UNIVERSITÀ DI NAPOLI
L'ORIENTALE

DOTTORATO IN ASIA AFRICA E MEDITERRANEO
Schema per redazione progetto di ricerca dottorato

PhD PROGRAMME IN ASIAN, AFRICAN AND MEDITERRANEAN STUDIES
Form for presentation of Research Project

1 - Titolo del Progetto di Ricerca/Title of Research Project

Condition assessment of degradation of underwater and coastal sites and artefacts:
Case studies for conservation on the Red Sea and the Mediterranean

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Riccardo Mancinelli

2 - Settore scientifico-disciplinare a cui si riferisce il progetto/ Academic discipline to which your project is related

Aims and objectives:

The purpose of the PhD project is to investigate how some chemical, physical and biological degradation factors may affect underwater and coastal sites and artefacts to identify ways for long-term preservation and conservation.

The following are the objectives of the PhD project:

- Examining different chemical and biological components of underwater and coastal sites and artefacts at selected locations in the Mediterranean and the Red Sea.(Bagnato et al., 2014; Budetta et al., 2020)
- Using various analytical techniques to examine the various materials from various sites and artefacts from one coastal and underwater area to another between the Mediterranean Sea and the Red Sea in Egypt and Italy.(Esposito et al., 2023; Greco et al., 2021)
- Investigating the deterioration factors that the underwater and coastal sites and artefacts are exposed to due to land movement, erosion, flooding, and weathering. (Bethencourt et al., 2018)

- Building an analytical comparison between the conditions of underwater sites and artefacts in the Red Sea and the Mediterranean Sea.

Methodology

- Applying a diagnostic analysis of the artefact or the site.
- Performing an inventory of the types of materials in the moveable and immovable archaeology of the site. (Coltorti & Tognaccini, 2019; Lv et al., 2022)
- Studying the history of the previous degradation impacts that affected the selected underwater or coastal sites or artefacts and their locations through a mapping system.(Silva et al., 2006)
- Applying risk assessment techniques such as fault tree analysis to assess various impacts of geological phenomena and deterioration factors on underwater and coastal sites.(Hong, 2023; Raimondi et al., 2023)
- Using non-destructive devices and remote sensing devices (in situ and laboratory) in analysing the causes and influences of climate change and assessing the conservation condition.(Björdal et al., 2000; Guirado et al., 2015; Lazic et al., 2005; Łucejko et al., 2009; Ødegård et al., 2016)
- Determining the most suitable conservation technique to prevent further deterioration factors.(Björdal et al., 2000; Chen et al., 2021; Fujishima et al., 2000)
- Carrying out periodic monitoring for the conservation conditions and deterioration factors.(Guerriero et al., 2021; Maresca et al., 2022)
- Applying analytical methods and materials, such as experimental mock-ups.(Sáez-Hernández et al., 2022)

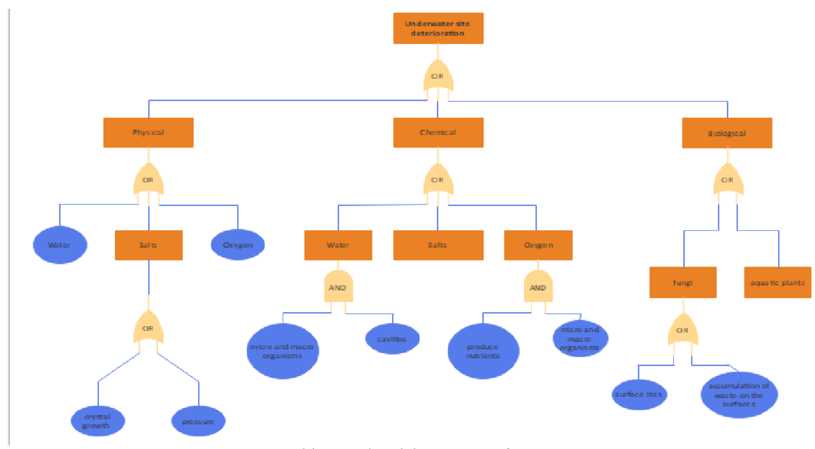


Table 2 analysed deterioration factors

The proposed analytical devices will be determined according to the state of each object or site and according to their availability in the laboratories; (Reggiannini & Salvetti, 2017) Multispectral Imaging (UVM, VIS, IR, and VIL); ATR-FTIR to study the chemical components of polymer materials; XRF to study the elemental composition of materials; (Romagnoli et al., 2018) XRD to characterise the properties of the material,(Ruffolo et al., 2017) such as crystal structure and size; (Zisi & Dix, 2018) CT-Scan and X-ray to give 3D images of the object by producing layers from different angles; Spectrophotometry to determine quantities of substances in solution; (Zisi & Dix, 2018) Spectroscopy for the analysis of organic and inorganic materials; (Wang et al., 2023) Corrosion Inspection Scanners to scan critical components or infrastructure; Laser Scanners, Scanning Electron Microscopy Analysis (SEM); Digital Microscope to analyse and investigate the micro fabric of the object.

The Device	The Use
Multispectral Imaging (UVM, VIS, IR, and VIL)	study multi layers of the object
ATR-FTIR	chemical components of polymer materials
XRF	the elemental composition of materials
XRD	characterise the properties of the material, such as crystal structure and size
X-ray	give 3D images of the object by producing layers from different angles
Spectrophotometry	determine quantities of substances in solution
Spectroscopy	analysis of organic and inorganic materials
Corrosion Inspection Scanners	scan critical components or infrastructure
Scanning Electron Microscopy Analysis (SEM)	analyse and investigate the micro fabric of the object

3 - Abstract del progetto/Project abstract 5000 caratteri – 5000 characters

4 - Stato dell’arte/State of the art 5000 caratteri – 5000 characters

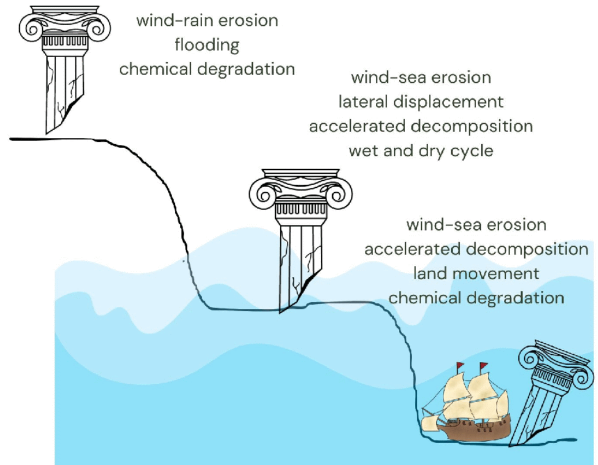
5 – Bibliografia/Bibliography 5000 caratteri – 5000 characters

Overview

Variations in solar activity or volcanic eruptions may be the cause for the long-term temperature and weather fluctuations. (Benvenuti et al., 2008) The materials used to construct submerged and coastal sites and artefacts are affected by weather and chemical changes. (Björdal & Nilsson, 2002; Łucejko et al., 2012a) The capacity for submerged and coastal archaeology to advance underwater conservation research is considerable. Therefore, the study of human interventions and natural degradation is encouraged in the field of underwater and coastal conservation. Different coastal and submerged sites are affected by two different geological factors, tectonic mobility, and sediment failure.

Different geological hazards, such as land movement, (Cannatelli et al., 2020a; Lima et al., 2009) weathering, erosion,(Dawson et al., 2020) flooding, etc, affect the underwater and coastal sites and artefacts.(Abuzied et al., 2016; Cioni et al., 2021; Dumont et al., 2023; Paris et al., 2019)

Submerged and coastal sites on slopes are exposed to a range of geological hazards,(Bertolin et al., 2021; El-Haddad et al., 2017) in particular, dynamic movements are caused by earthquakes or tectonic movements.(Bubeck et al., 2015; Paris et al., 2019) Consequently, these movements cause unexpected and swift changes that create disastrous problems, including slope failure and erosion, whether chemical or physical erosion.(Ricca et al., 2020; Sepe et al., 2023) The gradual but slow-moving phenomenon known as bradyseism is another factor that contributes to underwater and coastal slope failure.(Cannatelli et al., 2020b) Such deterioration factors would result in the chemical, mechanical, or biological weathering of rocks, minerals, or stones. (Aloise et al., 2014)



Depending on climatic and natural conditions, erosion and flooding issues may arise immediately or over time; however, the natural offshore rocks along the coast help to slow down erosion processes. Because of the offshore coral reefs, the Red Sea is, therefore, better protected from the erosion problem than the Mediterranean Sea, although the Red Sea is nevertheless vulnerable to flooding issues, particularly on the shores that are situated in wadi (valleys). The seawater, the waves, or the wind could all cause erosion and other deterioration factors. Whether an artefact or site is coastal or submerged, erosion and flooding cause layer loss, and the extent of the loss varies depending on the substance and size of the object.

According to Law No. 183/1989, the landslide and land movement hazards are managed by Italian government institutions, particularly in the countries of the southern regions, (Scolobig & Pelling, 2016) such as Naples and Calabria. (De Vivo & Rolandi, 2020; Ietto et al., 2022; Natale et al., 2022) Besides, the angle of the slope,(Purkis et al., 2022) seismic activity,(Sawyer et al., 2019) the structure of the site,(Fowler, 2020) and changes in sea level rise are some of the characteristics of the landslides and land movement hazards.(D'Argenio et al., 2004)

Climate change may be the trigger behind many of those hazards that affect underwater and coastal sites or artefacts with a group of deterioration factors,(Al-Thuwaynee et al., 2023) which requires careful study and analysis techniques aiming at determining the preservation and conservation of sites and artefacts.(Rovella et al., 2019)

The researcher or conservator would be able to identify any chemical or geomorphological changes that occur at underwater or coastal sites or artefacts through the study of the chemical, physical and biological degradation.

Hence, a multidisciplinary approach is proposed in the current PhD proposal to identify marine geological and chemical processes that affect the formation and decay of underwater sites and artefacts.(Reyes et al., 2018; Simeone et al., 2012) The results of the research, survey, and analysis will be used to construct a conservation plan.(Medaglia et al., 2020a; Silvianita et al., 2015). For the duration of the project,

various risk assessment approaches,(Novellino et al., 2021; Williams et al., 2023). including fault tree analysis (FTA)(Kargar et al., 2022; Liang et al., 2023) which will be utilised to examine the conditions of some sites and artefacts, and the effects of land movement, weathering, erosion, flooding, and conservation efforts. The FTA contributes to determining some elements that cause damage and deterioration by employing the proper analysis procedures,(Nunes et al., 2023; Sangiorgio et al., 2022) which results in the selection of sustainable conservation solutions for the underwater or coastal site or artefact.(Zhou et al., 2022)
The types of materials that will be targeted for analysis, examination, and conservation will be determined after conducting a set of tests on organic and inorganic materials in different coastal and underwater environments.
Additionally, some of underwater and coastal sites and artefacts in Egypt and Italy, in the Red Sea and the Mediterranean (Camerlenghi et al., 2010; C. Haldane, 1996a; Morhange et al., 1999; Stiros, 2020a), will be investigated as part of the analysis and methodologies for the PhD thesis. In addition to studying and evaluating their conservation actions, the research will contribute to the examination of physical, chemical, and biological factors resulting from land movement,(*CambridgeCore_Citation_08Jan2024*, n.d.; Isaia et al., 2019) weathering, erosion, and flooding.(Dix et al., 2008)
Table 1 shows the goal and plan of the PhD project.

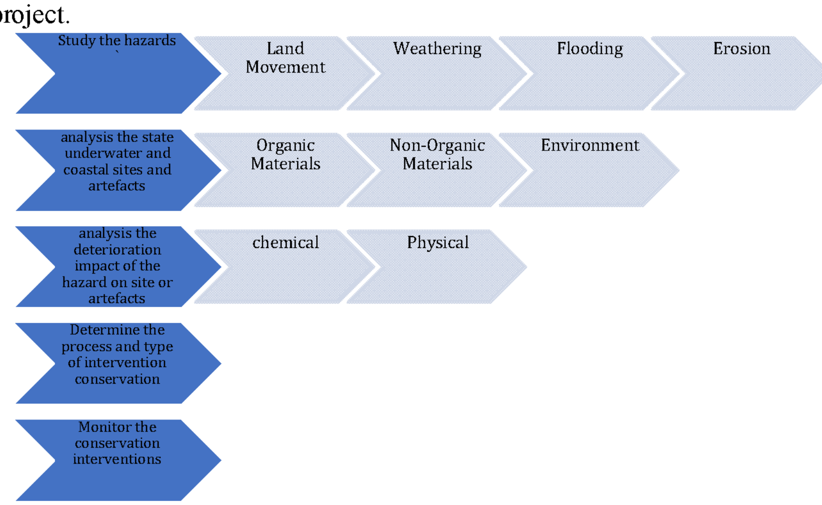


Table 1

6 - Descrizione del progetto/Description of the Project 15.000 caratteri 15000 characters

IT Va indicato per quale dei tre curricula si intende concorrere.
EN Please indicate for which curriculum you intend to apply

IT Indicare se, in alternativa, si intende concorrere per una delle 6 borse PNRR DM. N.118/2023, nel qual caso va indicata la tematica di riferimento,
Le relative tematiche sono consultabili nell'Allegato A.

EN Please indicate if you intend to apply, rather than for a curriculum, for one of the 6 grants funded by Next Generation EU – National Recovery and Resilience Plan, M.D. 118/2023, in which case you need to indicate for which research topic, The research topics may be consulted in Attachment A (Allegato A).

7 - Risultati attesi e ricadute applicative/ Expected results and application effects (max 3000 caratteri/max 3000 characters)

Outcomes and impact:
This study will contribute to the assessment of geological and environmental factors affecting coastal and underwater sites and artefacts, as well as the analysis of the chemical and biological characteristics of the site or object. Those analyses result in the adoption of the best methods for the conservation, preservation, and preventive conservation techniques of the site. Further, the study will be applied to several different underwater and coastal sites in the Red Sea, the Mediterranean, in Egypt and Italy as case studies, to compare different types of deterioration factors, causes of damage, and applicable conservation and preservation methods. Also, the study aims to set up laboratory and in-situ experiments to verify the completion of the investigation and analysis processes in a practical way and to reach accurate and appropriate conservation decisions and processes.
Case studies of Sites and Artefacts:
The following list contains the proposed sites and related artefacts to be studied and analysed at the condition of obtaining permits or participating in joining excavation missions:
The first region is the Red Sea;

1- Mersa Gawasis, as coastal site (Safaga – Red Sea)
2- Wadi Al Jarf, as coastal site (Suez – Red Sea)
3- Sadana Island Shipwreck, as underwater shipwreck (Safaga – Red Sea)

The second region is Alexandria on the Mediterranean

1- Eastern Harbour of Alexandria, as underwater site (Alexandria – Mediterranean)

The third region is Campi Flegrei and Naples on the Mediterranean

1- Baia submerged Roman, as underwater site (Campi Flegrei – Mediterranean)
2- Gaiola Park, as underwater site (Naples – Mediterranean)

The fourth region is Capo Rizzuto, Crotone on the Mediterranean

1- Shipwreck of Bengala in Capo Rizzuto, as underwater shipwreck (Crotone – Mediterranean)

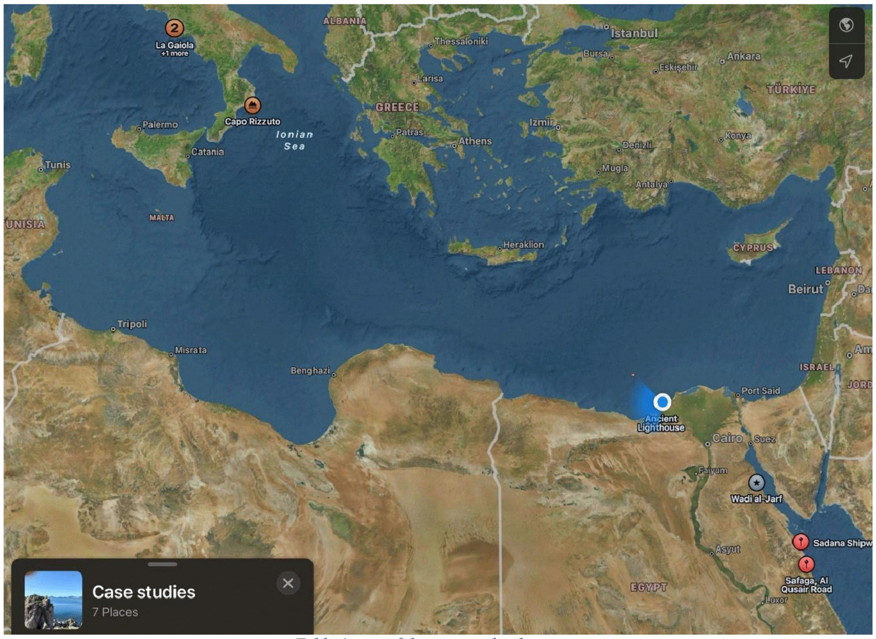


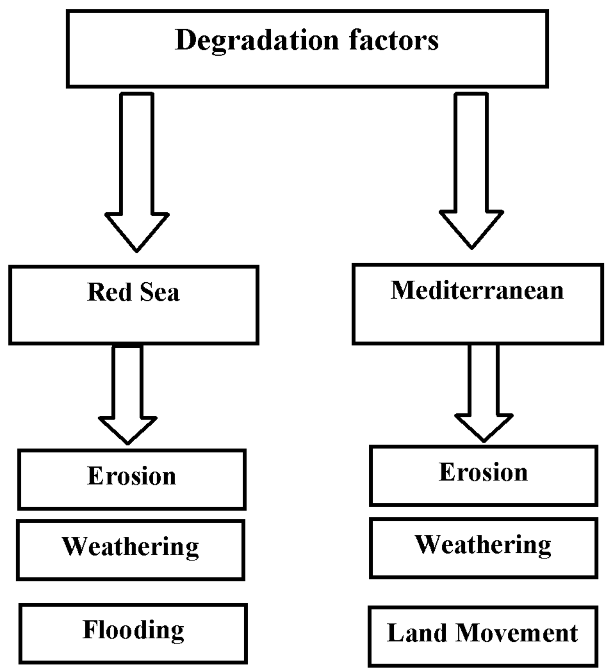
Table 3 map of the case studies locations

According to the material, the current condition, and the surrounding environment, a comparison study will be conducted between the sites or artefacts in Egypt and Italy. (Abdel Samiee et al., 2017) Examination and analysis devices will be standardised on the same type of materials to study the differences among the cases. The locations will be selected from (on cliffs, slopes, valleys, and close to volcanoes) and the raw materials will be selected among (sedimentary rocks, stones, especially limestone, sandstone, and marble; minerals, especially iron, sodium minerals, and copper; ceramics; organic materials like wood and ropes) then the selected materials will be utilised for analysis and conserving the proposed sites. Table 4 shows the analysing sequence for the sites and artefacts.

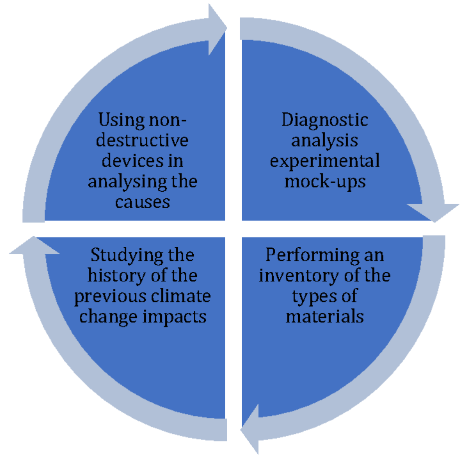
The FTA system will lead to conservation intervention recommendations based on the current condition of the site or artefact. This will eventually result in the FTA system, which can be used by any researcher or conservator to guide decisions on the conservation and preservation of underwater and coastal sites and artefacts that are being affected by climate change. (Di Rita et al., 2015)

According to their availability, the type of material, the state of the cases, and their locations—whether submerged or coastal—the devices that will be employed are described above.

Moreover, it is suggested that the chemical and biological damage factors will be evaluated, and the chemical components of the materials will be studied. The following factors are listed as ones that will likely be taken into consideration: acidity, humidity, salts, temperature, organisms, biological colonisation, biofouling, coastal habitat, oxidation, hydrothermal activities, carbonation, and vulnerability. Depending on the availability and the primary analysis results, samples from the site and the artefacts will be taken or examined in situ. (Ricca et al., 2016) The planned samples' components will include sedimentary rocks, and stones, particularly limestone, and sandstone; marble, minerals, including iron, copper, and sodium minerals; ceramics, and organic materials like wood and ropes. (Mattei et al., 2020)



Methodology



Outcome

1- Applying risk assessment techniques such as fault tree analysis
2- Determining the most suitable conservation technique to prevent further deterioration.
3- Carrying out periodic monitoring for the conservation conditions & deterioration factors

As the proposed sites and artefacts for the study will be:

Mersa Gawasis, (Safaga – Red Sea)

The site values: Mersa Gawasis is located 25 kilometres to the south of Safaga. (Veldmeijer et al., 2008) The site is an ancient Egyptian harbour from the reign of King Senusret I in the 12th Dynasty. (Bard & Fattovich, 2011) This harbour was used for sea-faring expeditions to the Punt Lands. (Agius et al., 2017; Bard & Fattovich, 2010)

The main structure and materials: The harbour is divided into three sections: east, west, and central; The eastern sector, which lies along the shoreline, and the western sector are still in good condition. However, the central sector was destroyed during the railroad's reconstruction in the 1980s. (Bard & Fattovich, 2010, 2011) The harbour has seven rock-cut chambers, niches for stela, four caves carved along the western terrace, and slipways for ships. (Bard et al., 2009) There are also different inorganic materials and artefacts, such as some limestone artefacts like stelae. (Cheryl Ward & El-maguid, 2010) There are sloped buildings as well as ceremonial ones like a coral rock shrine or small temple, a natural rock shelter, small cottages, mudbrick, ceramics, jars, stone anchors, and conglomerate stones. Also, there are organic materials like conch shells, hearths with fish bones, barnacles, and donkey bones, in addition to graffito in bad condition with a cartouche and other signs and clay sealings. Also, there are some organic artefacts like wooden boxes, mats, basketry, cloth, fragments of food like bread, lithic tools, and 500 fragments of cordage. As there are remains of large ships' hull plank parts. The macroscopic investigation has been used in the past excavation seasons,(Cheryl Ward & El-maguid, 2010) which gave potential results that the ropes or the cordage were made of papyrus, half a grass, or palm leaf.

Deterioration factors and study plan: There are some rock-cut galleries and structures that are not stable, and some fragments are affected due to their depositions, as there are some rope and wood fragments that are on a thick layer of reeds. (Galal & Gad, 2010; Veldmeijer et al., 2008) This indicates that there are issues with weathering on the artefacts and structures, whether chemical, biological, or physical damage, which requires taking samples for analysis of the site materials and their deterioration composition, then carrying out cleaning and treatment operations, and then applying sustainable protection processes from weathering risks. Also, there are previous measurements of temperature and RH.(Ward & Zazzaro, 2016) Reports from earlier seasons indicate that the caves' temperatures and RH were lower than those outdoors. To develop ways of preservation based on moisture and heat factors on the stones, wood, and other existing materials, temperature and RH rates will be evaluated on an annual basis through previous data.

Because the site is in a valley, it is vulnerable to elements like flooding and wind erosion. (Ward & Zazzaro, 2016) As a result, the location reveals many deterioration factors, including salinity and calcification. Depending on the type of material, degree of susceptibility, and deposition, analysis, and monitoring of the effects of wind erosion and floods on the site will be applied. (Dawson, 2013) Based on the results, methods for treating erosion and flooding effects will be developed, followed by plans for long-term erosion and flooding protection of the site.

Wadi Al Jarf, (Suez – Red Sea)

The site values: Old Kingdom Egyptians, particularly those of the 4th dynasty, used the harbour at Wadi Al-Jarf. (Burgos & Laroze, 2020; Potter, 2022) It is located near Ayn Sukhna, 20 kilometres south of Zafarana, south of Sinai, and west of the Suez Gulf. From Wadi Al-Jarf to Memphis, various minerals like copper and turquoise were transported using the harbour.(Tallet, n.d., 2012)

The main structure and materials: A limestone hill has been excavated into the site which was used to create a network of 30 storage galleries; (Tallet & Marouard, 2014) Some of the galleries are built around rocks, while others are carved. (يسري, 2018) Additionally, there is a storage facility for jars, settlement areas, a stone structure, a breakwater mole, ceramics, limestone anchors, mud layers, clay mortar, and red pigments. (Tallet & Marouard, 2014) Along with organic artefacts like bones, fragments of wood, disassembled boats, and papyri with pigments. Like Mersa Gawasis, the building's structure includes wooden beams that were recycled from boats to support the structure. Organic structures, like wood, may contribute to structural degradation if they are exposed to weathering, erosion, and variations in temperature and relative humidity.(Tallet, 2012)

Deterioration factors and study plan: The effects of weathering, floods, and wind erosion on both organic and inorganic materials will be examined to determine the elemental compositions and conditions. (Hou et al., 2009) Various organic and inorganic materials will be examined and assessed using non-invasive tools. (Iliev et al., 2006) Following the data loggers' measurements will help with regular monitoring of the temperature and humidity readings.(La Russa et al., 2014) The conservation procedures relating to coating, (La Russa et al., 2016) supporting, consolidation, chemical or mechanical cleaning, and storage techniques will be implemented following each case. (La Russa et al., 2012)

Sadana Island Shipwreck (Safaga – Red Sea)

The site values: North of Safaga, in the Red Sea, at a depth of 30 to 48 metres and next to a coral reef, there is the Sadana Island Shipwreck. (Braun, 2005; C. Haldane, 1996b) The Institute of Nautical Archaeology-Egypt (INA-Egypt) began the initial excavation work on the Sadana shipwreck in 1994, and a project is currently being supported by the Honor Frost Foundation. (C. W. Haldane, 1995; Khalil & Mustafa, 2002)

The main structure and materials: The Sadana's artefacts are made of a variety of inorganic materials, including porcelain, ceramic, and earthenware items like bottles, water pipes, and charcoal holders, as well as some of these items are decorated.(López-Arce et al., 2013; Ward, 2000) In addition to bronze goods like sheaves that weigh 12 kilogrammes, there are also copper artefacts and fragments like pots, handles, bowls, kettles, loops and glass artefacts, which are mostly bottles. (Ward, 2000; Ward & Baram, 2006) The organic elements, mostly consist of wood, (Björdal et al., 1999a) seeds, plants, and seashells. It is known that the ship was also transporting various items like pepper, coriander, coffee, fragrant resin and gums, myrrh, and storax.

Deterioration factors and study plan: few investigations, such as gas chromatography and microscopic analysis, had been performed on samples, but the shipwreck and its artefacts still require additional analysis to determine the chemical composition and to evaluate and assess the conditions. (Łucejko et al., 2012b)

As a result of being buried in marine waters, the Sadana shipwreck requires investigation and study of the mineral, stone, and sedimentary components to determine the rates of corrosion and erosion, as well as the impact of water chemistry and biology on the shipwreck's structure and artefacts to monitor the quality of the protection and coating materials. Samples will be gathered from the shipwreck site, and experimental mockups will be placed. (Björdal et al., 1999b)

Eastern Harbour of Alexandria, (Alexandria – Mediterranean)

The site values: One of the oldest harbours in the world, Alexandria's eastern harbour is home to several submerged and maritime artefacts and sites.(CHALARI et al., n.d.) The eastern harbour has witnessed several prosperous periods and commercial booms, from the Hellenistic and Roman to the modern centuries.(Goddio, 1998)

The main structure and materials: Numerous significant Ptolemaic sites have been found in the eastern harbour,(Morand, 2020) including the palace of Cleopatra VII, as well as the remains of temples, residences, statues, mosaic fragments, and the lighthouse's original building blocks, along with various coins, anchors, and jars.

Deterioration factors and study plan: The coast of Alexandria is unstable due to the seismic movements, destructive tsunami waves and local co-seismic subsidence. (Marriner & Morhange, 2007) The positions of the archaeological sites in the eastern harbour were determined using a variety of surveying techniques, including magnetic

resonance magnetometers (NMR), side-scan sonar, sub-bottom profilers, and satellite positioning systems (DGPS). (Stiros, 2020b; Véron et al., 2013) The eastern harbour of Alexandria is currently plagued by dangerous issues, including natural dangers such as coastal erosion, corrosion, land movement, and sea level rise, as well as human interventions like violations of concrete buildings on the port, looting, and vandalism. (Garcia & Barreiros, 2018; Sprouse et al., 2016)
To examine the conditions and compositions of the organic and inorganic elements, it is necessary to collect different samples from the site.(Wijesinghe et al., 2020) Such as, large stone blocks can also be analysed using hydrodynamic analysis techniques,(Yadav et al., 2022) as cracks and deposits, (Sharma et al., 2016) as well as the degree to which bradyseism and land movements impact. (Palumbo et al., 2005) Analyse the effects of weathering, acidity, and salinity (Rawat & Jain, 2022) as well as determine the proper coatings to apply. Consolidation and support techniques will be selected to slow down and prevent the processes of erosion,(Farghali & El-Dek, 2022) deposition, dissolution, land movement, and weathering. additionally, reduce the damage that corrosion causes to metals. Additionally, the study will evaluate the characteristics and impact of seawater absorption on material changes both before and after the protective coating.

Baia submerged Roman (Naples – Mediterranean)

The site values: In Naples, southern Italy, an area of Roman remains can be seen at Baia Park. It is distinguished by the existence of Villa Con Ingresso a Protiro.(Barbara Davidde METHODS AND STRATEGIES FOR THE CONSERVATION AND MUSEUM DISPLAY IN SITU OF UNDERWATER CULTURAL HERITAGE, n.d.)
The archaeological part of Baia is located 15 km west of Naples and the submerged part is 5 meters depth below water surface. The site is back to 4th century AD, and it is divided into 3 main zones:
1- Zone A: includes the tract of the sea in front of Punta del L'Epitaffio, which is protected and has many human activities such as fishing with rods and fishing lines. As there is guided underwater visits.
2- Zone B: includes the tract of the sea between the pier of "Lido di Augusto" and the land stretch of Lido Montenuovo. This zone is under general conservation, therefor free navigation, anchorage, mooring, snorkelling, and fishing are prohibited except the fishing by residents. There is navigation management system for boats.
3- Zone C: includes the remaining tract of sea inside the park boundary. It has partial protection so activities like fishing and using anchors need permissions to be practiced.

The main structure and materials: The main environmental and geological changes in the area were caused by earthquakes, volcanoes, and weathering, which caused the site to be divided into submerged and coastal areas and resulted in a large slope with a difference starting at 10 metres under the current ground level and increasing to 15 metres or more. The area is distinguished by its vastness; it is divided into six main zones, and its antiquities vary between mosaic floors, stone and marble statues, stone columns, and brick walls, which express the villa in the Roman era and its uses.(Davidde Petriaggi et al., 2020; Nadeau et al., 2021)

Deterioration factors and study plan: Excavation and conservation operations are still being conducted periodically; this is what makes the area an experimental field to achieve in-situ conservation and preservation.(Chiodini et al., 2021) In addition to the fact that the region is still experiencing bradyseism and land movement, (Mancinelli & Petriaggi, 2004) which cause the mosaic's cracks, seasonal consolidating work is done to support them. According to research conducted by the researcher in December 2022 with restorers working at the Baia site, it was discovered that there is an ongoing problem with erosion, deposition, and dissolution that occur to the mosaic even after the conservation, and this is one of the strong indications of the continuous bradyseism. As a result, the sea bottom needs to be filled in gaps to lessen the movement and deposition in the mosaic layers.

The Baia site is marked by the presence of ongoing conservation works that have been conducted continuously over a long period of time and on a seasonal basis. To assess the degree of the influence of coating and consolidation operations, particularly on the mosaics and stone blocks, to protect them from bradyseism, land movement, erosion, and weathering impacts, it will be helpful to refer to the previous conservation operations at the site of Baia. Given that it is situated on the other side of the Mediterranean coast from those Italian sites, Gaiola and Capo Rizzuto, as well as the Eastern Harbour of Alexandria, the comparative study with those sites will gain insight from this.(Davidde, 2002)

Gaiola Park (Naples – Mediterranean)

The site values: In terms of the location's volcanic character and the past manifestations of climate change, the Gaiola area is comparable to Baia. Further, Gaiola is covered by several environmental protection legislation because it was designated a protected area in 2002.

The main structure and materials: The site has different materials and production processes than there were in Roman times because the Gaiola site comprises remains from both modern and ancient eras.(Ricci et al., 2013) The Gaiola sites also include a villa on the island and two other stone buildings on the area's coast. As well as the site has anchors or amphora and rocks. The site artefacts and structures are vulnerable to degradation with erosion, biological organisms, and sea level rise.

Deterioration factors and study plan:

The Gaiola site has structural components that are above and below the water, which causes the weathering and erosion processes to be more rapid and unstable.(Mattei et al., 2019) Coating and supporting operations will be crucial to preventing erosion. (Petriaggi, 2016) To work on protecting the foundations of the buildings from the influence of slow and quick movements, it is also necessary to examine the movement of the sea bottom.(Corbisiero, 2022; Hong, 2023)

Shipwreck of Bengala in Capo Rizzuto (Crotone – Mediterranean)

The site values: The Bengala's wreck has been found in Capo Rizzuto, Crotone, Italy. Being an iron screw steamer, it is at a depth of 29 metres. Tonnes of coal and clippers were being loaded onto the ship just before it sank.

The main structure and materials: The wreck is still being researched and analysed because there are not many references to it at this time. The site and surrounding area are being studied by the University of Calabria, and the studies indicate that the seabed where the wreck is located had a gradual slope and was made up of sand and rocks, that the hull existed as a single piece, that the superstructures of the wreck, such as the broadsides and the main deck, are collapsed, and that the anchors are in place.(Medaglia et al., 2020b)

Deterioration factors and study plan: The wreck is exposed to both natural and human-caused decay elements, however the region is protected by preservation rules. The site includes the existence of flora, wildlife, and marine life. In the proposed situations, this is the only iron shipwreck in the project. The wreck is not close to the coast like the other proposed cases in the Mediterranean, either in Egypt or Italy. There are strong unstable weathering movements in the zone it is in, this will lead to studies of the issues with weathering on minerals that form large-sized structures. This will make the study erosion and weathering in Crotona fruitful for more accurate results about large-scale structures.

The selected materials will be among:

The Site	The region	The materials
Marsa Gawasis	Red Sea	Coastal, organic, and inorganic
Wadi Al Jarf	Red Sea	Coastal, organic, and inorganic
Eastern Harbour of Alexandria	Mediterranean	Coastal and Underwater. organic and inorganic
Baia	Mediterranean	Underwater. organic and inorganic
Gaiola Park	Mediterranean	Coastal and Underwater. inorganic
Sadana Island Shipwreck	Red Sea	Underwater. inorganic
Shipwreck of Bengala in Capo Rizzuto	Mediterranean	Underwater. inorganic

Preliminary Timeline:

Task No.	Title of Task/ Sub-task	Start Date	End Date	Duration (Months)	1st Year												2nd Year												3rd year											
					M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12
	ACR																																							
	AP																																							
	AP																																							
	ARC																																							
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	ARC																																							
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	W \ AP																																							
	AC \ FT																																							
	AP																																							
	AP																																							

1- academic research (ACR)
2- analytical process (AP)
3- testing (T)
4- final results (FT)
5- writing (W)