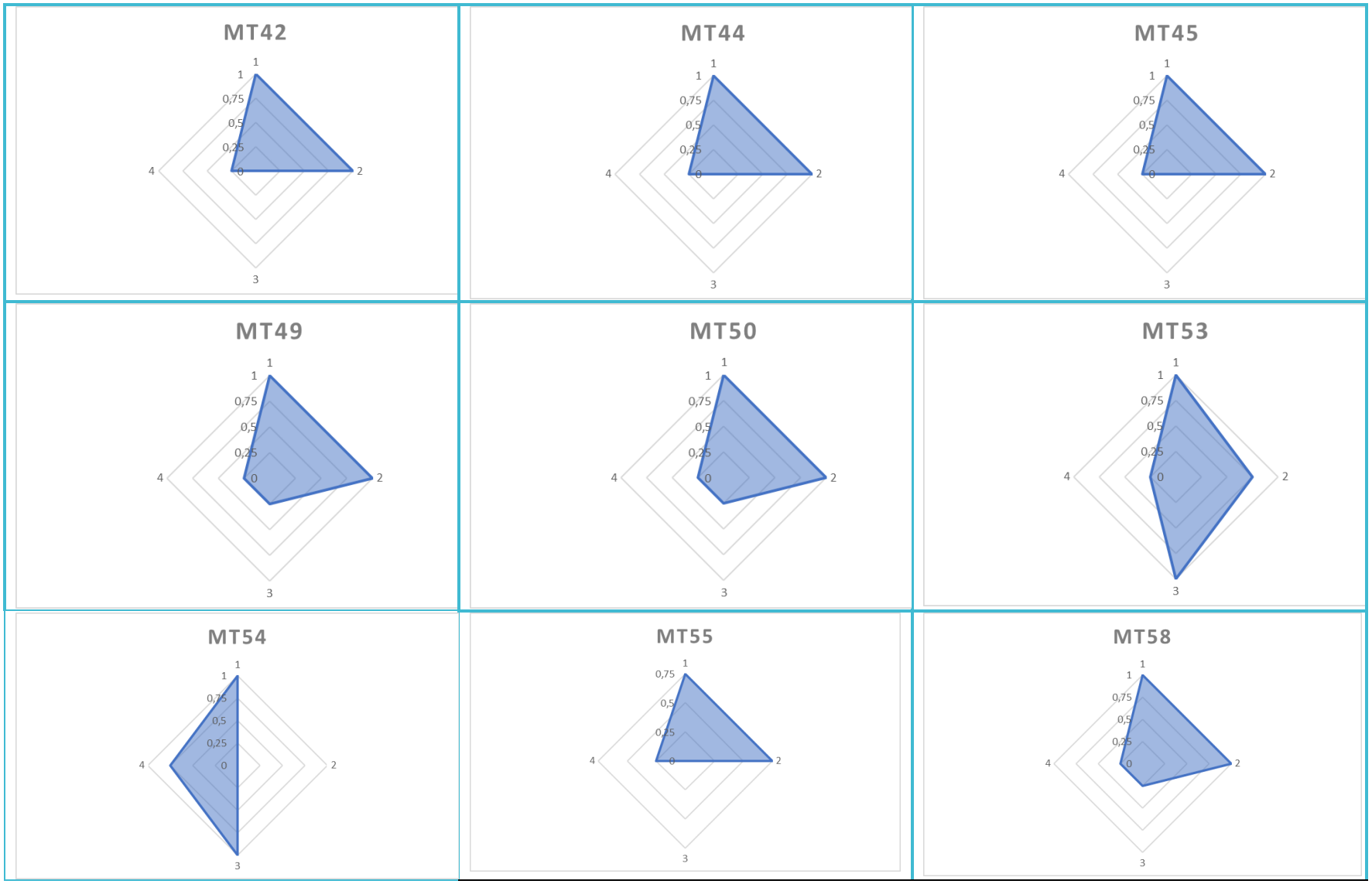
Legend:

1. Integrity
2. Rerpresentativeness
3. Rarity
4. Paleogrographical model

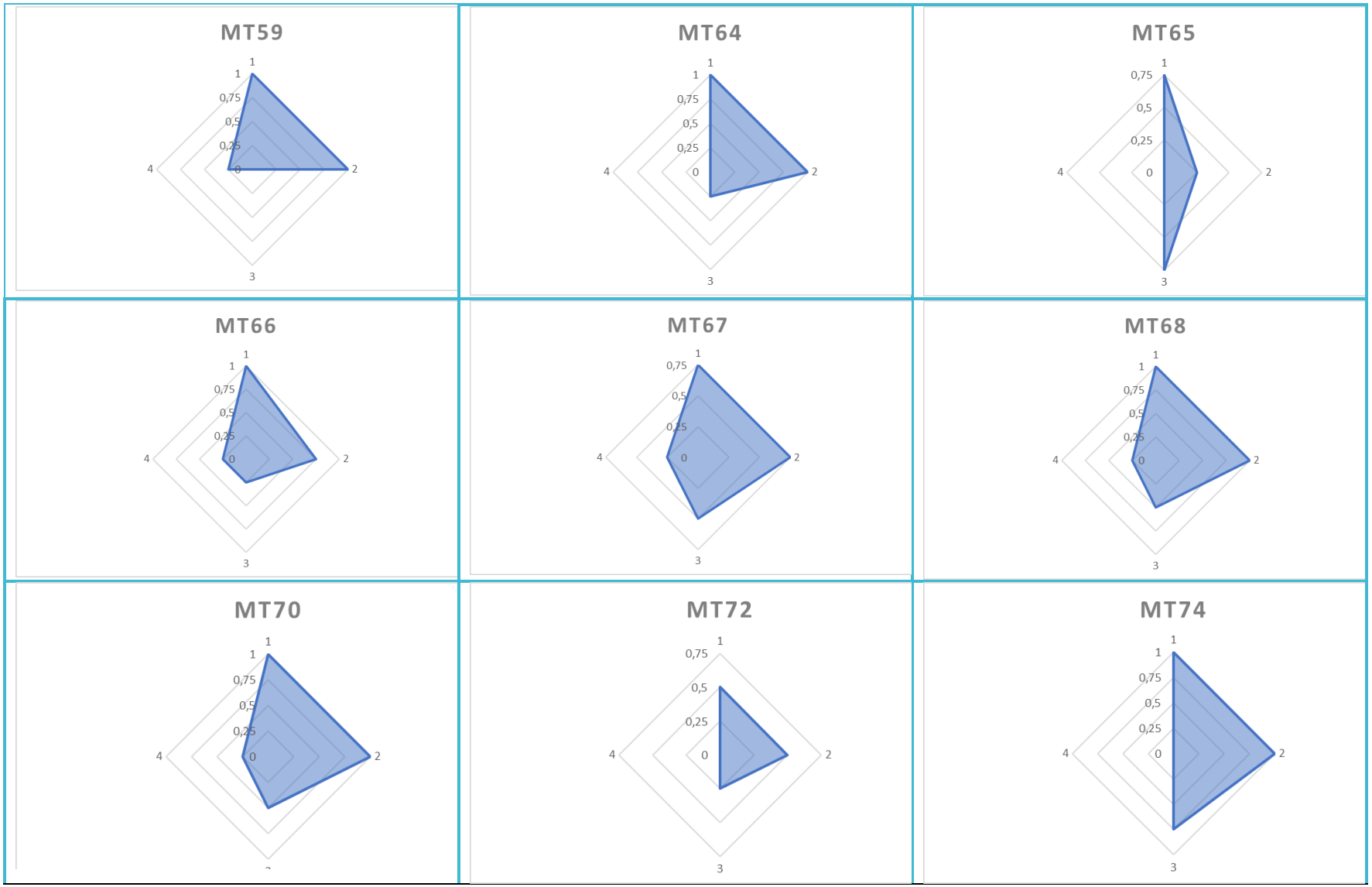
Annex 3a: Representation of the scientific value of the potential geosites by radar graphs (Reynard et al. 2007)



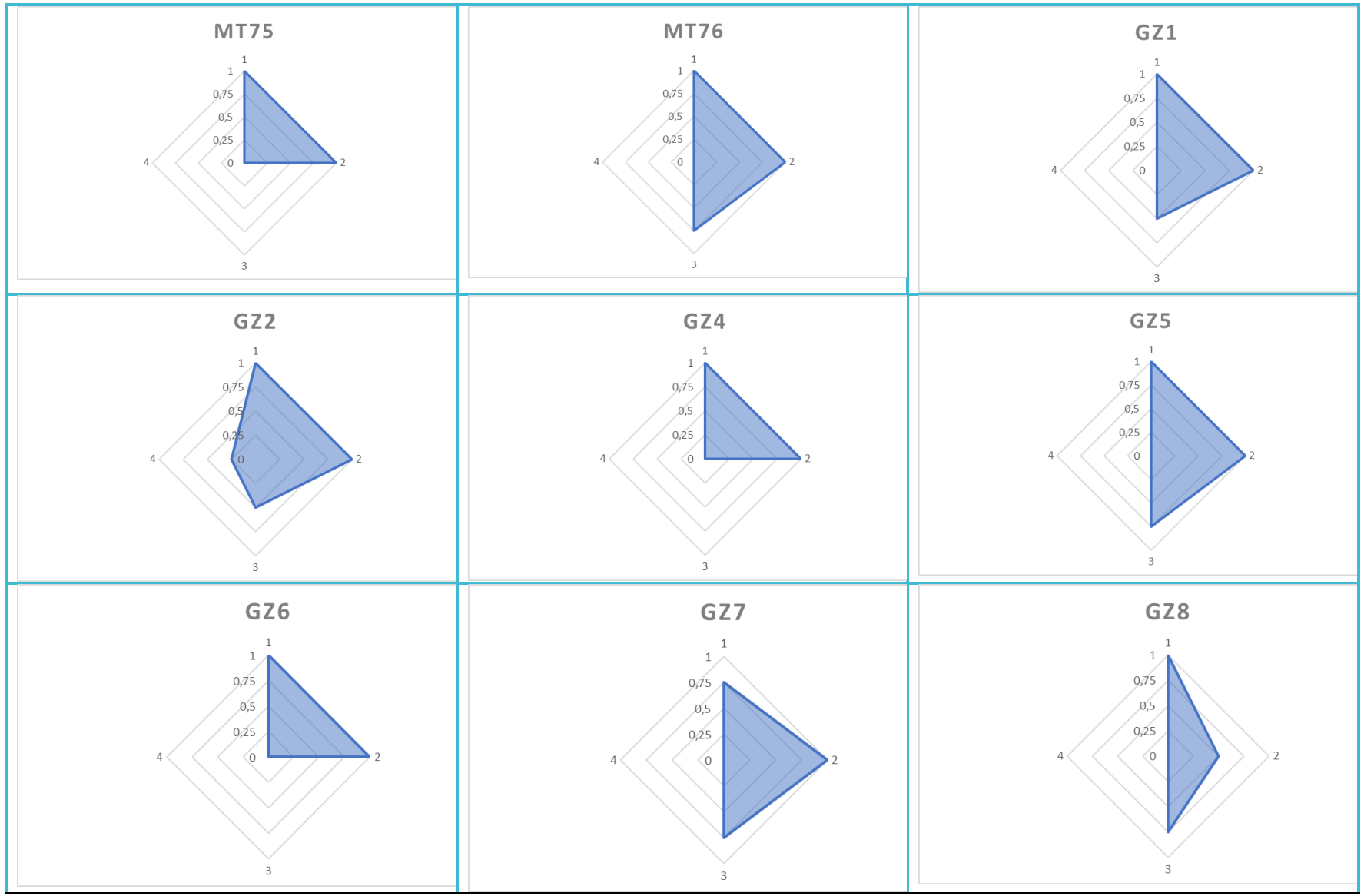
Annex 3a: Representation of the scientific value of the potential geosites by radar graphs (Reynard et al. 2007)



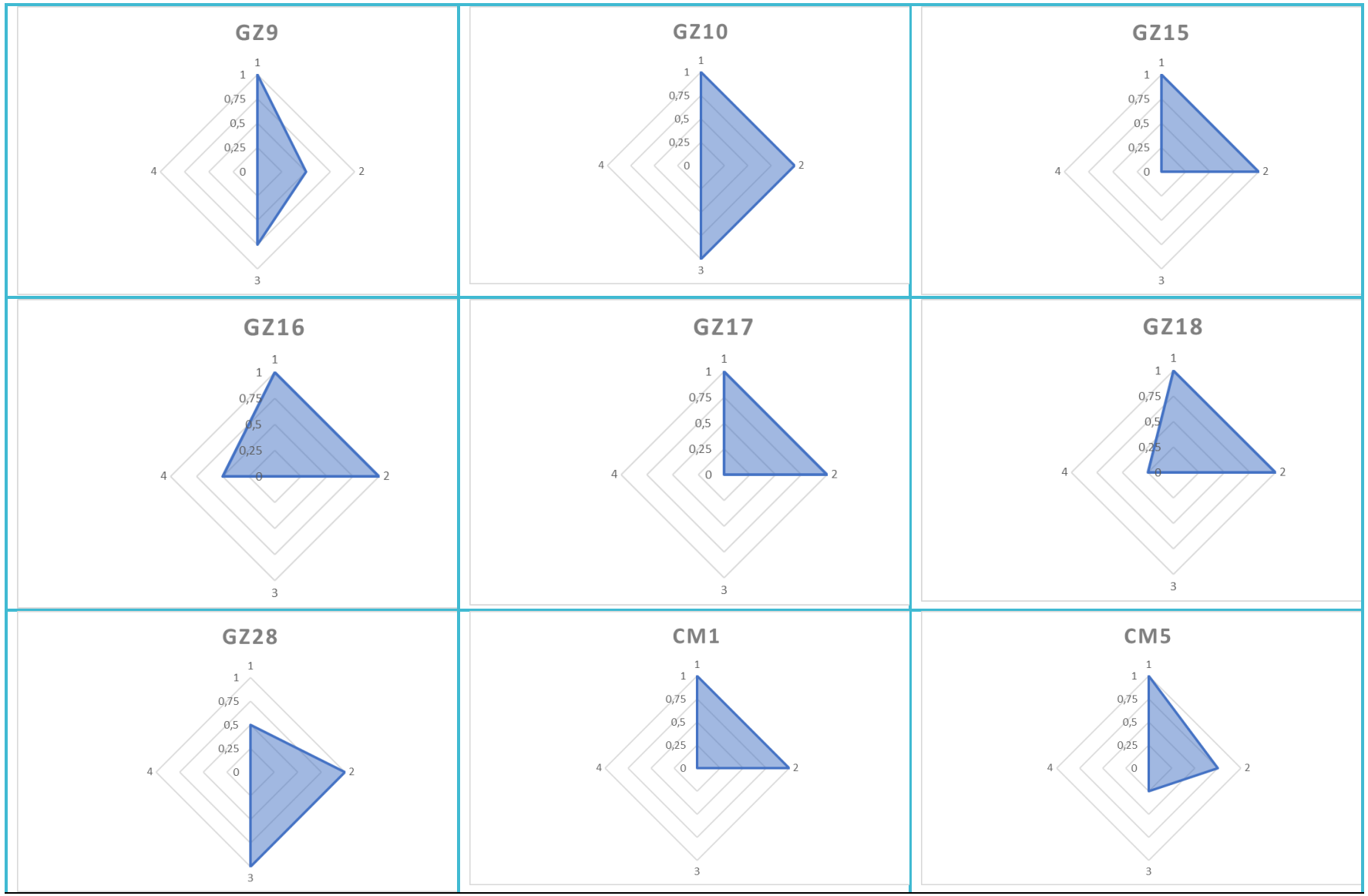
Annex 3a: Representation of the scientific value of the potential geosites by radar graphs (Reynard et al. 2007)



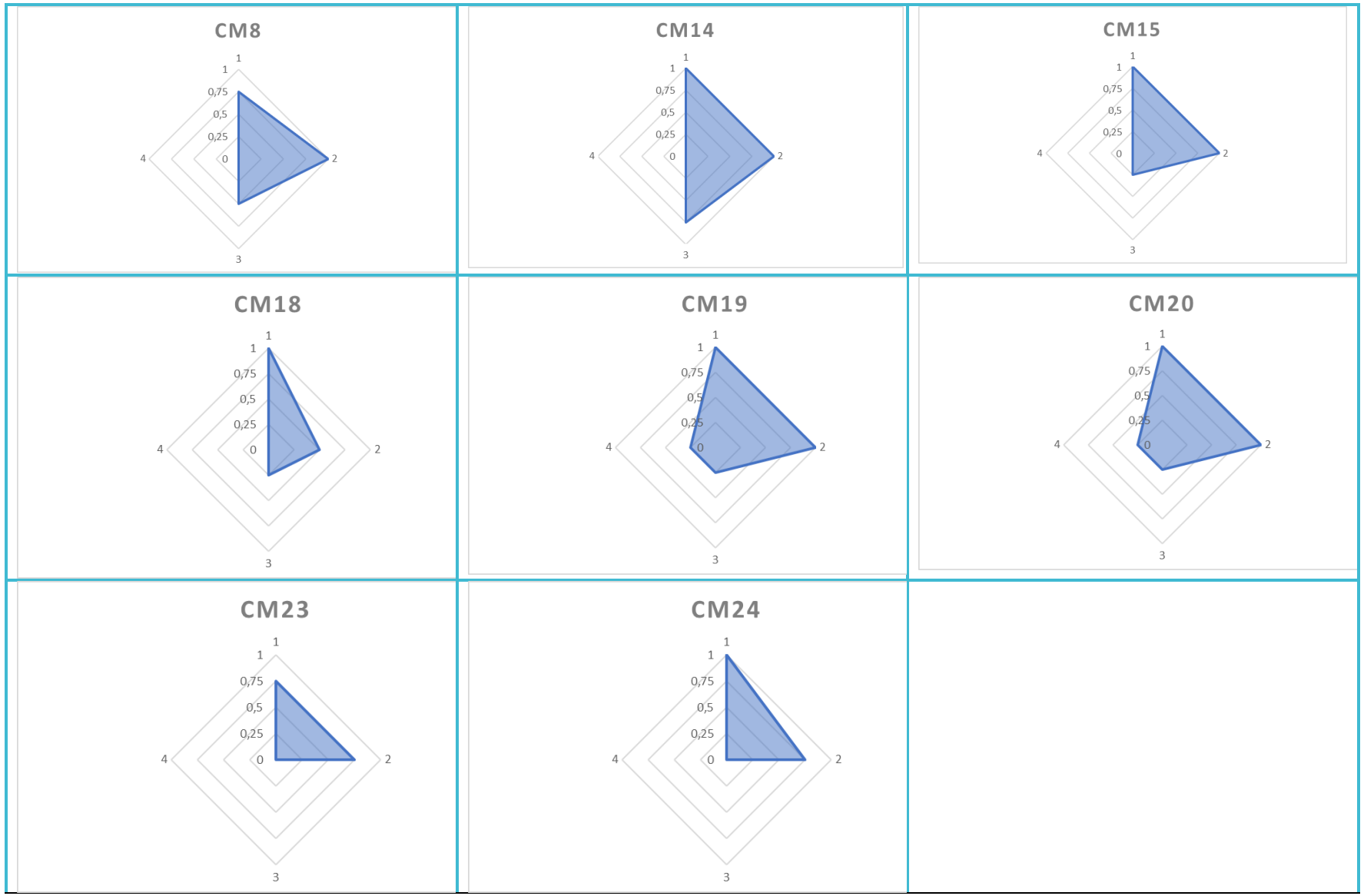
Annex 3a: Representation of the scientific value of the potential geosites by radar graphs (Reynard et al. 2007)



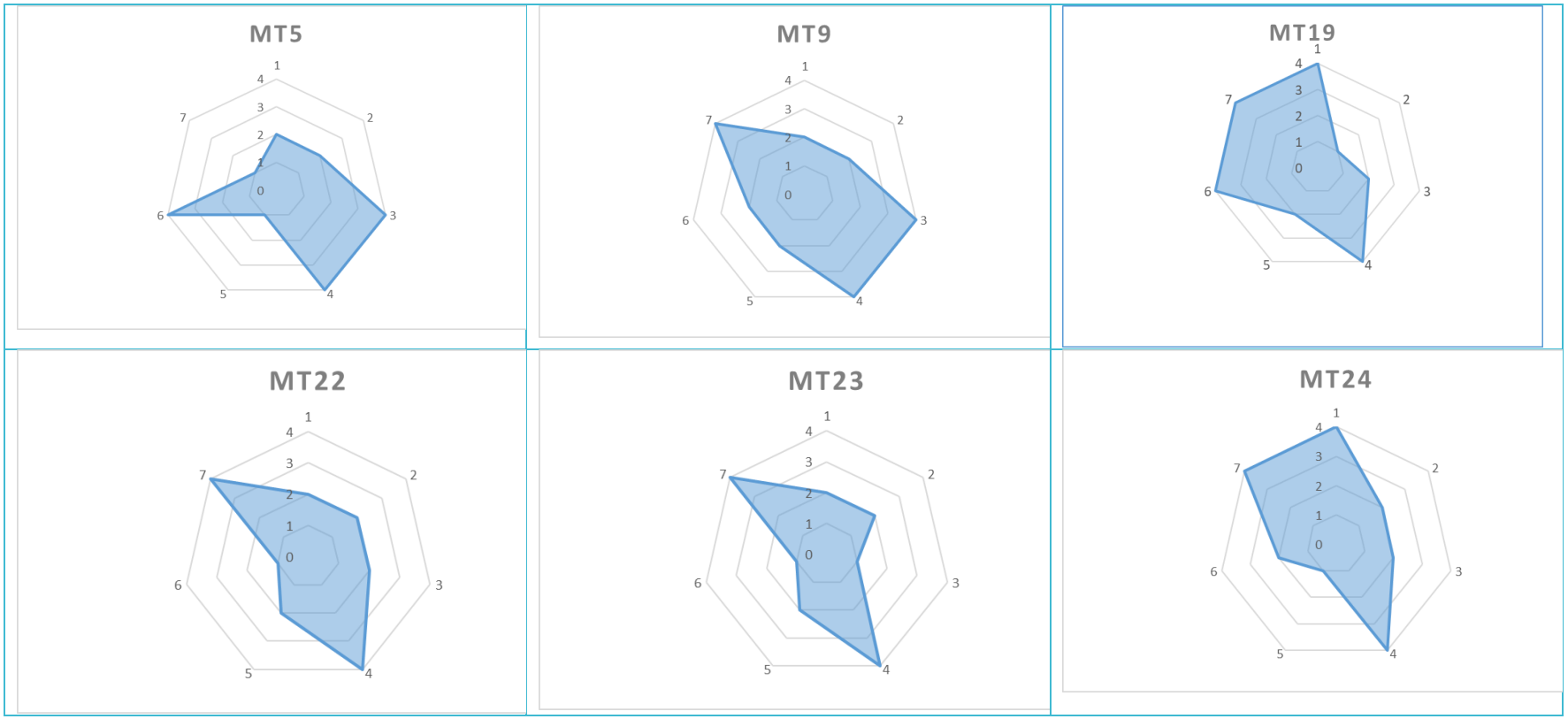
Annex 3a: Representation of the scientific value of the potential geosites by radar graphs (Reynard et al. 2007)



Annex 3a: Representation of the scientific value of the potential geosites by radar graphs (Reynard et al. 2007)



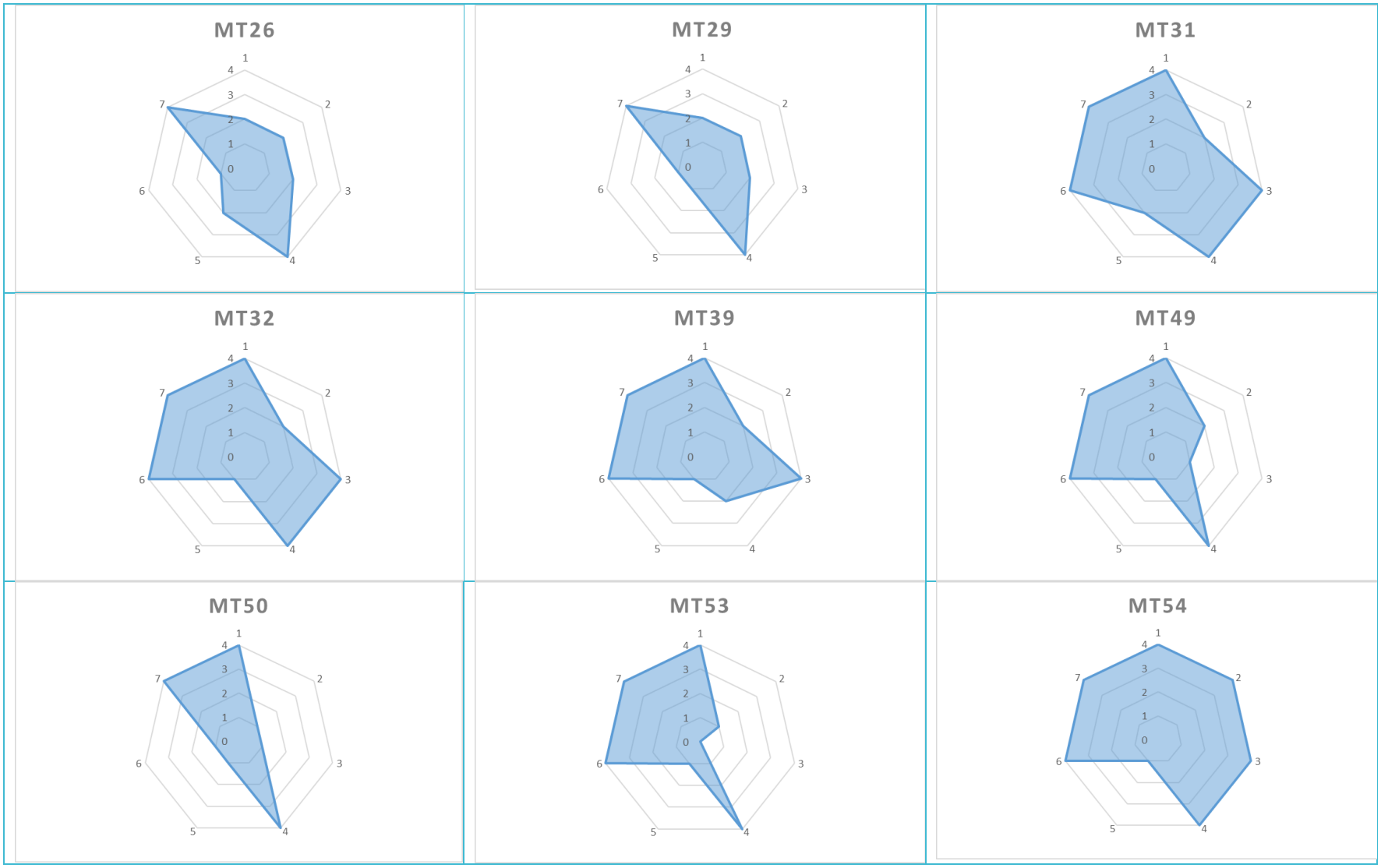
Annex 3b: Representation of the scientific value of the potential geosites by radar graphs (Brilha, 2016)



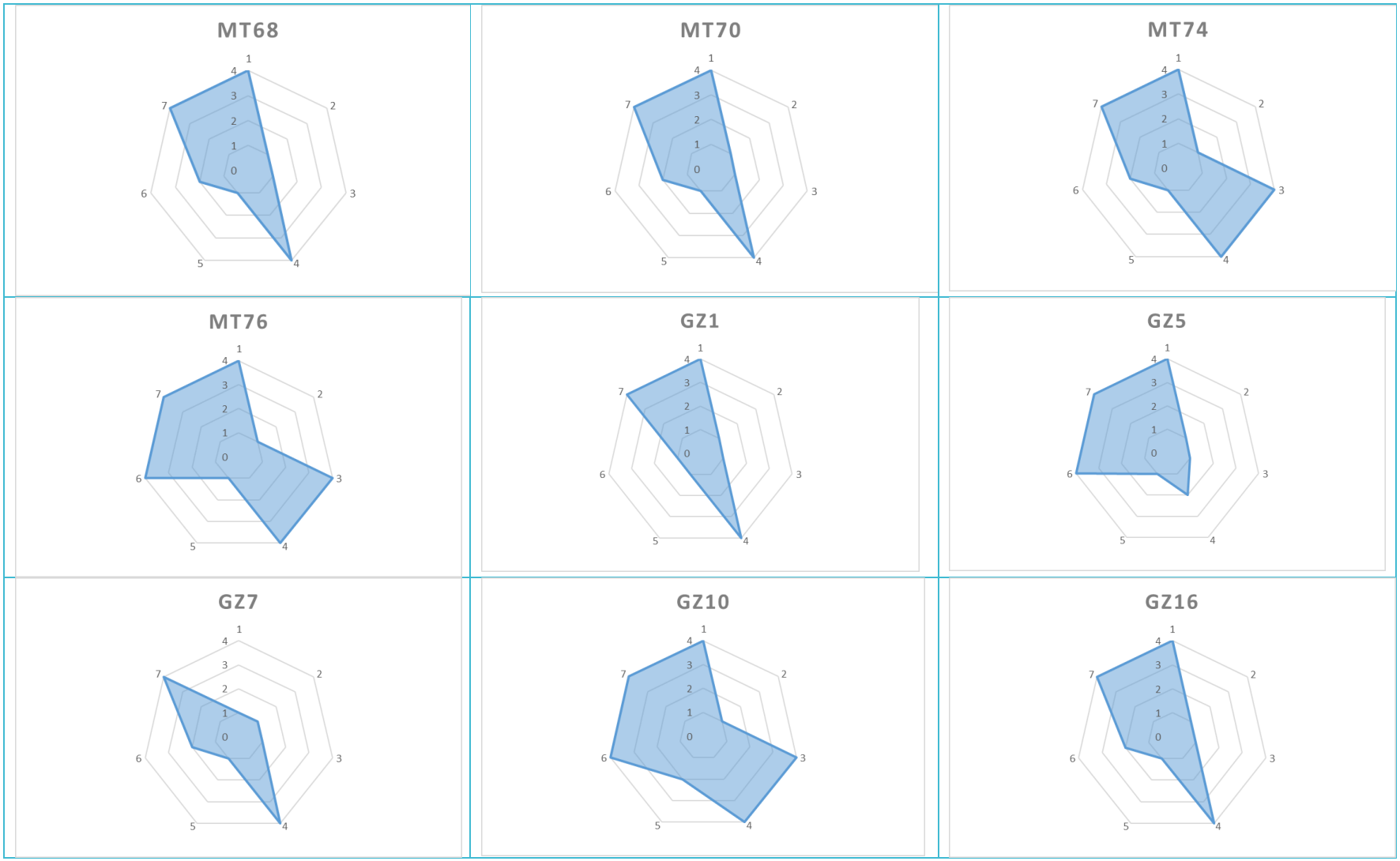
Legend:

1- Representativeness
2- Key locality
3- Scientific knowledge
4- Integrity
5- Geological diversity
6- Rarity
7- Use limitation

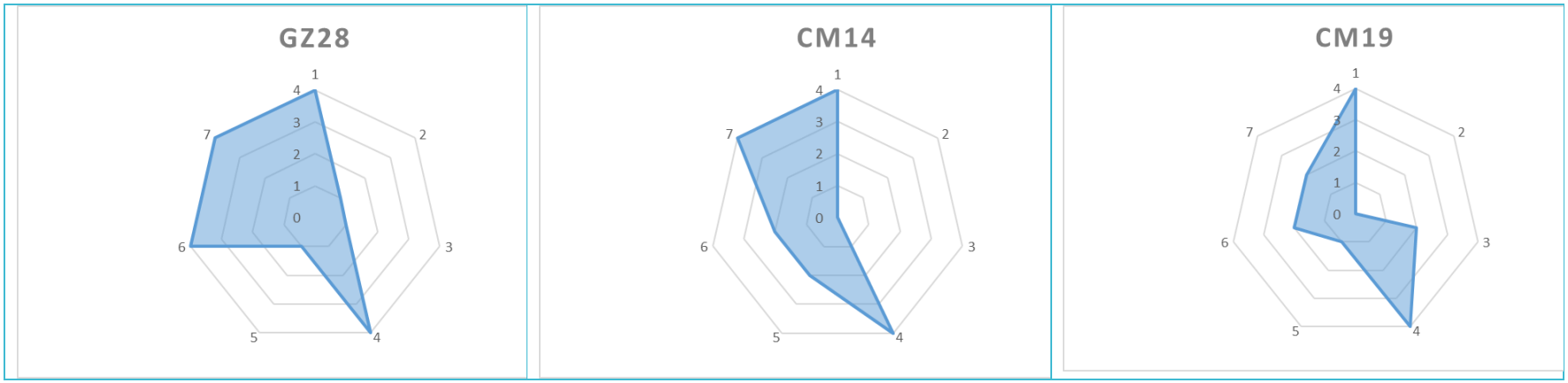
Annex 3b: Representation of the scientific value of the potential geosites by radar graphs (Brilha, 2016)



Annex 3b: Representation of the scientific value of the potential geosites by radar graphs (Brilha, 2016)



Annex 3b: Representation of the scientific value of the potential geosites by radar graphs (Brilha, 2016)



Annex 4: Degree of interest assessment of the 27 geosites

	International relevance						National relevance					Local		
	scientific papers on the geosite	scientific papers on the area	GSSP or ASSP	unique example on the study area	geosite known by international scientists	international protected area	geosites used for educational activities/field work	national papers on the geosite	international papers in the geosite's area	geosite rare or representative at national scale	known by national scientists	no scientific publication on the geosite	representative or rare at regional scale	interest by locals
MT5						x					x		x	x
MT9						x					x		x	x
MT19	x					x	x		x	x	x			
MT22						x							x	x
MT23						x							x	x
MT24						x							x	x
MT26						x							x	x
MT29						x							x	x
MT31						x							x	x
MT32	x	x				x	x	x	x	x	x			
MT39						x							x	x
MT49	x	x		x	x	x								
MT50						x							x	x
MT53						x	x		x	x	x	x		
MT54	x	x	x	x	x	x								
MT68						x							x	x
MT70						x							x	x
MT74	x	x		x	x	x								
MT76	x					x	x	x	x	x	x			
GZ1		x				x			x	x	x	x		
GZ5						x						x	x	x
GZ7						x							x	x
GZ10	x	x		x	x	x						x		

GZ16												x	x	x
GZ28												x	x	x
CM14						x		x					x	x
CM19						x		x					x	x

Annex 5: Degradation risk assessment of the 27 geosites

	Vulnerability						Public Use								
	Natural vulnerability			Anthropogenic vulnerability											
GEOSITE	Active processes	Proximity to area with active process of degradation	TOTAL NATURAL VULNERABILITY 0-6	Economic interest	Illegal collecting	TOTAL ANTHROPOGENIC VULNERABILITY 0-6	Legal protection	Proximity to area or activity that can cause degradation	Accessibility	Density of population	Physical protection	Degradation	Control of access	TOTAL PUBLIC USE 0-21	TOTAL DEGRADATION RISK 0-33
MT5	3	1	4	0	0	0	1	0	0	0	3	0	3	7	11
MT9	3	1	4	0	0	0	1	0	2	2	3	2	3	13	17
MT19	0	0	0	0	0	0	1	0	2	2	3	0	3	11	11
MT22	0	0	0	0	0	0	1	3	3	2	3	0	3	15	15
MT23	0	0	0	0	0	0	1	0	1	2	3	0	3	10	10
MT24	2	1	3	0	0	0	1	0	1	2	3	1	3	11	14
MT26	0	0	0	0	0	0	1	0	1	2	3	0	3	10	10
MT29	3	1	4	0	0	0	1	0	0	2	3	0	3	9	13
MT31	0	0	0	0	1	1	1	0	0	2	3	0	3	9	10
MT32	0	1	1	0	0	0	1	0	0	2	3	0	3	9	10
MT39	0	1	1	0	0	0	1	0	0	2	3	0	3	9	10
MT49	0	0	0	0	0	0	1	0	0	1	3	1	3	9	9
MT50	3	1	4	0	0	0	1	0	0	1	3	1	3	9	13
MT53	0	0	0	0	0	0	1	0	0	1	3	0	3	8	8
MT54	3	1	4	0	0	0	1	0	0	1	3	0	3	8	12
MT68	0	1	1	0	0	0	1	0	0	2	3	1	3	10	11
MT70	0	1	1	0	0	0	1	0	0	2	3	1	3	10	11
MT74	3	0	3	0	0	0	1	0	3	2	2	1	2	11	14
MT76	0	0	0	0	0	0	1	0	3	2	2	0	3	11	11
GZ1	0	0	0	0	0	0	3	0	1	2	2	1	2	11	11
GZ5	0	1	1	0	0	0	3	0	3	2	3	1	2	14	15
GZ7	1	0	1	0	0	0	1	0	3	1	3	1	3	12	13
GZ10	0	0	0	0	0	0	1	0	3	1	3	1	3	12	12
GZ16	3	1	4	0	0	0	3	0	1	2	3	0	3	12	16
GZ28	0	0	0	0	0	0	3	0	0	2	3	1	3	12	12
CM14	1	0	1	0	0	0	1	0	1	0	3	0	3	8	9
CM19	1	0	1	0	0	0	1	0	0	0	3	0	3	7	8