Proposal for a

Malta National Seabed Mapping Programme

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Executive summary

The Maltese continental shelf comprises our largest single natural resource. It covers an area of almost 76,000 km^2 of seabed that is very poorly mapped and understood.

Here we propose the **Malta National Seabed Mapping Programme** with the aim of mapping the entire Maltese continental shelf and create a range of integrated mapping products of the physical and biological features of the seabed.

The strategic drivers for, and the primary benefits associated with, the **Malta National Seabed Mapping Programme** are numerous and relate to:

- international and local legislative requirements and obligations;
- marine non-renewable resources;
- marine biological resources;
- marine environmental management and monitoring;
- maritime spatial planning;
- fisheries and aquaculture;
- shipping and navigation;
- renewable energy solutions;
- tourism;
- offshore infrastructure resources;
- natural hazard prediction and risk assessment;
- protection of offshore cultural heritage;
- development of a knowledge-based economy;
- scientific research.

The proposed 4 year programme, which has an estimated cost of around €3.9 million, will include 8 work packages (WP):

- WP1: data acquisition;
- WP2: data processing;
- WP3: data interpretation;
- WP4: capacity building;
- WP5: data storage and management;
- WP6: data integration and exchange;
- WP7: dissemination;
- WP8: value added exploitation.

These work packages can be implemented through a co-ordinated approach between the University of Malta and a number of Government departments and agencies.

The data and products generated will be beneficial to wide range of users from industry, public authorities, scientists and civil society. They will constitute a valuable national asset that will comprise the body of knowledge required for the operation and management of our seabed, and that will underpin present and future economic, environmental, infrastructural, and social decisions. The **Malta National Seabed Mapping Programme** will also support the development of a national policy for marine resource management in line with the European Union's Communications on **Blue Growth** and **Europe 2020**.

1. INTRODUCTION

The Maltese continental shelf covers an area of almost 76,000 km^2 of seabed, which is equivalent to **240 times** the area of the Maltese terrestrial landmass (Figure 1). This seabed comprises Malta's largest single natural resource. In comparison to many countries, particularly in the Mediterranean region, the offshore territory of the Maltese Islands is very poorly mapped, as clearly demonstrated by a bathymetric map of the Mediterranean Sea published recently by CIESM (Figure 2). Seabed data are a national asset – they comprise the body of knowledge required for the operation and management of our continental shelf, and they underpin present and future economic, environmental, infrastructural, social and policy decisions. Many countries around the world have recognised the need for a comprehensive national seabed survey to map and identify the opportunities in their seabed territories. Ireland was the first country in the world to map its national marine territories (INSS, INFOMAR), and several other European countries have followed suite (e.g. MAREANO in Norway, MAGIC in Italy, FINMARINET in Finland, ESCAPE in Spain, INSS in Israel).

In this document we are proposing the **Malta National Seabed Mapping Programme**, with the aim of mapping the entire Maltese continental shelf. We want to produce an unparallel data set in the Mediterranean Sea, one that will exist as legacy data underpinning future programmes. The focus of the **Malta National Seabed Mapping Programme** is the creation of a range of integrated mapping products of the physical and biological features of the seabed, extending to a depth of 3900 m. This programme will build on a recent project, led by the Malta Environment and Planning Authority and co-financed by the European Regional Development Fund (ERDF), which has mapped the Maltese coastal waters within 1 nautical mile of the coastline. The direct costs of, and the scale of benefits from, the **Malta National Seabed Mapping Programme** are such that it cannot be undertaken without Government/EU funding.

This document comprises the following chapters:

Chapter 2 lists the numerous strategic drivers for the **Malta National Seabed Mapping Programme**, and the projected benefits and users of the data sets and products generated.

Chapter 3 defines the details of the operational framework of the **Malta National Seabed Mapping Programme**, as well as potential participants, time frame and budget.

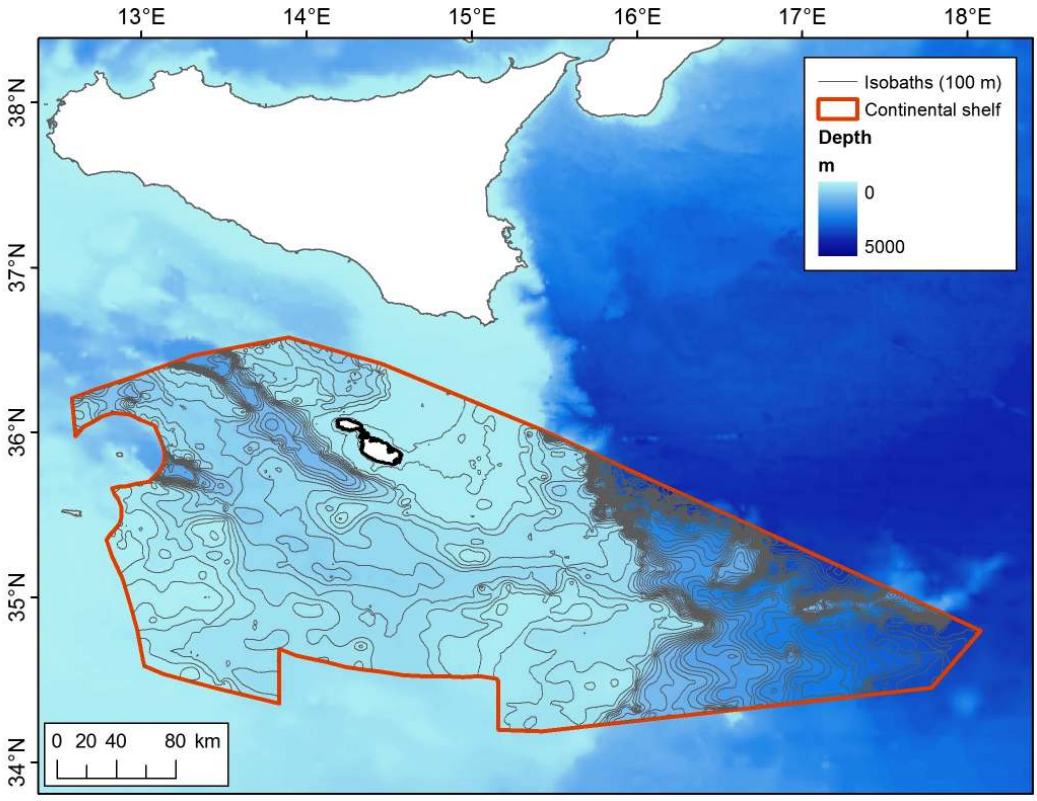

Figure 1: Low resolution bathymetric and isobath map of the Maltese continental shelf, central Mediterranean Sea. (Source: GEBCO).

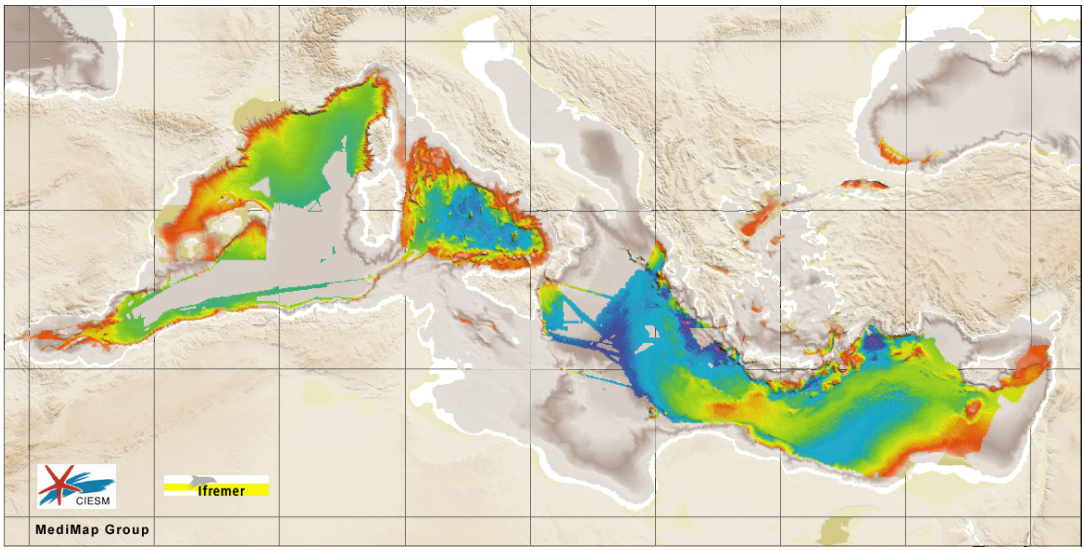

Figure 2: Morpho-bathymetric map of the Mediterranean Sea published by CIESM/Ifremer Medimap Group highlighting the gap in seabed data coverage in the central Mediterranean Sea. This map does not include bathymetric data offshore Italy from the recent MAGIC project or offshore data from the Maltese continental shelf that were acquired by the private sector and are held confidentially by the Government of Malta.

2. RATIONALE

2.1 Strategic drivers and benefits

The world's oceans cover 70% of Earth's surface and host 90% of all known living species. They play a fundamental role in the functioning of the planet and provide vital resources. In spite of this, the oceans remain the least explored and understood environments on our planet.

Over the past two decades, many countries around the world have awoken to the exploration of their oceans. This has been driven by rapid advances in underwater exploration technology and, more importantly, by a higher appreciation of the immense benefits that can be derived from knowing their seas better.

Here we list some of these benefits, together with the numerous strategic drivers and legislative requirements for seabed mapping, which comprise the principal motivation for our proposal for a **Malta National Seabed Mapping Programme**.

2.1.1 Legislative requirements and obligations

The Maltese Islands are subject to a number of EU directives and are signatory to a number of international treaties and agreements, many of which require surveying and monitoring of our seabed in relation to protection of the marine environment, preservation of underwater cultural heritage, and safe navigation of vessels, among others. The information that will be provided through the completion of the **Malta National Seabed Mapping Programme** is necessary to assist the government, both directly and indirectly, in complying with these requirements.

The following are some of the relevant legislative instruments that apply to the Maltese Islands and that would benefit from good quality seabed data:

i. **UNCLOS** (United Nations Convention on the Law of the Sea, signed in 1982) is the overarching international policy framework for all ocean policies. The main objective of UNCLOS is to establish "the legal order for the seas and oceans, which will facilitate international communication and will promote the peaceful use of the seas and oceans, the equitable and efficient utilisation of their resources, the conservation of their living resources, and the study, protection and preservation of the marine environment". Accurate seabed data are vital to the delineation of normal and straight baselines, the projection of maritime jurisdictional limits and the reconciliation of competing claims and successful resolution of disputes. There are several provisions in UNCLOS

regarding the promotion and transfer of marine technology, the duty of all states to protect objects of an archaeological and historical nature found at sea, and the fostering of co-operation for this purpose. Both UNCLOS and the Territorial Sea Convention place an obligation on coastal States to "give appropriate publicity to any danger to navigation, of which it has knowledge, within its territorial sea".

ii. **SOLAS**, the International Convention for the Safety of Life at Sea, operates under the IMO (International Maritime Organisation, most recent amendment in 2011) and contains a complex body of rules dealing with the safety of ships, the carriage of goods, the construction and management of ships, and measures designed to enhance maritime safety. Specific obligations arising from SOLAS require parties to the convention 'to arrange for the collection and compilation of hydrographic data and the publication, dissemination and keeping up to date of all nautical information necessary for safe navigation'. In inshore areas, the Maltese hydrographic charts are currently based on data acquired in the 1950s and thus need urgent revision, although data arising from a current ERDF project led by the Malta Environment and Planning Authority will likely improve hydrographic charts up to 1 nautical mile from the coastline. Apart from updating Maltese hydrographic charts, data from the **Malta National Seabed Mapping Programme** will also inform decisions and recommendations of the IMO regarding deep-water routes for vessels, areas to be avoided, and other routing measures.

iii. The Maltese Islands have obligations to protect marine biodiversity and to safeguard the marine environment from pollution. This is mainly achieved through the creation of protected areas, as specified within **UNCLOS, MARPOL** (International Convention for the Prevention of Pollution from Ships, modified in 1978), the EU **Habitats Directive** (92/43/EEC), the **CBD** (Convention on Biological Diversity, signed in 1992) and the **IMO** framework (established in 1959). The **Habitats Directive**, in particular, outlines the conservation measures required by each member state to list priority habitats and species, identify the areas of each habitat requiring protection and the measures needed to maintain their conservation importance. This is achieved through the designation of Special Areas of Conservation (SACs). A network of marine SACs has been designated by the Maltese Islands, but all of these are located in inshore areas. Data from the **Malta National Seabed Mapping Programme** are essential for the identification and characterisation of new offshore sites to be protected under the Habitats Directive.

iv. The **Strategic Environmental Assessment Directive** (2001/42/EC) aims to provide "a high level of protection of the environment' and to 'contribute to the integration of environmental considerations' into the preparation and adoption of certain plans and programmes that are likely to have significant effects on

the environment. Strategic Environmental Assessment is required for all plans and programmes that are prepared for fisheries, energy, transport, industry, waste management, water management and tourism, and which are likely to have significant effects on the environment. Information to be provided in a Strategic Environmental Assessment includes the "environmental characteristics of areas likely to be significantly affected" and "the likely significant effects on the environment". Assessments prepared for marine plans and programmes will require a high level of baseline information on the seabed environment.

v. The objective of the **Marine Strategy Framework Directive** (2008/56/EC) is to protect, conserve and improve the quality of the marine environment through the achievement of good environmental status in European seas within a defined time period. The directive defines ecosystem–based marine regions as the implementation unit, which are defined on the basis of their hydrological, oceanographic and biogeographic features. The availability of baseline seabed data will significantly enhance the Maltese Islands' ability to implement this directive.

vi. Detailed seabed mapping will help reduce the conflicts in the coastal zone, which in the Maltese Islands extends to 12 nautical miles, by identifying the different resource potential around the coast. This will allow a scientific approach to the designation of areas for different activities and the highlighting of areas in need of special protection. A multi-agency approach to data utilisation and management is in keeping with the ideology of the holistic approach to marine management as set out in the European Union's Recommendation on **Integrated Coastal Zone Management** (ICZM, based on the Protocol on Integrated Coastal Zone Management in the Mediterranean, 2011, and the European Union's ratification of this protocol by council decision 2010/631/EU) and the **Water Framework Directive** (2000/60/EC). The ICZM recommendation, in particular, requires that member states carry out a stock-take, which includes a description of "the environmental, social and economic characteristics and natural resources of the coastal zone". Data from the **Malta National Seabed Mapping Programme** will support the implementation of these strategies by providing a detailed description of the physical environment and the drafting of seabed classification maps.

vii. Seabed data will enable the evaluation of the abundance and distribution of fish stocks, the identification of seabed areas suitable for new fisheries or certain types of fishing gear, and the protection of marine ecosystems in seas under Maltese jurisdiction, thus complying with the **Common Fisheries Policy**. The Maltese Islands already collect data for the **General Fisheries Commission for the Mediterranean**, and the **Malta National Seabed**

Mapping Programme will complement these efforts by acquiring data on benthic species.

viii. Shipwrecks and other artefacts of archaeological significance are an integral part of the State's heritage and are protected by international laws such as the 2001 **UNESCO** (United Nations Educational, Scientific and Cultural Organisation) **Convention on the Protection of the Underwater Cultural Heritage** and the **1992 European Convention on the Protection of Archaeological Heritage** (signed in 1992). The data acquired by the **Malta National Seabed Mapping Programme** will assist in the identification of marine natural and cultural heritage sites, and the creation of public awareness, appreciation and protection of such sites. The data from the programme will also be extremely useful in helping the Maltese Islands in discharging its duty to protect heritage by ensuring that the threats emanating from the commercial exploitation of the seabed, such as hydrocarbon exploitation, cable-laying, fishing, coastal reclamation and offshore energy development, are taken into consideration in the licensing of such activities.

In conclusion, the seabed maps arising from the **Malta National Seabed Mapping Programme** are required to provide the base data to develop policies and programmes that ensure compliance with international legislation. In the absence of the **Malta National Seabed Mapping Programme**, the country may incur fines imposed by the European Union. Furthermore, specific mapping exercises would have to be undertaken, from which there would be no additional benefit from the data captured.

The seabed data acquired under the **Malta National Seabed Mapping Programme** should be nationally sourced; not relying on international projects or funding sources provides **increased security in terms of ownership and access to national marine data**.

2.1.2 Marine non-renewable resources

The potential of the Maltese marine non-renewable resources has not yet been fully explored. Detailed maps of seabed geology and topography will provide geological information on the seabed surface, which will inform and significantly improve **hydrocarbon prospecting** in our seas, as well as augment knowledge of other **resources** that may be located on the Maltese seabed. The geological setting of some parts of the Maltese seabed may be conducive to the development of sapropels - which are used in the production of fertilisers, biofuels and cosmetics - aggregates, as well as mineral deposits, which provide raw materials for the heavy and high-tech industry. Deep sea mining is fast becoming a reality (Figure 3), as demonstrated by the recent

issue of 17 prospecting licenses for state and private companies by the United Nations' International Seabed Authority. We thus need to assess the potential occurrence of these resources in our seas and ensure their responsible exploitation. Deep sea mining is one of the main activities promoted by the Blue Growth strategy of the European Union (see section 2.1.15).

Figure 3: Deep sea mining activities offshore Fiji, Pacific Ocean.

2.1.3 Marine biological resources

Marine ecosystems are fragile biodiversity hotspots that are sensitive to human activities. We still have a poor idea of what type of life inhabits the deep seafloor around us (Figure 4), what is the legacy of anthropogenic activities on these ecosystems, how to protect them, and how to exploit them sustainably (e.g. for pharmaceutics, biotechnology, etc.). The conservation and preservation of marine biodiversity may lead to a conflict of interest between fishing and other commercial sectors, interest groups and policy makers. Thus, it is becoming increasingly important to obtain accurate information on the location and extent of habitat types to facilitate the sound management, development and protection of sensitive areas.

Data from the **Malta National Seabed Mapping Programme** will assist in the designation of marine SACs and provide decision support for best practices for commercial activities. Such designations cannot be made with insufficient or incomplete data, and if these designations are not made, the Government of Malta

could have sanctions imposed, including fines, by the European Union.

Data from the programme will also inform biotechnology companies where to look for unusual life forms when looking for new pharmaceutical products or enzymes. The biodiversity sector is potentially enormous - the diverse nature of marine ecosystems provides the basis on which a significant contribution could be made to medical science, and the economic impact of a major biotechnology discovery could be worth billions. Marine biotechnology is one of the main activities promoted by the Blue Growth strategy of the European Union (see section 2.1.15).

Figure 4: Video capture of live black coral communities discovered during the recent CUMECS cruise at a depth of 344 m, 90 km east of Marsaxlokk.

2.1.4 Marine environmental management and monitoring

Numerous coastal and marine environmental management tools are underpinned by seabed mapping. The availability of accurate charts will assist in:

- The selection of Marine Protected Areas (MPAs) to either protect specific habitats or a representative range of habitats across a given sea area;
- Planning monitoring surveys by identifying areas likely to support a particular habitat of interest;

- Measuring the effectiveness of management practices by estimating the temporal changes in the seabed and habitats through a time series of seabed maps;
- Providing information to assist in locating and planning offshore projects, such as pier/marina development and coastal protection works, offshore wind farms and land reclamation, in an environmentally sustainable way.

2.1.5 Maritime Spatial Planning

In order to ensure the sustainable development of the marine sector, it will be necessary to create and successfully manage a cohesive marine strategy that addresses the sometimes conflicting needs of different stakeholders, e.g. the fishing and aquaculture sector, conservationists, the public, private operators, policy makers, environmentalists, etc. An important tool in implementing such a strategy is maritime spatial planning (Deidun et al., 2011). Maritime spatial planning is commonly understood as a public process for analysing and planning the spatial and temporal distribution of human activities in sea areas to achieve economic, environmental and social objectives. The ultimate aim of maritime spatial planning is to draw up plans to identify the utilisation of maritime space for different sea uses (Figure 5). A key step in maritime spatial planning is to collect and analyse data on the current status of ecological, oceanographic and socio-economic conditions in order to make appropriate planning decisions. Seabed data, in particular bathymetry, seabed geology, sediment type, and the distribution of marine habitats, are essential to carry out such a task.

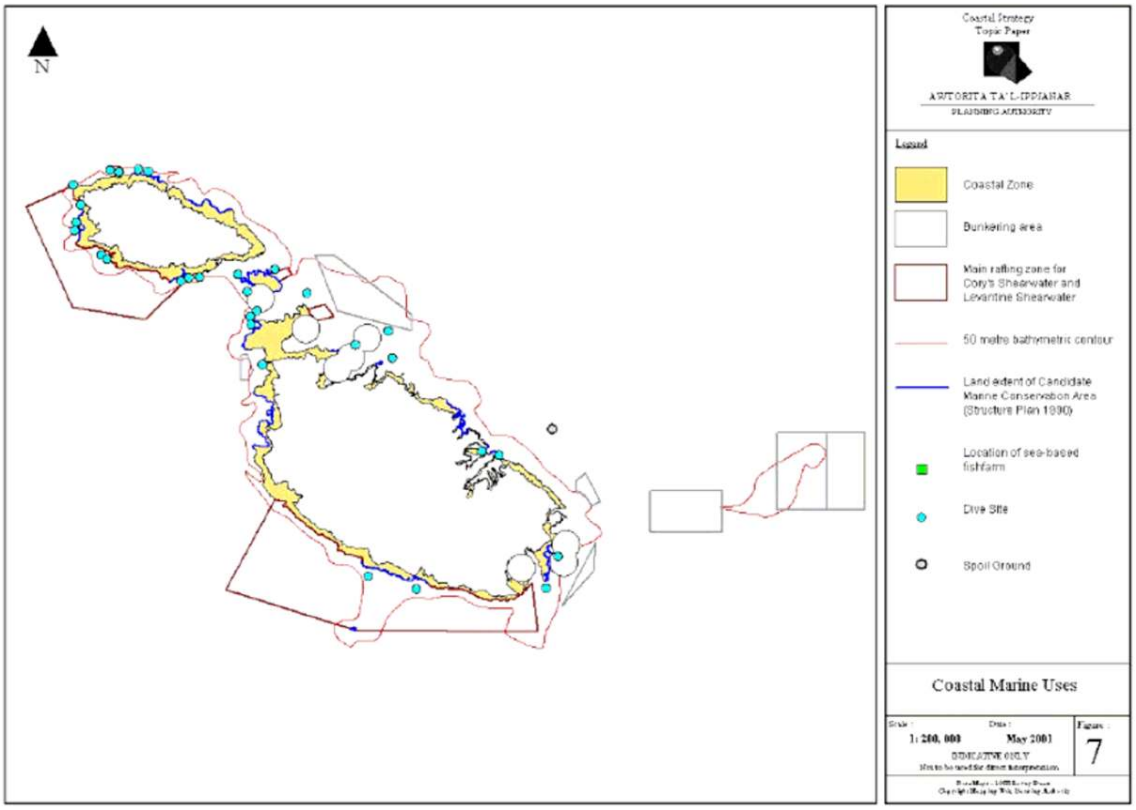

Figure 5: Coastal marine uses in the Maltese Islands (Malta Environment and Planning Authority, 2002).

2.1.6 Fisheries and aquaculture

Seabed mapping has become a critical tool in fisheries management and there is an increasing requirement to obtain more accurate information on the location and extent of habitat types to facilitate their sound management and development. Seabed data are crucial to improve, manage, conserve and recover fish stocks, to reach maximum sustainable yield of stocks by 2020, as per Common Fisheries Policy, and to develop a management plan for deep-water stocks.

Acoustic mapping and classification of resource habitat are essential for the establishment of a viable, sustainable and well managed fisheries sector. Data from the **Malta National Seabed Mapping Programme** will be relevant to the identification of fish habitats and fish spawning/nursery areas, and to scientific research on the distribution and migratory patterns of migratory fish species.

Detailed seabed topography maps will also result in significant environmental benefits because they may be used to provide information to fishermen in order to locate the most desirable fishing areas, thus reducing time at sea (and thus fuel use, costs, and

carbon emissions) and focus on areas without seabed obstacles, thus reducing gear loss and potential damage to wrecks and sensitive marine habitats (e.g. coral, spawning grounds).

Aquaculture is one of the main activities promoted by the Blue Growth strategy of the European Union (see section 2.1.15). Accurate knowledge of bathymetry and seabed composition are essential in the selection of the most appropriate sites for the expansion of the local aquaculture industry, in estimating their carrying capacity, and in modelling pollution arising from aquaculture activities.

Figure 6: Fish farming in a submerged aquaculture cage.

2.1.7 Shipping and navigation

The Government has an obligation to provide accurate charts for shipping. If an accident were to occur in national waters, the State is liable for the total cost of clean up if the accident is attributable to poor charting in national waters. Ports and port companies have identified the need for more accurate baseline bathymetric data to allow them to maintain approach channels and berths. However, whilst surveying within the port limits to maintain access is ongoing (Figure 7), accurate charts outside the port limits are often not available. The **Malta National Seabed Mapping Programme** will provide a comprehensive set of charts that will address these issues. Accurate seabed maps will allow identification of obstacles in the approach to ports (thus ensuring safety of maritime traffic), improve efficiency of the transport network,

identify and manage bunkering areas, enable the designation of places of refuge and provide assistance in search and recovery operations.

Figure 7: Aerial view of the Malta Freeport Terminal.

2.1.8 Renewable energy solutions

The marine area holds significant potential for the production of renewable or alternative sources of energy. The optimal location of power generators to harness blue energy (e.g. wind, wave or solar energy, ocean currents, osmotic power, ocean thermal energy conversion) can depend on a number of factors, including water depth, sea bed conditions, oceanographic characteristics, and distance from shore. Commercial interest in offshore renewable energy developments is expected to grow substantially in the following years. For example, 10% of wind installations in Europe are currently offshore and this value will increase to 60% by 2030 (Directorate General for Maritime Affairs and Fisheries, 2012) (Figure 8). Up to date marine data will be required to support the growth in blue energy, and data collected during the **Malta National Seabed Mapping Programme** (e.g. bathymetry, seabed characteristics, vertical ocean profiles) can assist in site selection and licensing policies for renewable energy developments. Blue energy is one of the main activities promoted by the Blue Growth strategy of the European Union (see section 2.1.15).

Carbon capture and storage – the capture of carbon dioxide and its long term storage underground - is regarded as a key technology for the reduction of carbon dioxide emissions from power plants into the atmosphere and the mitigation of human-induced climate change. In the absence of data, the Maltese Islands have taken a stand against carbon capture and storage, and they are yet to embark on an investigation of its potential. Certain parts of the Maltese seabed are likely to have the right geological characteristics to be used as carbon storage sites. Seabed data from the

Malta National Seabed Mapping Programme will assist in the identification of these sites and the evaluation of their carbon storage potential. The European Union provides funding through NER300 for subsidising installations of innovative renewable energy technology and carbon capture and storage.

Figure 8: Offshore wind farm in Danish waters.

2.1.9 Tourism

The outputs of the **Malta National Seabed Mapping Programme** will also contribute to the development of the most important sector of the Maltese economy. The provision of seabed data will improve the safety of water based leisure activities by allowing more accurate charts to be produced. Diving activities would be particularly enhanced with the provision of detailed information regarding ship wrecks and submerged landscapes. The high quality seabed data that will be acquired may be utilised to develop 3D virtual environments of the Maltese seabed, which can be used as promotional and educational material, particularly for persons with disabilities who cannot experience the marine environment first-hand.

2.1.10 Offshore infrastructure resources

The seafloor around the Maltese Islands hosts numerous cables for electricity and communications, some of which are of strategic national and international importance. There will be a continued need for **cables and pipelines** in the near

future as more fibre-optic cable routes are planned and, particularly, if oil and gas deposits are located. Comprehensive bathymetric and physical maps of the seabed will contribute to the decision making process for the most effective locations for laying cables and pipelines in the marine area, in order to minimise environmental disturbance and avoid geohazards. Such information is fundamental for licensing, design, construction and operation of offshore installations. Accurate seabed data are also vital for identifying potential sites for **land reclamation** offshore the Maltese Islands and assist in the development of **artificial reefs**, which can provide a habitat for fisheries and new diving sites close to the shore.

2.1.11 Natural hazard prediction and risk assessment

As an island nation, it is essential that the Maltese Islands develop an in-depth understanding of the physical marine environment in order to identify the major sources of natural hazards and plan an appropriate mitigation plan. Among the natural hazards that are likely to affect the Maltese Islands and their marine territories are:

(a) **Submarine landslides**: Available seabed data show evidence of shallow submarine landslides to the north, west and east of the Maltese Islands. During the CUMECS cruise alone, 67 submarine landslides were discovered in a seafloor area the size of the Maltese Islands and located at the edge of the Malta Plateau (Figure 9). Submarine landslides constitute a major hazard to seabed infrastructure, and they are estimated to cause 300 million Euros worth of damage to pipelines globally every year (Urgeles, 2009).

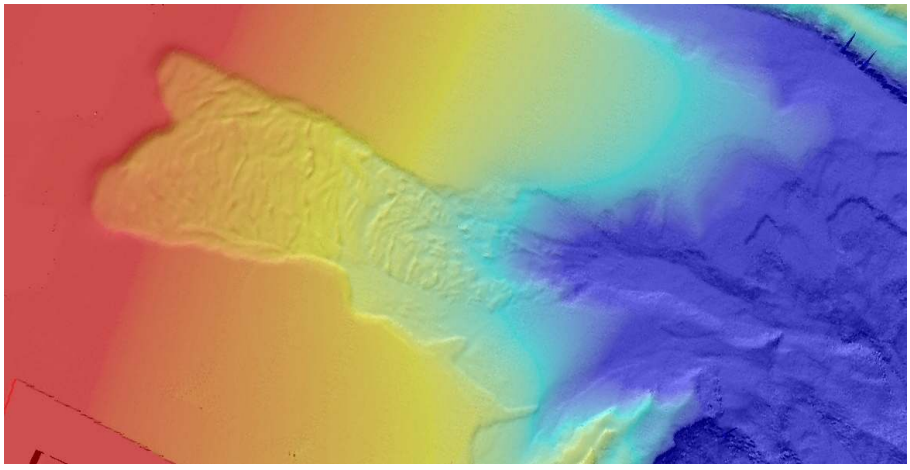

Figure 9: Multibeam bathymetry image of the largest of 67 submarine landslides discovered 90 km east of Malta. The landslide has an area of 20 km^2.

(b) **Earthquakes**: A historical catalogue of earthquakes shows that the Maltese Islands have felt earthquakes of up to intensity VIII in the last 500 years, and that a number of these have been accompanied by serious damage to buildings (Galea, 2007). The epicentres of historical damaging earthquakes are varied, and include large Greek events, although a significant earthquake hazard arises from events occurring in the sea bed around the Maltese Islands and on the Malta-Sicily Escarpment. Detailed bathymetric data from the Malta National Seabed Mapping Project will provide important information about potentially dangerous offshore seismogenic structures.

(c) **Tsunamis**: Submarine landslides and earthquakes are a potential source of tsunamis. Tsunamis are not unknown to the Maltese Islands, as shown by records of such events in 1693 and 1908 AD. A recent study has estimated that the probability of a tsunami wave exceeding 1 m occurring somewhere in the Mediterranean in the next 30 years is almost 100% (Sorensen et al., 2012). Models of tsunami wave propagation and run up using low resolution seabed data show that, if an earthquake were to occur offshore Greece, a 6 m high wave would affect Marsaxlokk Bay (Figure 10).

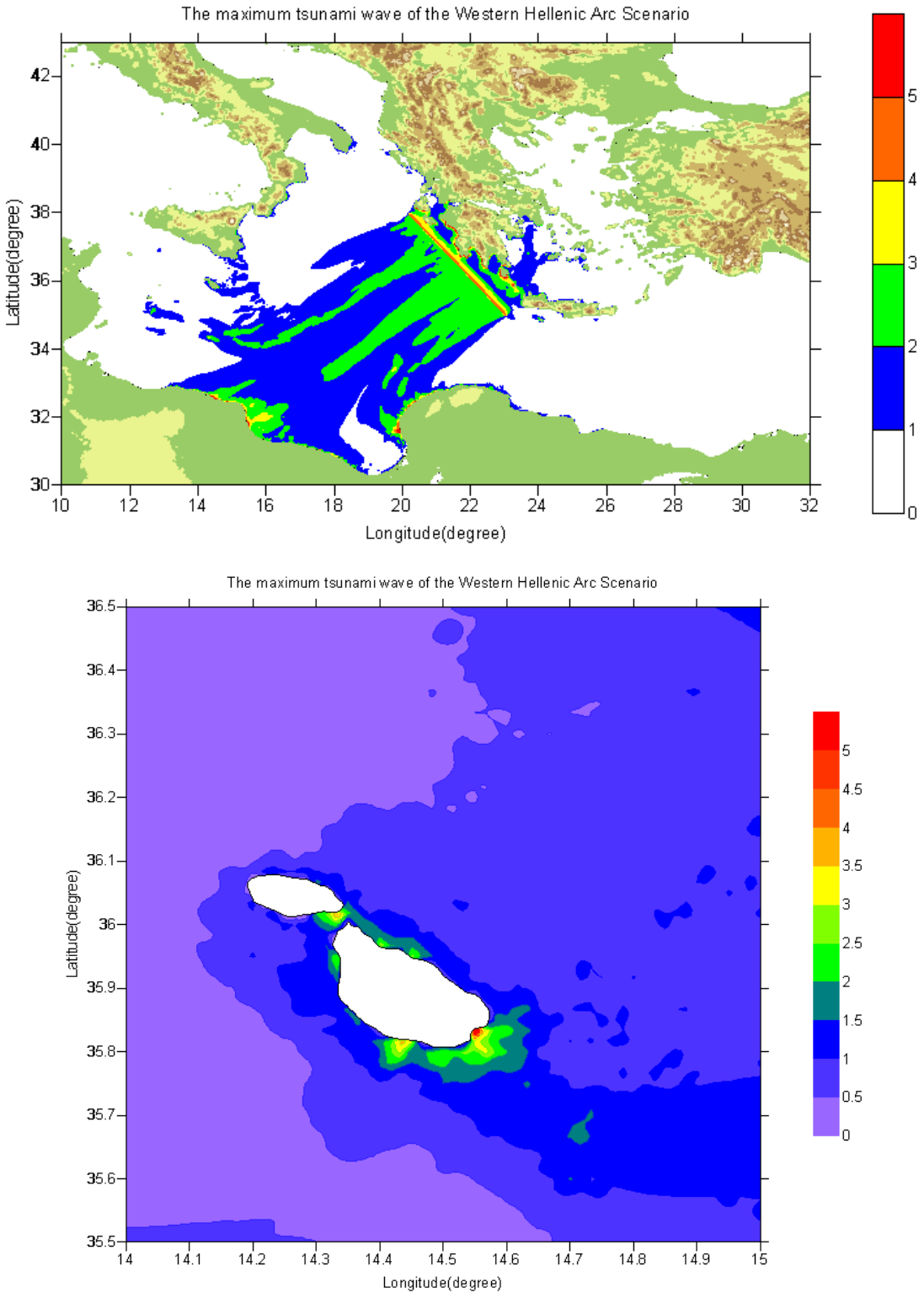

Figure 10: Modelled tsunami wave propagation and height from an earthquake occurring offshore Greece (Ruangrassamee and Intavee, 2008).

If any of these natural hazards were to occur in the near future, the impact on the Maltese Islands could be catastrophic as they would affect power generation, water production, coastal settlements and industry, tourism, ports, etc. There is thus an urgent need to map the above geological processes, estimate the likelihood of their occurrence, and determine if they pose a risk to the Maltese Islands and the surrounding seabed infrastructure. Data from the **Malta National Seabed Mapping Programme** will not only allow identification of submarine landslides and faults that were/might be responsible for generating earthquakes and tsunamis, but they will be crucial for modelling the magnitude and extent of their impact (e.g. tsunami wave propagation and run up along the Maltese coastline) and designing appropriate warning systems. Information on past and future geohazards is also useful to insurance companies to estimate the likelihood of future damage.

(d) **Climate change**: Rising sea levels and increasing storm frequency, associated with future climate change, may contribute to an increased rate of coastal erosion and the incidence of storm and flood-related events, all of which have a direct effect on property, coastal infrastructure and offshore developments. Data from the **Malta National Seabed Mapping Programme** will inform the development of the Maltese coastal strategy in response to climate change, and improve local climate change models and their accuracy in estimating impacts of changing environmental factors, particularly in terms of hydrodynamics. Seabed habitat information can also act as a baseline to quantify the impact of climate change on the marine environment in the future.

2.1.12 Protection of offshore cultural heritage

The Maltese Islands are committed to preserving their submerged cultural heritage. Outputs from the **Malta National Seabed Mapping Programme** will include the identification of anomalies in the seabed, which may be caused by wrecks (Figure 11), the exact location of which may not be currently known. This information, combined with additional detailed investigations in the future, will contribute to the preservation of specific areas of archaeological interest and ensure that commercial activities do not adversely affect such areas.

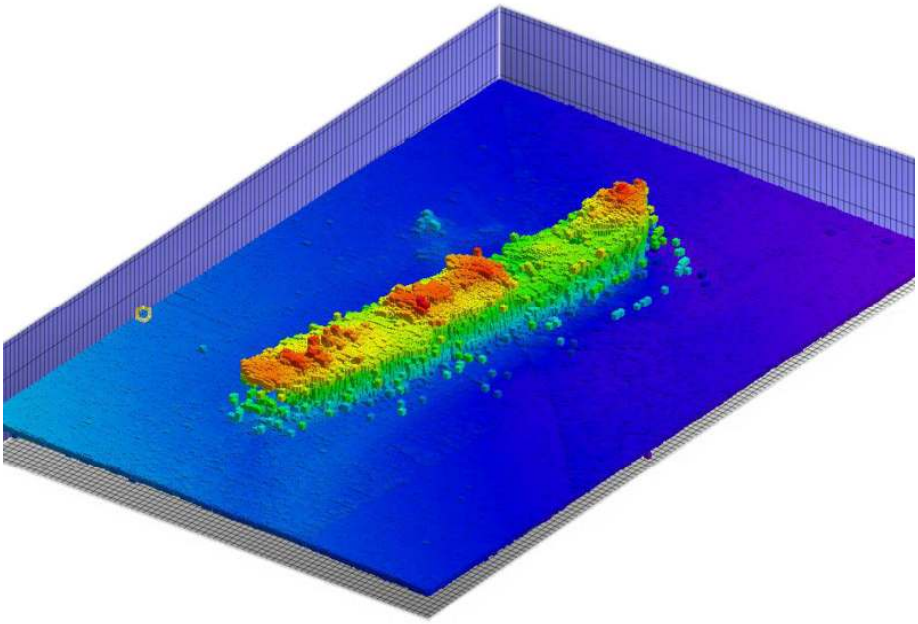

Figure 11: A detailed multibeam bathymetric image of a ship wreck.

2.1.13 Developing our knowledge-based economy

The Maltese Islands are seeking to achieve a strategic shift towards a knowledge-based society and economy. **Research, technology** and **innovation** have a critical role to play in this regard, and in recent years the Maltese Government has increased investment in these sectors.

A key element of the proposed programme is the value added component in developing our knowledge-based economy. The **Malta National Seabed Mapping Programme** will act as a strong catalyst for research and innovation in the marine sector by providing a hugely valuable knowledge base on Malta's largest natural resource for further research and development by academic and technology communities. The seabed data acquired will contribute to further research and economic activity in the marine sector, and consequently enhance revenue to the scientific and industrial communities, and the State. The 'leverage' value of the data asset in terms of research and development activity is expected be high, particularly in view of the maritime focus of the Horizon 2020 programme. As interest in deep ocean research and observation systems grows within the European Union, there is great scope for the Maltese Islands to increase future efforts and earnings in this area. By embarking on the **Malta National Seabed Mapping Programme**, the Maltese Islands will be enhancing their knowledge base and develop a potential for growth within a sustainable development context. Policies and decisions will be built on and based on state-of-the-art information and one of the Europe 2020 goals (increase

investment in Research and Development) will be fulfilled. The Maltese Islands should also be ambitious and develop their own national targets to achieve sustainable growth; recognising the huge comparative potential of the marine environment for such growth is a first step in this direction.

The **Malta National Seabed Mapping Programme** is also expected to:

- Create intellectual capacity that is not present in the Maltese Islands;
- Develop a world class capacity to acquire, process, manage and interpret large, complex marine data sets;
- Bring together a community of marine researchers from diverse backgrounds who have been working in isolation;
- Act as a stimulus to expand local marine research to broader horizons;
- Raise the profile of marine science in the Maltese Islands internationally;
- Provide Maltese scientists with a competitive advantage in terms of developing international partnerships and obtaining academic and commercial marine-related funding from international sources;
- Attract high calibre researchers and conferences to the Maltese Islands;
- Increase the contribution of the geosciences sector to the Maltese Government's agenda by providing expert advice on key issues.

2.1.14 Addressing key scientific questions

Several important questions related to how the deep sea functions are still waiting to be answered. The central Mediterranean is a unique natural laboratory for addressing many of these questions because it hosts a concentration of very diverse processes within a relatively small area. Our seafloor is a unique archive of past environmental change, and deciphering its record is fundamental to model how the planet will change in the future, e.g. in terms of climate change, ocean circulation, sea level rise, ecosystems shifts and geohazards, all of which have significant impacts on human well-being and natural ecosystems. Scientific understanding is also absolutely vital to reconcile environmental protection with sustainable development over the years to come. This urgent need to invest in deep sea research is supported by many important international documents, among which are:

(a) The white paper of the EU funded Deep-Sea and Sub-Seafloor Frontier project (http://www.deep-sea-frontier.eu/);
(b) The science plan of the International Ocean Drilling Programme (http://www.iodp.org/science-plan-for-2013-2023). IODP is the largest multinational earth science programme in the world.

2.1.15 Stimulating Blue Growth and meeting Europe 2020 goals

According to Maria Damanaki, Commissioner for Maritime Affairs and Fisheries:

> "*The European economy can benefit from a more structured approach to marine knowledge. This can improve the competitiveness of those working on our seas and coasts by €300 million per year. It can generate new opportunities worth another €200 million a year. The benefits of reduced uncertainty are harder to calculate but we estimate that if we could reduce uncertainty in future sea-level rise by 25% a year, we would save those in charge of protecting Europe's coastlines another €100 million a year. A first set of pilot projects have shown this approach to be feasible. We will build on the lessons learned from these.*"
>
> (Drewes, 2012)

Communication (COM(2012) 494) "**Blue Growth** opportunities for marine and maritime sustainable growth" (13th September 2012) delineates the long-term strategy of the European Commission to support growth in the maritime sector as a whole. It focuses on existing, emerging and potential activities such as:

- Blue energy
- Aquaculture
- Maritime, coastal and cruise tourism
- Marine mineral resources
- Blue biotechnology

Europe 2020, the European Union's growth strategy for the coming decade, is based on 5 themes:

- employment
- research and development
- climate change and energy sustainability
- education
- fighting poverty and social exclusion

Our seas offer new opportunities for growth and jobs to meet the goals of Blue Growth and Europe 2020, and the rapid advances in underwater observation and technology can be used in a range of nascent industries. To realise this potential, possible future investments in the marine sector should be facilitated by lowering costs, reducing risks

and stimulating innovation, while ensuring that the expansion of the blue economy is sustainable. Our marine resources are large but not infinite, and we need to know what the state of the sea is now and how it might change in the future.

It is here that the **Malta National Seabed Mapping Programme** plays a fundamental role. Outputs from the programme are expected to cut the costs of operations at sea, stimulate innovation, and reduce uncertainty in the future behaviour of the sea. They will also attract international businesses and investment locally, encourage the development of niche high tech industries related to the marine sector (e.g. instrumentation, ICT, materials, biotechnology), complement the national focus on ICT, value-added manufacturing, environment and energy resources, and biotechnology, and be a catalyst for activities leading to economic growth and excellence in research and technology development. These domestic marine-based industries will generate increased exports and will be a springboard for increased commercial success in the marine technology sector, giving the Maltese Islands a leading edge that will attract world leaders to invest in marine products and services locally. By utilising the data from the **Malta National Seabed Mapping Programme**, marine-based industries can develop and thrive in a manner compatible with environmental responsibility.

Our proposed programme also implements the initiatives proposed in the green paper entitled **Marine Knowledge 2020**. A fundamental component of the EU Integrated Maritime Policy, Marine Knowledge 2020 entails the preparation of a seamless multi-resolution digital seabed map of all European waters containing information on topography, geology, habitats and ecosystems by 2020. This project is aimed at helping industry, public authorities and researchers find and make effective use of marine data.

The economic benefits resulting from the **Malta National Seabed Mapping Programme** are difficult to quantify. The experience of other countries has shown that the benefits arising from their seabed mapping programmes were significantly greater than the costs incurred. In the case of Ireland, the estimated cost of INFOMAR (the shallow water mapping programme) is 84 million Euros. The estimated present value of benefits arising from commercial activities, knowledge-based economy and legislative compliance, in the case of INFOMAR being completed by 2016, is in the range of 440 million Euros (Pricewaterhouse Coopers, 2008).

In addition, our programme will encourage the development of commercial opportunities related to the international survey market. Hydrography is by far the largest ocean survey business activity worldwide and is forecast to remain so in the following years (INFOMAR, 2007). Many coastal states worldwide will have an interest

in undertaking EEZ surveys in the short and medium term, and the Maltese Islands can develop a strategy to identify such commercial opportunities.

The programme may stimulate or act as a catalyst for activities and benefits which are currently unknown. Among these are speculative benefits arising from a hydrocarbon find, a major biotechnology discovery, a major inward investment project, and the avoidance of major costs such as an environmental disaster, which could be worth billions to the Maltese economy.

2.1.16 Additional benefits

It is impossible for a government to effectively manage a resource without having detailed information of what the resource includes. Accessible high quality marine information from the programme, linked to better decision-making tools, will result in more effective sustainable management of our marine resources. A primary benefit of the outputs from the **Malta National Seabed Mapping Programme** is thus the public good component that arises from appropriate policy decisions on marine resource management and safety issues.

In the event of the **Malta National Seabed Mapping Programme** not being undertaken, public policy decisions in related sectors may be adversely affected due to an absence of comprehensive and accurate supporting data. Failure to adequately take and implement policy decisions required under European Union and international law could attract significant financial penalties for the State. This may result in individual State organisations undertaking their own survey activities in an un-coordinated manner, resulting in some spending without the benefits of a coordinated programme. Our proposed programme will result in better planning of the acquisition of marine information, reduced overlaps and duplications of effort, increased dissemination of the information, and more efficient use of available funding.

Other benefits associated with the **Malta National Seabed Mapping Programme** include the following:

- The programme will position Malta with an international brand for leading edge integrated and multidisciplinary marine research and development through a high quality seabed digital database, resulting in international recognition for the leading nature of the work being undertaken.
- Malta will be at the forefront of hydrographic and geophysical mapping, and the associated interpretation of these types of data, in the central Mediterranean and North African regions.

2.2 Data users

A wide range of sectors and activities require accurate seabed data. The primary data sets resulting from the **Malta National Seabed Mapping Programme** will be beneficial to many users, among which are:

2.2.1 **Industry**: e.g. oil and gas, renewable energy, offshore installations, cables/pipelines installations, mining, biotechnology, fishing, aquaculture, insurance, diving operators, marine leisure activities, coastal and offshore engineering, environmental assessment.

2.2.2 **Public authorities**: e.g. environmental authorities, port authorities, fishery authorities, public health authorities, civil protection authorities, tourism authorities, pollution control, search and rescue, coastal zone management, various Ministries.

2.2.3 **Scientists**: e.g. academics, researchers, educators, research organisations, museum curators.

2.2.4 **Civil society**: e.g. NGOs, general public.

3. THE MALTA NATIONAL SEABED MAPPING PROGRAMME

3.1 Programme structure

This section outlines the framework for the proposed **Malta National Seabed Mapping Programme**, which is divided into **2 stages** and **8 work packages** (WP):

STAGE 1:

3.1.1 WP1: Data acquisition
3.1.2 WP2: Data processing
3.1.3 WP3: Data interpretation
3.1.4 WP4: Capacity building

STAGE 2:

3.1.5 WP5: Data storage and management
3.1.6 WP6: Data integration and exchange
3.1.7 WP7: Dissemination
3.1.8 WP8: Value added exploitation

Stage 1 and WPs 1-4 are the minimum requirements for the proposed programme. Stage 2 and WPs 5-8 are additional tasks that will ensure that the maximum value of the investment made is achieved.

STAGE 1:

3.1.1 WP1: Data acquisition

3.1.1.1 Types of data

Based on a comparative review of standard seabed exploration methodologies, particularly those used in other national seabed mapping programmes, we suggest that five types of seabed data should be acquired from Maltese marine territories using four different instruments:

(a) **Multibeam Echosounder** (MBES): A MBES is an acoustic instrument used to estimate the depth of the seabed. In MBES, high-frequency acoustic pulses are transmitted by a transducer mounted on the hull of a vessel. Echoes returned from the sea bed are detected by the same transducer, and the travel time of the echo is measured and converted into water depth. In recent years, MBES has become the key tool for systematic hydrographic surveying and seabed mapping programmes because of its cost-effectiveness and the impressively detailed seabed maps it can produce. Two types of data can be generated from MBES – **bathymetry** (which are used to produce high resolution 3D topographic maps of the seabed (Figure 12)) and **backscatter** (or acoustic intensity, which provides information on seabed physical properties and composition (Figure 13)). A high-resolution bathymetry map is a **fundamental requirement** for a wide range of applications associated with mapping marine environments. It provides a baseline data set upon which all other (possibly time-varying) seabed data can be viewed.

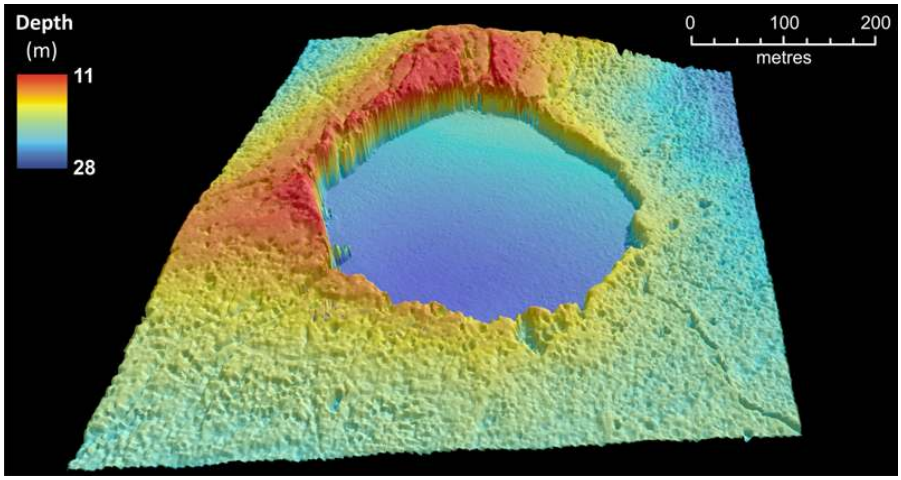

Figure 12: An example of multibeam bathymetry data set of a collapsed cave from Sikka l-Bajda.

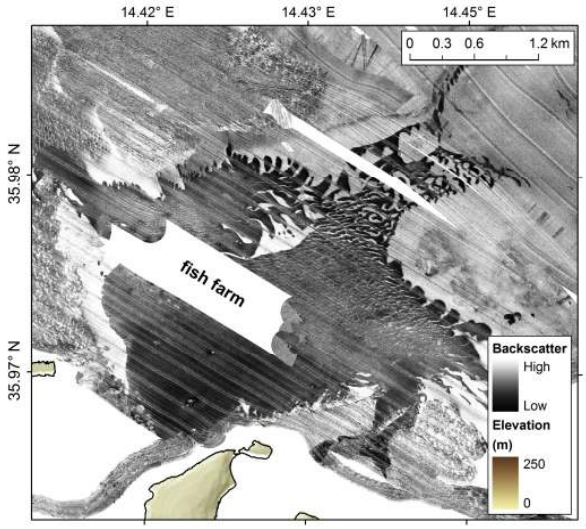

Figure 13: An example of multibeam backscatter data set from offshore Qawra point.

(b) **High resolution seismic profiling** (HRSP): A single-channel HRSP system operates in a similar way to MBES, but it generates a lower frequency acoustic pulse that penetrates the seabed and that is capable of imaging the shallow sub-seabed in high resolution (Figure 14). HRSP data can be acquired simultaneously with MBES data, and they are crucial in providing information on sediment thickness and the nature and structure of the sub-seabed.

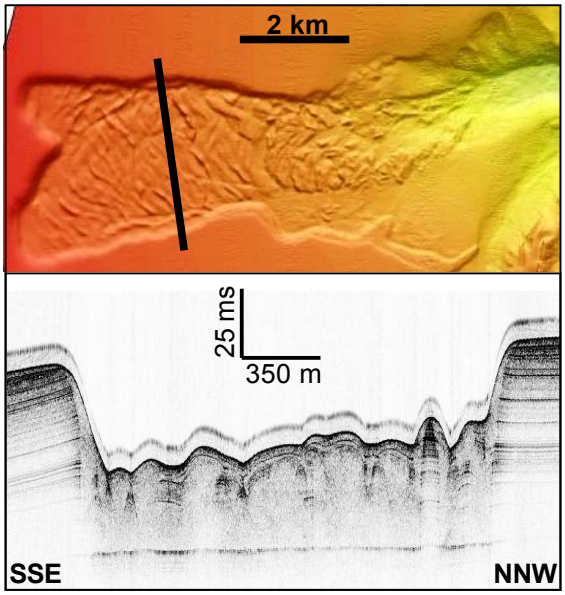

Figure 14: HRSP data acquired across a large submarine landslide located to the east of Malta. The profile shows very clearly the chaotic nature of the mobilised sediment and the failure surface in the middle, and the stratified, undisturbed sediment on the sides.

(c) **Grab sampling**: Collection of seabed samples is absolutely necessary to ground-truth and calibrate the acoustic data described above and to produce accurate and realistic maps of seabed composition. We recommend that seabed samples should be acquired using a grab sampler because this system ensures large samples for a variety of analyses (e.g. geological, geochemical, biological, etc.), guarantees a constant sample area, is easy to retrieve with no loss of sample, and can withstand repeated deck handling and bottom impact (Figure 15).

Figure 15: Grab sampler being deployed in Maltese waters.

(d) **Conductivity-Temperature-Density (CTD) profiler**: An essential requirement of a seabed mapping programme using acoustic techniques is detailed information on the sound velocity profile in the water column. This information allows accurate conversion of the acoustic data into bathymetric depth. We propose that sound velocity profiles should be measured using a CTD profiler to provide important supplementary information on the water's physical properties (e.g. temperature, salinity).

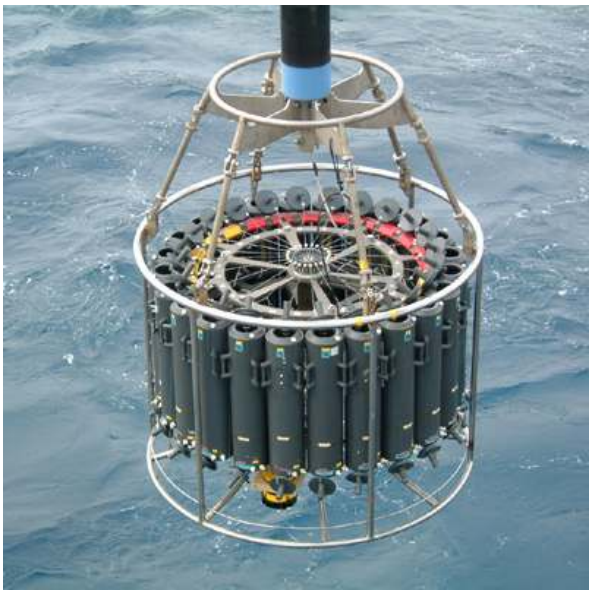

Figure 16: A CTD profiler being deployed in Maltese waters.

Additional data that should be acquired to calibrate these data sets include:

- Precise position of the vessel using a differential GPS;
- Roll, pitch and heave from sensors to correct for vessel motion;
- Hourly tide readings from sensors operated by the University of Malta or from high accuracy GPS systems.

3.1.1.2 Survey plan

A survey plan to acquire all the above seabed data sets has to take into account the distribution of depth in the Maltese continental shelf, which is represented in Figure 17.

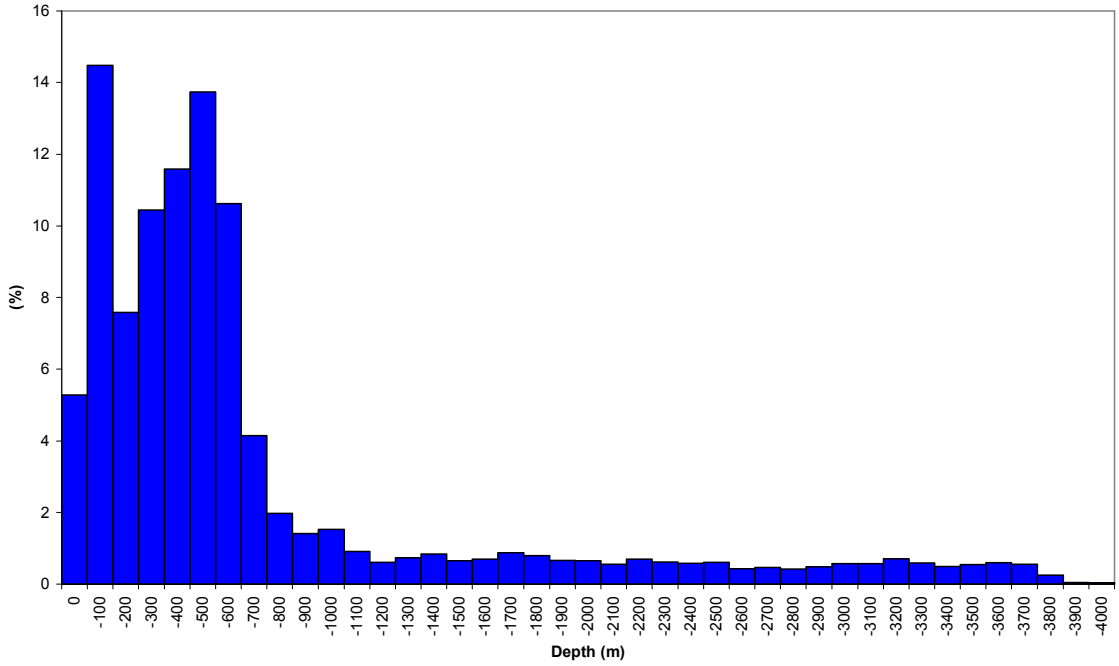

Figure 17: Histogram of seabed depth distribution of the Maltese continental shelf (Source: GEBCO).

Because of the bimodal distribution of seabed depth, the **Malta National Seabed Mapping Programme** should involve two surveys (Figure 18):

(i) **Survey 1: shallow water survey** (between 0 m and 500 m water depth, equivalent to 49.4% of the continental shelf).

(ii) **Survey 2: deep water survey** (between 501 m and 4000 m water depth, equivalent to 50.6% of the continental shelf).

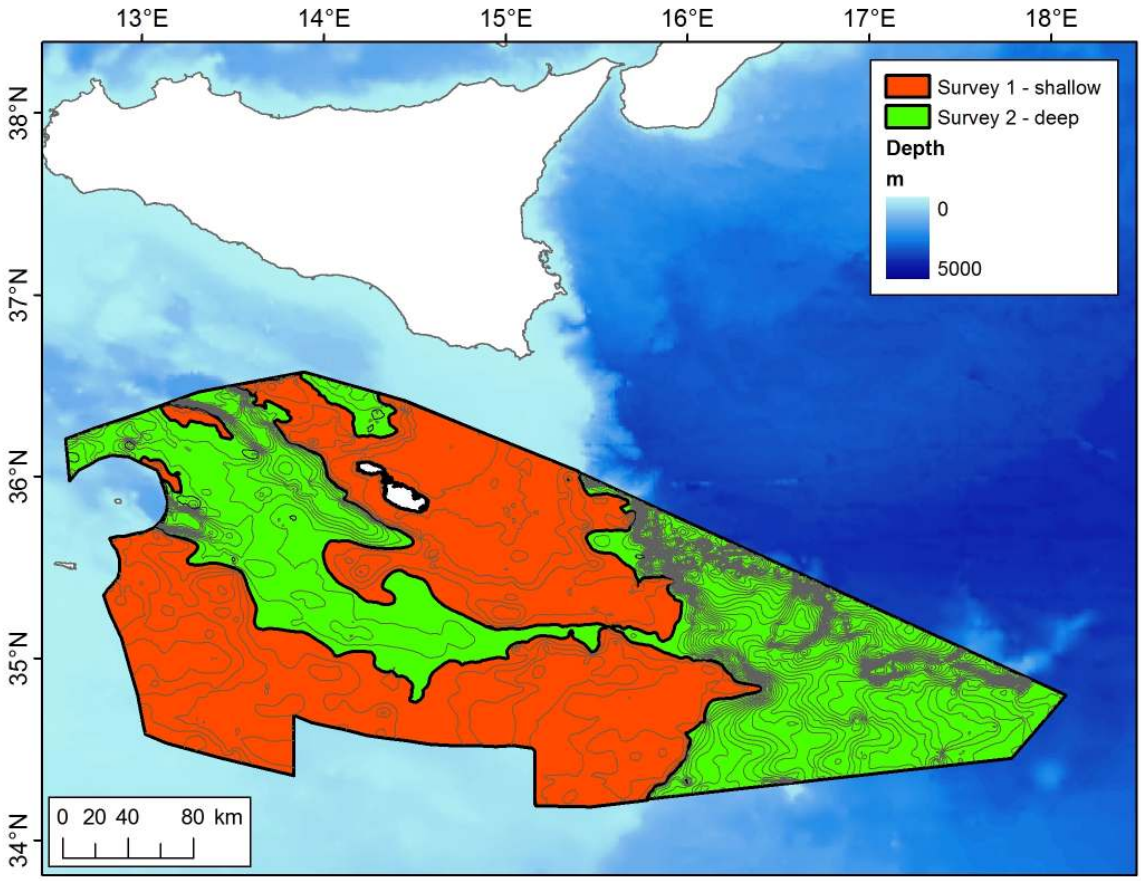

Figure 18: Proposed areas for surveys 1 and 2.

Survey 1 should ideally be carried out with a small vessel, whereas Survey 2 should involve a larger (ocean-going class) vessel. The surveys would involve acquisition of MBES data from the entire survey area, the simultaneous acquisition of HRSP data from the same area, and the collection of grab samples and CTD profiles from selected sites.

Assuming that the surveys will be carried out according to the following criteria:

- Mean survey speed of 7 knots, mean transit speed of 10 knots and allowing for turns at termination of survey lines;
- Minimum MBES swath overlap of 20%;
- MBES swath width equivalent to 5 times the water depth;
- Daily CTD profiles from the deepest point;
- Collection of a minimum of 500 grab samples;
- Winch speed of 1 m/s.

the estimated duration of **Survey 1 is 281 days** and of **Survey 2 is 63 days**. These estimates take into consideration 10% contingency for equipment malfunction and

unfavourable weather conditions. Taking into account the fact that surveys cannot be carried out every day of the year because of the unavailability of vessels and crew, the variable weather conditions throughout the year, and the need for the vessels to return to port every few weeks, we estimate that **Survey 1 can realistically be completed in 3 years** whereas **Survey 2 can be completed in 1 year**.

In our calculations we also consider that grab sampling surveys may only be carried out after the MBES and HRSP surveys because accurate seabed maps will be required to select the best sampling sites.

Furthermore, since 360 km^2 of seabed between 0 and 200 m water depth have already been mapped within the framework of an ERDF project led by the Malta Environment and Planning Authority, this area of seabed has been excluded from the calculations.

Deliverables:

(**D1a**) Unprocessed primary data sets (MBES, HRSP, seabed samples, CTD profiles) for the entire Maltese continental shelf.
(**D1b**) A report on a recommended suite of surveying standards based on the experience and knowledge acquired during the data acquisition phase of the programme, as well as the provision of an advisory service to public agencies and private sector companies undertaking mapping activities in Maltese waters.

3.1.2 WP2: Data processing

The acquired MBES, HRSP and CTD data will be thoroughly processed using industry-standard software packages to make them suitable for visualisation, analyses and interpretation.

Processing of the grab samples will include description, photographing and sub-sampling on board the vessel, the determination of sediment grain size and mineralogy, and identification of benthic macro-organisms (> 1 mm), at appropriate laboratories.

Deliverables:

(**D2a**) Baseline data: Processed bathymetry, backscatter, seismic reflection, and CTD data for the entire Maltese continental shelf.
(**D2b**) Catalogue of and report on sediment/rock samples collected from all sampling sites.
(**D2c**) Catalogue of and report on benthic macro-organisms collected from all sampling sites.

3.1.3 WP3: Data interpretation

The objective of WP3 is to take the outputs from the primary data sets and extract as much valuable seabed information as possible.

Although it is not being proposed as a research programme, the **Malta National Seabed Mapping Programme** does provide the necessary technical capacity, assets and baseline data resource to support the interpretation of data in relation to demand led products and policy requirements, and to significantly augment marine research activity locally. An **associated research programme** is thus proposed to generate the following **products**:

- Seabed depth and topographic derivative maps (e.g. shaded relief maps, slope maps, contour maps, textural maps, etc.);
- Seabed classification maps, produced using in house state-of-the-art quantitative tools (e.g. Micallef et al., 2012; Micallef et al., 2013) (Figure 19), in terms of seabed geology and landscapes, seabed sediment type thickness (isopach), seabed processes, geohazards, physical habitats and biological habitats;
- 3D maps and models of the most distinctive landscape and geological features of the seabed;
- Nautical charts;
- Map of shipwrecks;
- Vertical profiles of sea temperature and salinity.

The associated research programme will also enable three students from the University of Malta to follow PhD degrees in marine geosciences and address a number of basic and applied marine research problems of national importance. These research projects will include:

(i) The risk of earthquake and submarine landslide generated **tsunami hazards** in the Maltese Islands.
(ii) The palaeogeographic evolution of the central Mediterranean and implications for past and future **climate change**.
(iii) Identification of potential **blue energy sites** using advanced seabed mapping methodologies.

The associated research programme will address the Europe 2020 goal related to tertiary education (see section 2.1.15).

Deliverables:

(**D3a**) Products in Geographic Information System (GIS) format; (**D3b**) Scientific articles and conference communications to present the on-going and final results of the associated research programme.

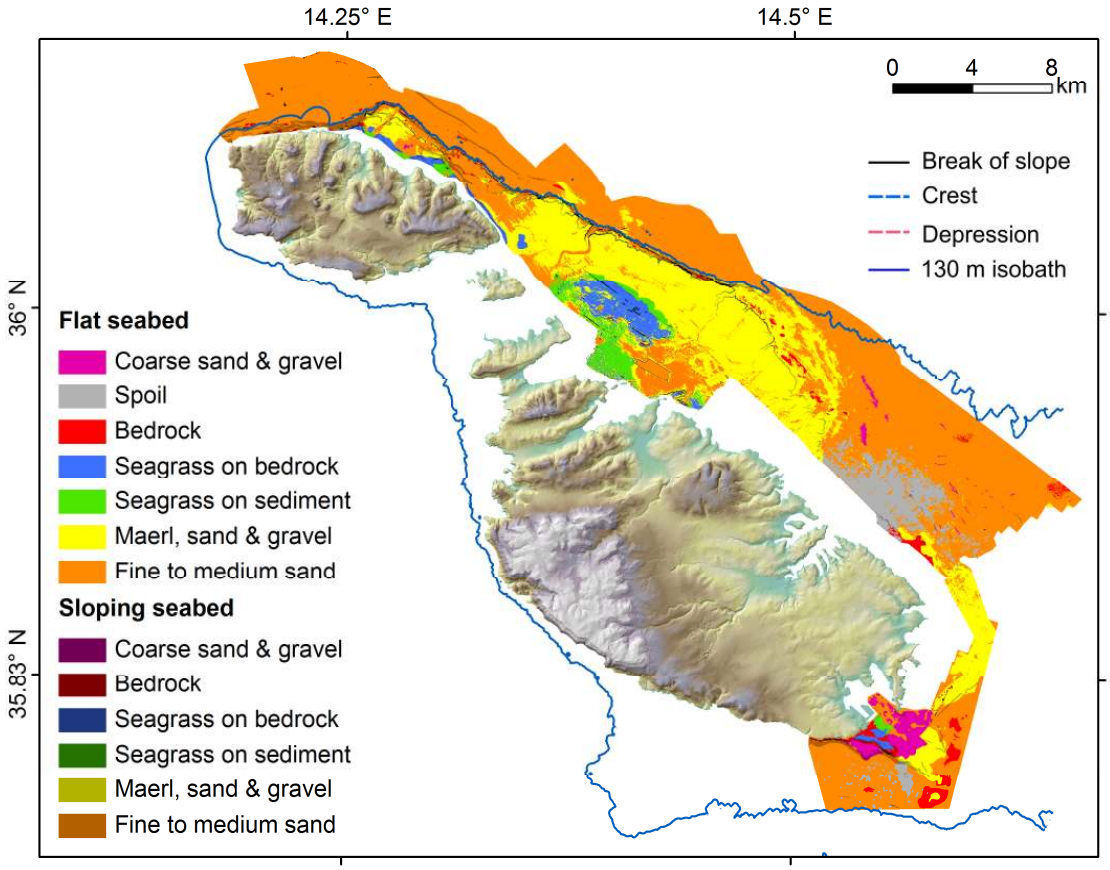

Figure 19: Habitat map of the coastal waters of the Maltese Islands generated using a semi-automated methodology developed at the University of Malta (Micallef et al., 2012; Micallef et al., 2013).

3.1.4 WP4: Capacity building

Existing local capacity in seabed exploration and surveying is very limited.

Capacity building is an essential component of the **Malta National Seabed Mapping Programme**. We will provide an ad-hoc training course in seabed exploration and surveying to employees of the Government of Malta. The course will provide comprehensive training in the theoretical, scientific, technological and operational aspects of seabed exploration and surveying through theoretical classes and hands-on practical sessions in the laboratory and on a research vessel.

Government of Malta employees, academic staff, undergraduate and postgraduate students will be encouraged to participate in all the stages of the **Malta National Seabed Mapping Programme** to develop marine research and mapping capabilities. Undergraduate and Masters students will also be encouraged to pursue dissertation projects in marine sciences using the data acquired during the programme.

The creation of a local pool of talent will be fundamental for the Government of Malta to address future challenges related to offshore development, management and resource exploitation.

Deliverables:

(**D4a**) Trained pool of scientists, students and Government employees who can actively participate in WPs 1-2 and in future offshore projects.

STAGE 2:

Stage 1 of the **Malta National Seabed Mapping Programme** will generate a state-of-the-art geodatabase of marine data and mapping products for the entire Maltese continental shelf. Our vision for the **Malta National Seabed Mapping Programme** is one of continuity, and not of a one-off project. We want the proposed programme to constitute the foundation for the integration of national marine data and future marine policy development, and we want to ensure that the potential of the data acquired during stage 1 is fully exploited. For this reason we are proposing stage 2, which comprises the following WPs:

3.1.5 WP5: Data storage and management

A data storage solution for the large volumes of digital data to be generated during the **Malta National Seabed Mapping Programme** will be required to manipulate the multi-dimensional marine geospatial data sets, avoid fragmentation of data and create a knowledge base of national marine resources. This should involve back up storage of the digital data at three different national repositories, one of which should be the University of Malta. A conservative estimate of the final size of the database of raw and processed data and deliverables is in the region of 40 Terabytes.

Storage of the seabed sediment samples, on the other hand, will require:

- A refrigerator (minimum volume of 20 m^3) to store the acquired sediment samples in plastic bags at a temperature of 4-5 °C to prevent geochemical reactions, the growth of organics or evaporation in the samples.
- Space to store glass jars containing benthic macro-organisms in buffered 4% formaldehyde.

Deliverables:

(**D5a**) Storage systems for digital data (raw and processed), derived products, and samples of seabed sediment and macro-organisms.

3.1.6 WP6: Data integration and exchange

A marine GIS should be developed to integrate the data acquired during the **Malta National Seabed Mapping Programme** with seabed data already available in the various Government departments, and to make these data available to a broad range of stakeholders. The GIS should provide seamless and rapid access to all types of data according to multiple layers of access rights to different users, and for this reason standard operating procedures in data management and exchange should be developed. Our vision is to develop a single national repository of marine data administered by a central entity and to continuously build a marine knowledge base over time. This will facilitate the development of specific information services for the public and private sector and have the potential to deliver on specific customised public service queries and requirements. The need for a marine GIS had already been underscored by Policy MCO 3 of the Structure Plan for the Maltese Islands.

Deliverables:

(**D6a**) Marine GIS that integrates the data acquired under the **Malta National Seabed Mapping Programme** with data already held by the Government of Malta; the GIS will function as a National Repository for marine data; (**D6b**) National Marine Data Exchange Service that provides improved dissemination of data and information to policy makers and the public and private sector.

3.1.7 WP7: Dissemination

Efficient mechanisms for the dissemination of the **Malta National Seabed Mapping Programme** and its products to researchers, policy makers, the private sector and the public, both locally and abroad, need to be in place to fully exploit the products generated. This can be carried out via:

- Project **website** with web-integrated data visualisation systems;
- **Virtual seabed environments**, which would allow users to navigate through the data sets to gain a 3D perspective of the surveyed areas;
- **Atlas** of the Maltese seabed, featuring the most stunning features of the Maltese seabed territory;
- **Presentations** at specialised conferences (e.g. Ocean Business, Oceanology International, Offshore Technology Conference);
- **Interviews, press releases** and **TV advertisements**;
- **Exhibits** at national museums;
- Participation in **public understanding of science** activities;
- **Open days** on research vessels;
- **Open invitation** to general public to join the mapping surveys.

Deliverables:

(**D7**) Dissemination products listed above.

3.1.8 WP8: Value added exploitation

In order to deliver a range of value added opportunities and provide financial and political return on the investment in capacity and capability made in this programme, we propose:

- The development of **decision support tools**: A decision support system helps decision-makers resolve issues using the synthesis and application of information and knowledge. Data from the **Malta National Seabed Mapping Programme**, if integrated with other data in a decision support system, can deliver on specific customised public service requirements and commercial applications. Such a system should be developed in close consultation with end users in the Government and private sector to define the problems being addressed, identify scenarios, generate forecasts and communicate results using maps, graphs and animations. This part of the **Malta National Seabed Mapping Programme** provides unique commercial opportunities.
- The **dissemination of expertise** developed during the programme abroad: The **Malta National Seabed Mapping Programme** will develop a unique pool of local talent and the University of Malta and the Government of Malta should initiate a public-private partnership to actively pursue opportunities related to marine resource mapping in third countries.

Deliverables:

(**D8a**) Decision support tools to deliver data and products on specific public service requirements and commercial applications. (**D8b**) Public-private partnership pursuing commercial opportunities.

3.2 Management structure

There are needs for marine data acquisition from a variety of end users arising from regulatory obligations, sustainable resource development and the knowledge society based on scientific research programmes. The **Malta National Seabed Mapping Programme** should thus entail a co-ordinated approach that involves state agencies, Government departments and research/academic organisations.

We propose that **Stage 1** (WPs 1-4) of the **Malta National Seabed Mapping Programme** should be co-ordinated and implemented by the **Department of Physics of the University of Malta**. The team involved in WPs 1-4 will include University of Malta resident academic staff, undergraduate and postgraduate students, and contracted personnel. The Department of Physics of the University of Malta has the:

- Experience in the acquisition, processing and interpretation of all types of seabed data, and in the planning and execution of oceanographic expeditions;
- Experience with the management of large projects;
- Experience with provision of training courses in seafloor exploration and surveying;
- Access to an international network of experts, research vessels and state-of-the-art surveying and laboratory equipment;
- Access to software licenses at reduced academic rates.

Stage 1 will be carried out in partnership with a number of Government agencies and departments. We propose the following as potential partners because we have worked closely with them in the past years, although the Government of Malta will be invited to nominate the entities that will participate in Stage 1:

- Armed Forces of Malta
- Directorate of Continental Shelf
- Malta Environment & Planning Authority
- Malta Information Technology Agency
- Malta Resources Authority
- Malta Tourism Authority

- Ministry for Economy, Investment and Small Business
- Ministry for Sustainable Development, the Environment & Climate Change
- Ministry for Transport & Infrastructure
- National Hydrographic Office, Ports and Yachting Directorate
- Superintendence for Cultural Heritage
- Transport Malta

Stage 2 (WPs 5-8) of the **Malta National Seabed Mapping Programme** should be co-ordinated and implemented by the **Government of Malta**, through selected agencies and departments, with the University of Malta as a collaborator.

3.3 International advisory services

The **Malta National Seabed Mapping Programme** would benefit immensely from the skills and experience developed by other countries involved in national seabed mapping programmes. Ireland has led the way in Europe in undertaking a comprehensive national survey of its waters. It has conducted the largest EEZ survey so far and it has developed a world leading reputation for seabed mapping in terms of methodologies, human capacity, know how and physical infrastructure. We propose that a memorandum of understanding be signed with the Marine Institute of Ireland to provide consultancy and advice during all stages of the planning and implementation of the **Malta National Seabed Mapping Programme**.

3.4 Programme time-table

The **Malta National Seabed Mapping Programme** will be implemented during a 4 year period according to the time-table shown in Table 1.

Table 1: Time-table of the **Malta National Seabed Mapping Programme**.

Work package	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32	M33	M34	M35	M36	M37	M38	M39	M40	M41	M42	M43	M44	M45	M46	M47	M48
WP1: Data acquisition																																																		
Survey 1																																																		
Survey 2																																																		
WP2: Data processing																																																	
WP3: Data interpretation																																																
WP4: Capacity building																																																
WP5: Data storage & management																																															
WP6: Data integration & exchange																																														
WP7: Dissemination																																														
WP8: Value added exploitation																																														
Deliverables	D4a											D1a, D7												D2a, D2b, D2c, D7											D1a, D7													D1b, D2a, D2b, D2c, D3a, D3b, D5, D6a, D6b, D7, D8a, D8b

We recommend that this programme should ideally be **completed by 2017** because:

- It should be carried out in the shortest time possible because data are acquired and stored in digital format, and changes in acquisition and storage systems over a long project life could create potential IT issues and costs;
- Completing the project in a short period results in lower overall costs because project management costs are incurred over a shorter time and the cost of using commercial mapping vessels is expected to rise in the following years;
- The longer the duration of the programme, the greater the opportunity for other nations to erode the competitive advantage the Maltese Islands would enjoy;
- The programme will be completed by the time the Maltese Islands take presidency of the European Union and it can be used as a showcase project of the commitment of our nation towards sustainable ocean management and blue growth.

3.5 Programme budget

An indicative budget for the **Malta National Seabed Mapping Programme** is presented in Table 2. The total project budget amounts to €**3,871,995** and includes the following expenses:

Data acquisition: hire of vessel and equipment[*], fuel, crew and their mobilisation, contracted personnel for programme (four for Year 1, three for Years 2 and 3), consumables (e.g. plastic bags, stationery, printer cartridges, external hard drives, glass containers, chemicals, etc.), sample transport.

Data processing: contracted personnel for programme (same as for data acquisition, together with two staff for Year 4), three high performance computer systems for data processing and one server, software licenses (e.g. CARIS HIPS & SIPS, ArcGIS, Fledermaus, CODA, Kingdom Suite, etc.).

Data interpretation: salary and bench fees for three PhD students for three years; travel and registration fees to attend conferences; scientific publication costs.

Capacity building: training course for 10 Government of Malta employees; research fund for undergraduate and Masters projects related to the **Malta National Seabed Mapping Programme**.

Data storage and management: two servers with high capacity hard disks, refrigerator.

Data integration and exchange: salary for GIS technician.

Dissemination: Project website production, graphic design, marketing and communications, publication costs, copy editing costs, press conferences, travel and registration fees to participate in specialised conferences, conference stands, exhibits for museums, material for participation in public understanding of science activities, berthing fees, consumables.

Value added exploitation: salaries for software developer and business developer.

Project management: salary for project secretary.

[*] Estimations of vessel and equipment hire have been based on past quotes given to the University of Malta.

International advisor: Consultancy fees, travel and subsistence for an advisor from the Marine Institute of Ireland.

Other expenses, such as the salary of University of Malta resident academic staff and associated overheads, will be covered by the University of Malta.

Table 2: **Malta National Seabed Mapping Programme** budget.

Work package	Cost (Euros)				Total
	Year 1	Year 2	Year 3	Year 4	
STAGE 1					
WP1: Data acquisition					
Survey 1	447,445	447,445	447,445		**1,342,335**
Survey 2	1,190,660				**1,190,660**
Contracted personnel	100,000	75,000	75,000	50,000	**300,000**
Consumables and transport of samples	2,000	1,000	1,000		**4,000**
WP2: Data processing					
Contracted personnel				50,000	**50,000**
High performance computing systems	15,000				**15,000**
Software licenses	50,000	50,000	50,000	50,000	**200,000**
Laboratory measurements, overheads & consumables	5,000	5,000	5,000	5,000	**20,000**
WP3: Data interpretation					
PhD studentships		100,000	100,000	100,000	**300,000**
WP4: Capacity building					
Training course	20,000				**20,000**
Research fund for undergraduate/Masters students	5,000	5,000	5,000	5,000	**20,000**
Sub-total	**1,835,105**	**683,445**	**683,445**	**260,000**	**3,461,995**
STAGE 2					
WP5: Data storage and management					
Servers with high capacity hard disks	10,000				**10,000**
Sample storage facilities	10,000				**10,000**
WP6: Data integration and exchange		25,000	25,000	25,000	**75,000**
WP7: Dissemination	20,000	15,000	15,000	50,000	**100,000**
WP8: Value added exploitation			25,000	50,000	**75,000**
Other costs					
Project management	25,000	25,000	25,000	25,000	**100,000**
International advisor	10,000	10,000	10,000	10,000	**40,000**
Sub-total	**75,000**	**75,000**	**100,000**	**160,000**	**410,000**
Total	**1,910,105**	**758,445**	**783,445**	**420,000**	**3,871,995**

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