

Article

A Roadmap for the Sustainable Valorization of Accessible Underwater Cultural Heritage Sites

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Abstract: This paper presents a roadmap to enable the adoption of the BLUEMED model; an integrated plan developed within the BLUEMED project that promotes underwater cultural heritage (UCH) to both divers and non-divers and aims at sustainable tourism development in coastal areas and islands. Through augmented and virtual reality technologies, one can experience wet and dry diving to accessible underwater cultural heritage site(s) (AUCHS), through a physical dive at the sites or a virtual tour at Knowledge Awareness Centers (KACs). The roadmap provides guidelines, so that relevant stakeholders and competent authorities can implement the BLUEMED model and consider the various environmental, cultural, and socioeconomic factors of the area (locality), to ensure viability in the long-term. The roadmap focuses on the policy and technical parameters, including the cultural and environmental features of the site, the legislative framework, funding issues, the integration of technologies, the prospects for sustainable tourism development in the area, the stakeholder engagement, and the cooperation framework within a top-down or a bottom-up initiative, as well as the establishment and operation of the KACs.



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1. Introduction

Coastal tourism is among the priorities of the strategy for blue growth of the European Union [1], and local culture is regarded as a major attractor for tourists [2]. In parallel, alternative tourism is an emerging trend globally [3], and marine ecotourism, including scuba diving as an activity, is currently considered a very profitable market in the tourism industry [4], with scuba divers having reached 28 million worldwide [5]. Nevertheless, underwater cultural heritage (UCH) is rarely included in, or highlighted by, the tourist promotional campaigns [6] for islands and coastal locations. The responsible valorization of UCH can be a sustainable tourism strategy, with significant benefits for small economies, in terms of local socioeconomic development [7,8]. Recreational diving at accessible UCH sites and the development of thematic tourism in the area can generate direct and indirect income for the local communities [9,10]. The benefits include net revenues for the viable operation of underwater sites (e.g., admission fee) and for the local diving centers (e.g., from equipment rental or diving courses). In addition, the accommodation, food services, and other activities that visitors engage in during their stay in the area offer significant indirect income for local businesses. These profits enhance sustainable tourism development, given that cultural tourists and divers are considered high spenders [11,12]. Investment in underwater thematic tourism is an opportunity for sustainable blue growth; hence, the accessibility of UCH can develop coastal areas and islands as popular destinations among cultural travelers and divers. Therefore, the challenges and prospects of UCH related to blue growth global trends [13] and sustainable tourism development [14] need to be considered by policy makers, and UCH should be promoted as a destination for cultural tourists and divers.

Even though attempts have been made worldwide at the promotion of UCH for touristic or educational purposes and to raise awareness [15–17], much of this, including ancient and modern shipwrecks and submerged sites, remains hidden underwater. This may be, among other reasons, due to limited funding for underwater research and conservation works or because of restrictions to access, for the safeguarding of remains. However, keeping UCH sites inaccessible has often proven ineffective in terms of protection, with looting and illegal fishing being examples of human interventions that cause significant damage to sites. On the other hand, land-based maritime museums [18] provide the archaeological information and detailed description of the exhibits, yet the recovered finds are deprived of their cultural and marine environment. In the case of whole wrecks recovered and showcased on land, such as the popular Vasa Museum in Stockholm, Sweden or underwater museums developed in an aquarium setting, such as the Guangdong Maritime Silk Road Museum (Nanhai No. 1 Museum) in China, however impressive and appealing for visitors such exhibitions may be, they are a huge investment and a non-sustainable solution for small economies.

UCH needs to be broadly accessible in situ, so that the audience perceives fully its context and can be educated about its value and need for protection. According to UNESCO, in situ preservation, non-intrusive access, and the responsible promotion of UCH can raise public awareness and contribute to its protection [19]. Once people are familiar with their cultural heritage, they take pride and develop a strong local cultural identity [20] and, therefore, are more likely to be engaged in its safeguarding and protection [21].

Various initiatives have been undertaken worldwide over the past few years providing an in-situ experience at an underwater archaeological site, aiming at raising public awareness and including recreational divers [22]. Their strategies vary, depending on the remains (material, degree of preservation) and the accessibility of the site (depth, remoteness). For example, in Croatia protective frames have been placed over the remnants of some wrecks [23], while at the Underwater Archaeological Park of Baiae in Naples, Italy, the local diving centers are authorized to guide the visitors [24]. In most cases of in situ access, for the safety of the divers and the protection of the remains, an underwater path guides the visitors around the site. Indicatively, at the Kronprins Gustav Adolf in Helsinki, Finland, a diving trail with information signs guides the divers [25].

Recent technological advancements in underwater surveying and the digitalization of the underwater environment can increase the accessibility of UCH for a wider audience. The integration of augmented reality (AR) technologies into the creation of physical dive trails enhances the interactive experience for the visitors [26]. In addition, virtual reality (VR) applications offer the possibility of diving from a distance, even for non-divers. There have been various recent attempts [27–31] to bring UCH to the wider public, through immersive AR or VR experiences, and representing the cultural and marine environment of the sites. The integration of immersive technologies increases, not only virtual accessibility, but also the number of visitors at the actual sites [32]. In addition, virtual dive trails are ideal for educational purposes and for facilitating access to those who cannot dive [33].

This paper discusses how the operation of accessible underwater cultural heritage sites (AUCHS) contributes to the protection of UCH and enhances sustainable tourism development in the area around the site. In this context, the BLUEMED model is introduced, which aims at raising awareness about underwater cultural and natural heritage in both divers and non-divers, and at enhancing sustainable local tourism development on islands and coastal areas in the Mediterranean. The model was developed within BLUEMED, a project under the Interreg Med 2014–2020 EU Programme (<https://bluemed.interreg-med.eu/>, accessed on 30 November 2021) with the objective to ‘align/integrate regional development policies, plans and management practices for underwater museums and diving parks for a tourism valorization of underwater natural and cultural heritage, in accordance with the principles of sustainable, responsible, blue growth’. The paper presents a roadmap for areas with similar needs and features that could adopt the BLUEMED model.

2. The BLUEMED Model

The BLUEMED model focuses on the sustainable management and responsible promotion of AUCHS and aims at the protection of both underwater cultural and natural heritage, as well as the enhancement of sustainable tourism development in islands and coastal areas. The model is based on international good practices regarding legislation and management strategies for the protection and accessibility of UCH [34,35] and follows UNESCO 2001 Convention resolutions [19]. It is an integrated plan, with interventions that can be adjusted to the specific context of an area (locality) and which was tested within the BLUEMED project in pilot sites, which are presented below.

2.1. The BLUEMED Pilot Sites

The BLUEMED model was implemented at the pilot sites of the BLUEMED project in Italy, Greece, and Croatia (Figure 1). More specifically, these were the Baiae Underwater Archaeological Park and the Capo Rizzuto Marine Protected Area in Italy, the Cavtat Underwater Archaeological Site in Croatia and four accessible underwater archaeological sites in Greece: the ancient shipwreck in Peristera islet, near Alonissos, Northern Sporades and the three locations of ancient shipwrecks on the west coast of the Pagasitikos Gulf.

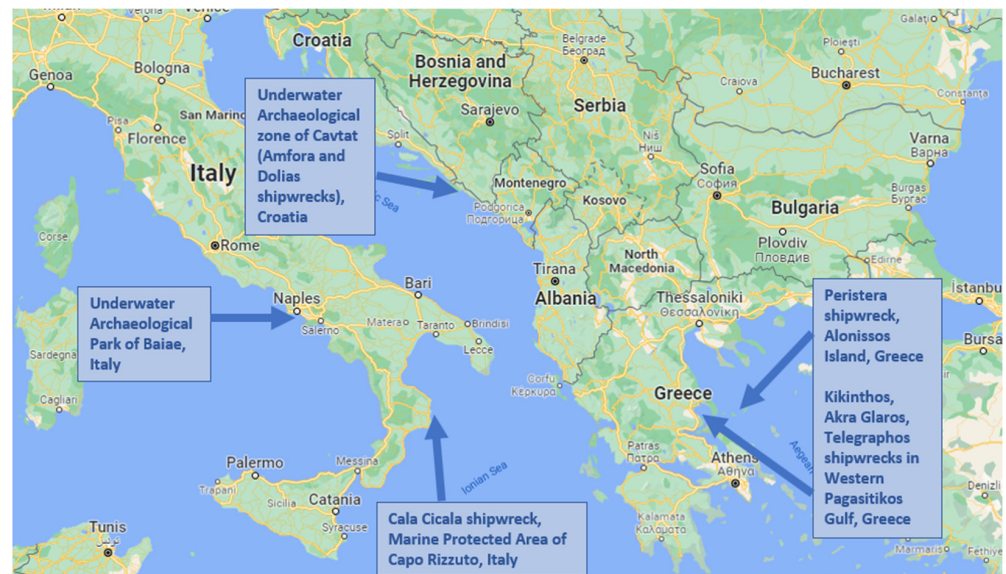


Figure 1. A map with the pilot sites, where the BLUEMED model has been implemented.

In Italy, the Cala Cicala shipwreck [36] lies between the Bay of Scifo and Capo Colonna in the Marine Protected Area, Capo Rizzuto in Crotone. The ship was a commercial vessel of the Roman imperial period. Today, one can see the cargo of 36 raw and semi-finished marble artifacts of different shapes and sizes (some almost 7 m long) at a depth of about 5–7 m on a rocky and partly sandy seabed with *Posidonia* meadows. Baiae is an ancient, submerged city, famed in antiquity for its climate, the beautiful surroundings, and the hydrothermal waters. It was a popular resort for the Roman aristocracy and the imperial family until the end of the 4th century AD, when it sank gradually due to bradyseism linked to the Phlegrean Field's volcanic activity. It is located on the northwestern coast of the Bay of Pozzuoli in Naples and lies at a depth of 5 m. The Underwater Archaeological Park of Baiae is organized in three zones and has several dive trails through the remains of luxurious villas and architectural structures [37].

In Croatia the two pilot sites are in the underwater archaeological zone of Cavtat [38]. The Amfora site is one of the largest and best-preserved ancient shipwrecks on the east coast of the Adriatic. The shipwreck dates to the 4th century AD and preserves a cargo of whole amphoras of the North African cylindrical type and the 'LR2' type amphoras from the Aegean basin. The site is covered with a protective cage and is home to shellfish, algae,

and various fish species. About 300 m away is located the Dolias site, a unique shipwreck of such cargo on the east Adriatic coast. It dates to the 1st century AD and consists of eight whole or almost whole dolia (or pithoi), each with a volume of about 1200 L, all spread on a sandy bottom, over an area of about 10×20 m.

The four pilot sites in Greece are all located in the Magnesia region in Central Greece [39]. The 'Peristera shipwreck' is found off the islet of Peristera, near Alonissos island in Northern Sporades [40]. Here, there lies, at a maximum depth of around 27 m, a shipwreck of an ancient merchant ship that dates to around 425 to 420 BC. The shipwreck cargo consists mainly of transport amphoras of two types, the Mendeian and the Peparethian type, both from famed Greek wine-production centers in antiquity, Mendi in Chalkidiki and Peparethos (modern Skopelos island), respectively. The amphoras are lying on the sandy seabed in an impressive concentration of 25×10 m that seems to maintain the shape of the unpreserved wooden hull of the ship. The large area and the huge number of amphoras, which based on estimations must be almost three thousand, indicate that vessels with huge cargoes sailed in the Mediterranean in the 5th century BC. Since 2020, Peristera has been the first accessible underwater archaeological site in Greece, open for recreational divers.

The other three Greek pilot sites are located at the Western Pagasitikos Gulf, close to the town of Amaliapolis. The Kikinthos shipwreck is located off the islet of Kikinthos and lies at a depth of 3 to 11 m [41]. It is a concentration (8×12 m) of mainly pithos sherds of three different types and amphora sherds that date to the 11th–13th century AD, to when the shipwreck is dated. The shipwreck cargo of large pithoi indicates trade activity in the area during the Middle Byzantine era, while other dispersed finds of ceramic sherds and anchors from different time periods place Kikinthos among the diachronic sea routes of the area. At Telegraphos bay, a Roman shipwreck lies on the sloping seabed at a depth of 17 to 23 m [42]. Even though the site has been looted, the excavation has uncovered scattered amphoras of three main types from the late Roman period (4th century AD), as well as smaller amounts of amphoras, of five different types. At a shallower depth, between 10 and 20 m, scattered sherds of amphoras form the remains of a second shipwreck that dates to the 12th–13th century AD. Akra Glaros Cape [43] is located at the Nies Bay, where at least four shipwrecks have been recognized, one Hellenistic (3rd–2nd century BC), an Early Roman one (1st–2nd century AD), and two of the Middle and Late Byzantine times (12th–13th century AD), where pottery of late Roman times is also present. Among the scattered finds two locations at the western part of the promontory have been selected as the pilot sites, since two full dives can take place there. At the first one, the rocky seabed at a depth of 15 m hosts anchors of different eras, including more than ten 'Y' or 'T' shaped iron anchors of the Middle Byzantine period and big amphora sherds. The second site is deeper at about 20 m, where one can see among the colorful marine flora intact amphoras and scattered fragments of a great stone stock of a wooden anchor of the Archaic period (7th–6th century BC).

2.2. BLUEMED Outcomes

BLUEMED focused on enhancing the physical and distant accessibility of UCH by developing and integrating innovative wet and dry dive technologies to attract divers and include the public and raise public awareness about UCH. For this purpose, an augmented diving system, based on the use of underwater tablets, was developed to enhance the diving experience for scuba divers or snorkelers visiting the pilot sites. In this context, an interactive system allows divers to follow the dive trail and find information at the predefined points of interest about the cultural remains and the marine environment, as well as 3D reconstructions of selected finds. In this way, the sites operate as 'underwater museums', in the sense that the dive becomes an interactive and educational experience.

To include non-divers or those who may have restrictions to diving (e.g., no license to dive below certain depths), a virtual diving system was developed, which allows a virtual tour at the pilot sites of the project [44]. With the use of a head-mounted display and a

controller, the user can select a site to visit and follow the virtual underwater trail to ‘make a stop’ at the points of interest and find out more about certain features of the site in an interactive and fun way.

To integrate these innovative applications for the promotion of UCH to a wide audience, BLUEMED introduced Knowledge Awareness Centers (KACs) [45], a novel type of an information point that combines an exhibition and a visitor center. Four KACs have been established within the BLUEMED project in three different countries, all located close to the respective pilot sites. A KAC is hosted at the National Archaeological Museum of Capo Colonna, in Crotone, Italy, and another KAC operates in the Archaeological Museum of Konavle, in Croatia. In Greece, two KACs were established and are currently hosted in public buildings. The first KAC is located in Chora, on Alonissos Island, near the AUCHS of ‘Peristera’. The second Greek KAC is located in Amaliapolis, a seaside village on the western coast of the Pagasitikos Gulf, where the other three BLUEMED pilot sites are found, nearby.

The idea was to host on land, and close to the sites, the VR diving system and a virtual exhibition of different AUCHS (Figure 2). KACs can provide archaeological and environmental information about the sites through an interactive touch screen and offer a virtual overview of the sites via the VR application. In addition, they can showcase replicas of underwater finds or the actual recovered artefacts, in the context of an exhibition, show educational videos, or hold events to promote local UCH and other AUCHS included in the BLUEMED network. From this perspective, KACs can contribute significantly to raising awareness among the visitors, both locals and tourists, about the value of underwater cultural and natural heritage. When established near the AUCHS, KACs may also support the operation of the sites (if this is in accordance with the management framework of the site), informing, for instance, the visitors about the visiting hours of the site or by scheduling the diving tours. Moreover, the virtual exhibitions of the KACs can become a local landmark and, by extension, contribute to the development of sustainable tourism in the area.



Figure 2. Trying the VR diving system at the Knowledge Awareness Center established in the frame of the BLUEMED project in Amaliapolis, Greece.

Aiming at the good performance of the model, BLUEMED also developed a solid validation methodology for the evaluation of the operational performance of both the KACs and the pilot sites, with key performance indicators (KPIs). These are based on constantly updated data that consider various parameters and variables, among which are the marine environment, the cultural context, the local socioeconomic impact, and financial aspects, in terms of the sustainable tourism development in the area. The evaluation tools created include questionnaires, which are different for the various KACs and sites and are available for the respective managing authorities for future use, in order to monitor, estimate, and evaluate the operation and management of the site(s), in terms of the satisfaction of the visitors; operational, financial, or technical issues; and environmental, cultural, and financial sustainability.

In addition, a web platform (<http://meddiveinthepast.eu/web/bluemed>, accessed on 30 November 2021) was created to provide information about the pilot sites and other AUCHS sites around the Mediterranean and promote this dynamic network through an interactive map (Figure 3). The platform includes the archaeological and historic background of ancient and modern wrecks, ancient, submerged settlements, diving parks, marine protected areas and underwater natural heritage sites, maritime museums, and knowledge awareness centers. In addition, the platform provides useful information, such as how one can dive at the designated locations, and it offers the possibility for a ‘dry dive’ at selected sites, through a virtual environment, simulating a scuba diving experience.

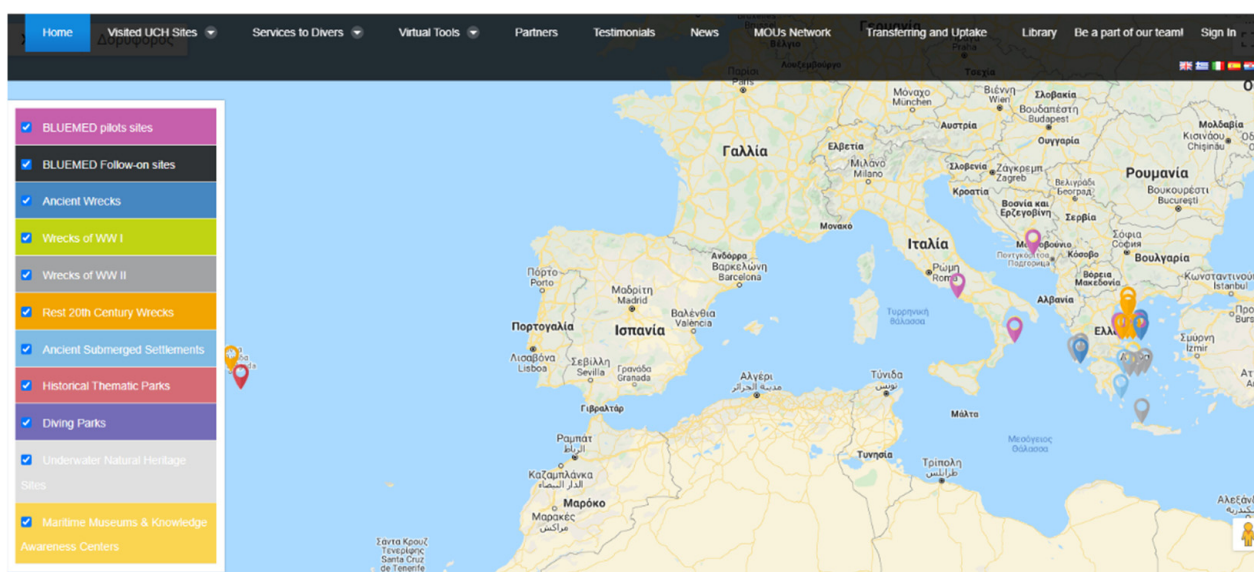


Figure 3. A screenshot of the homepage of the BLUEMED web platform with the contents and a map of the sites already included in the BLUEMED network. (<http://meddiveinthepast.eu/web/bluemed>, accessed on 30 November 2021).

Aiming at the active involvement of all interested parties in the implementation of the BLUEMED model, MoUs (memorandums of understanding) were signed by the different categories of stakeholders. These can be from the cultural, diving, and tourism sectors; as well as the competent authorities, including the Ministry of Culture or Tourism, regional authorities and local municipalities; as well as experts from different research fields (e.g., archaeologists, marine biologists); international organizations or local associations for the protection of the marine environment or culture; the management bodies of marine protected areas, AUCHS, diving parks, land museums, diving centers, tour operators, travel agencies etc. To encourage and assist the relevant stakeholders to join the dynamic BLUEMED network, a roadmap was developed within the project that provides a guide on how to adopt the BLUEMED model, and this is presented in detail in Section 3.

3. A Roadmap to Implement the BLUEMED Model

Within the BLUEMED project a roadmap was drafted to transfer its good practices and provide guidelines for other areas of implementing the BLUEMED model. The roadmap describes the parties that need to be involved in such an effort, which can be built on multidisciplinary synergies among the competent public authorities on a local, regional, and national level, and the stakeholders in the private sector related to tourism, diving, and culture. The roadmap also describes the milestones to be achieved and their expected impact, while it also considers possible risks and how to overcome obstacles. The expected challenges may regard limitations, such as funding issues, legislation barriers, limited promotion of the AUCHS, no 3D reconstruction model of the site being available, lack of tourism infrastructure, or limited awareness among the stakeholders on the local underwater cultural and natural heritage. In addition, the roadmap considers the specifics of each site and its location and provides a guide with a checklist of the steps to follow for the protection, responsible promotion, and sustainable management of an AUCHS (Figure 4).

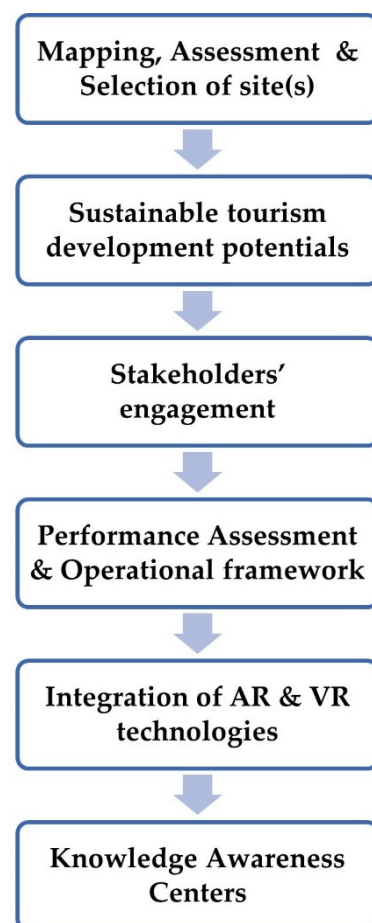


Figure 4. A scheme of the steps to achieve the milestones of the BLUEMED model.

The BLUEMED roadmap is a comprehensive and flexible plan that can be adjusted to coastal regions and islands with underwater cultural and natural heritage and be a viable intervention strategy in the long term. It focuses on issues related to the promotion, operation, and management of the AUCHS and defines the technical and policy requirements and addresses the key issues to consider, such as the preconditions for the selection of the site(s), the engagement of the stakeholders, the integration of innovative technologies, and the establishment of KACs. The roadmap includes six milestones that match the core elements of the BLUEMED model, and it presents the preconditions to fulfill and the steps to follow to implement the model; as a checklist and not in a progressive order. Therefore, the roadmap is a guide to confirming whether a UCH site meets all or

some of the BLUEMED model features, based on the degree of ‘maturity’ of the site, in other words the elements it may lack; the roadmap describes in which sectors additional preparation is needed.

The milestones of the roadmap are presented in Figure 4, and the detailed steps for each milestone are analyzed in the subsections below.

3.1. Mapping, Assessment, and Selection of Site(s)

A first step for the adoption of the BLUEMED model is the mapping of underwater cultural or natural heritage sites in the area. The Ministry of Culture or the Ministry of Environment are usually the competent authorities to approach, depending on the national legislative framework. The local and regional authorities, such as the municipality or the regional respective departments of culture and the environment can also direct to the responsible national public services and management bodies of the sites, which will provide all necessary information about the local UCH sites or marine protected areas. In the case of Greece, for example, the managing authority for the AUCHS is the Ephorate of Underwater Antiquities of the Ministry of Culture and Sports.

To decide which site to select for the implementation of the model, certain features of the candidate sites need to be considered. These include the preservation condition of the cultural remains, the physical accessibility parameters, and the legislative and management framework in force. Ancient or modern shipwrecks and submerged settlements can be included in the initiative, since both the divers and the public are attracted by the rare remains and the exciting stories behind the sinking or discovery of the finds.

The national legislative framework for the protection of UCH and the marine environment should be also considered. The site must be declared accessible by national law, and there should be a management framework that defines the operational regulations of the site, in terms of recreational diving. In case such a framework is not available or does not refer to critical details about accessibility and the activities allowed at the site, the competent authorities must clearly define those with the respective legislative acts. The operational framework of the site should also comply with cultural or environmental protection standards, as determined by the EU or international law. Moreover, if the site is within the limits of a marine protected zone, its impact on the marine ecosystem needs to be considered.

In terms of physical accessibility, the visibility (clearness and clarity of water), the weather conditions, the distance from the coast and the designated access points on land, and the proximity to busy nautical routes determine the attractiveness of the site as a diving destination. The depth of the site also defines the offered services, which may include scuba diving, technical diving, snorkeling, glass bottom boat tours, or on-site 3D rendering and, therefore, attract different audiences.

Another aspect to consider when selecting the site is to confirm that there is the necessary archaeological documentation, an abundance and good preservation of remains in situ, as well as an interesting story. These features, along with a variety of marine species of flora and fauna being found at the site, will help in designing an appealing dive trail with several points of interest to highlight with the AR technologies, and will enrich and enhance the diving experience. Other technical specifications include the installation of a surveillance system, such as live image recording at the site to ensure a safe tour at the site, for both the remains and the visitors.

3.2. Potential for Sustainable Tourism Development

In case several AUCHS are located in the area and meet the criterion of accessibility, then more than one site can be promoted. In fact, in this case the area could attract more visitors, who will potentially prolong their stay. Thus, the economy of scale created when more AUCHS are located nearby brings added value for both the sustainability of the site and the tourism development in the area. The potential of sustainable tourism development is also linked to variables such as tourism infrastructure, the quality of the offered services,

and the attractions and points of interest in the area around the site. These parameters are described in more detail below.

- The diving centers are critical for the implementation of the model, as their services contribute to both the sustainable operation of the site and the enhancement of recreational diving tourism. In the first case, the diving centers provide diving equipment or training to scuba divers and may organize guided diving or snorkeling tours at the site. In the second case, they can offer a variety of blue activities, such as canoeing, SUP (stand up paddle-boarding), etc., in the area and promote the sites at their facilities or on their websites by hosting digital applications.
- When the operation of an AUCHS is combined with other points of cultural interest and natural beauty on land (museums, monuments, parks etc.) or in sea (an underwater marine park), the area can become a popular destination for divers and cultural tourists. A variety of blue and green activities, such as diving, hiking, biking, climbing, caving, swimming, yachting, etc. highlight the natural surroundings, while occasions such as local festivals may attract a wider audience to the area. Through their visit to the KAC, the local museums, or the different service providers (diving centers, travel agencies, etc.) the visitors will find out about the AUCHS.
- Tourism infrastructure and quality services enhance tourism development in the area and, therefore, the viable operation of the site. Infrastructure includes accommodation (e.g., hotels, rooms to let, campsites etc.), food services (restaurants, supermarkets etc.), sports facilities, health care (hospitals, health clinics, pharmacies etc.), banking, and other services (telecommunications, car rental, etc.). In addition, transport possibilities by air, land, and sea, supported by a variety of means of local travel (bus, taxi, and car, moto, or bike rentals), and sufficient parking facilities, facilitate accessibility and mobility in the area and the visitors' stay. Quality services and well-trained staff are also essential, as divers and cultural travelers are interested in cultural and ecological issues and expect to receive relevant information. Therefore, the staff at the AUCHS (security guards, ticket clerks), the diving centers, and the KACs should be able to provide detailed historical, archaeological, and environmental information in an engaging way, to attract visitors.

3.3. Stakeholders' Engagement

To adopt the BLUEMED model the local key economic actors from different sectors, field experts, and the competent authorities need to be actively involved during the implementation of the action plan. The roadmap indicates the stakeholders whose engagement is crucial for the good performance of all efforts and how to approach them. Whether the approach is bottom-up or top-to-bottom, the direction determines the synergies built. In the first case, an initiative can approach the local stakeholders and the public authorities, while in the second case the competent bodies and policy makers can plan a strategy and include the local communities and all relevant actors from the private and public sectors.

Building a strong collaboration framework requires multidisciplinary synergies, with the involvement of different types of stakeholders (Figure 5). In the case of the BLUEMED model, these include the competent ministries of culture, tourism, environment, or development; regional authorities or municipalities; universities and research institutions (e.g., archaeologists, museologists, conservationists, marine biologists, cultural and creative industries experts); international organizations and local associations for underwater cultural and natural heritage; management bodies of marine protected areas, AUCHS, diving parks, and on land museums; and diving centers, tour operators, travel agencies, and tourism service providers in the accommodation and food sector. All stakeholders contribute with their own experience and knowledge. The competent authorities ensure responsible access and promotion of the site and the local stakeholders (cultural, diving, and tourism providers, etc.) support its promotion and, therefore, the viable operation.

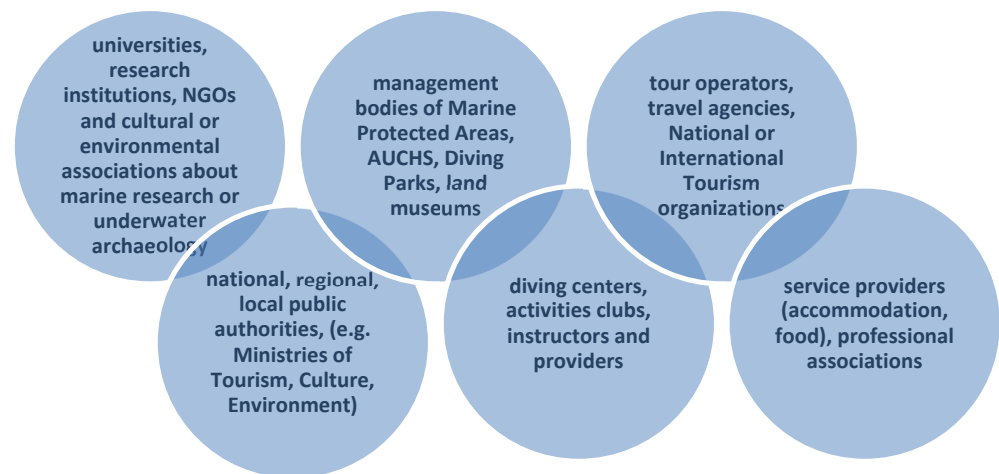


Figure 5. An indicative list of the different stakeholders who can participate in the implementation of the BLUEMED model in a diagram of the interrelation of their involvement.

Stakeholders need to be informed about the value of the local UCH and the potential for sustainable tourism development through responsible valorization. Therefore, information events, workshops, training seminars, and other types of events can be organized to present the model and the plan, explain the socioeconomic benefits for the local community, and reassure that the interventions, despite the expected barriers, do not threaten their investment. The roadmap includes a toolkit of training workshops, communication strategies, and MoUs, in order to include the necessary stakeholders and engage them with signing a memorandum of understanding (MoU).

3.4. Performance Assessment and Operational Framework

The roadmap defines a timeline for the achievement of the BLUEMED milestones, considering the expected barriers to be encountered and the parameters to take into account. One of the most common obstacles at the beginning of any endeavor is securing funding and drafting an efficient budget. The roadmap points out any technical elements to consider, including the 3D reconstruction of the site, the development of the AR and VR systems, equipment, or facilities and infrastructure, etc. In addition, it refers to funding opportunities (e.g., sponsorships or structural funds, projects co-funded by EU programs on sustainable tourism, culture, and the environment), contributing to the success of the investment.

Another barrier to overcome is often the fact that there is no 3D model of the site available, which affects the integration of AR and VR technologies. The roadmap provides a guide for the steps of this complex task, which entails field work, permissions, and cooperation among different field experts, and considers restrictions, in terms of protection of the cultural and natural heritage. The digitalization of the site enhances performance since the use of digital applications achieves promotion to a wide audience. The digital content of the site may be offered in different locations, either online or on land, while the promotional channels include the KACs, tourism agencies, and diving centers near the site, as well as information centers at tourist reception points, such as airports or museums. In fact, the use of digital technologies is a major current trend in the production of educational and promotional material on the Internet, as well as for conducting online surveys to evaluate destinations.

Regarding the viable operation of an AUCHS in the long term, the action plan monitors performance indicators and examines various financial, technical, and social parameters. These may regard technical issues, such as surveillance of the site or installation of technologies, the conduction of cultural or environmental studies about the site, and evaluation surveys about the visitors' experience at the site and the KAC or app user satisfaction. The roadmap monitors performance, based on environmental, cultural, and socioeconomic

indicators and highlights issues to be resolved, such as low public interest or insufficient tourist infrastructure. Therefore, it provides an assessment methodology based on KPIs, so that the action plan is updated regularly and the performance of the BLUEMED model is viable in the long term and has a positive impact. The assessment considers the evaluation of both the AUCHS and the KAC, with a list of different KPIs, in Table 1 are included the BLUEMED KPIs for the validation of AUCHS.

Table 1. A list of KPIs for the validation of the AUCHS operation.

Type of Indicator	KPIs for AUCHS Validation
Environmental/Ecological	<ul style="list-style-type: none"> • Species abundance. • Habitat distribution. • Water quality. • Marine Litter.
Cultural	<ul style="list-style-type: none"> • Local perception of the site. • Stakeholders' knowledge about the site. • Impact of controlled visits at the site in terms of protection of the remains.
Social (including Governance/Education)	<ul style="list-style-type: none"> • Availability of human resources. • Implementation of a management plan. • Cooperation with scientific research organizations of relevant fields. • Number of stakeholders trained in operational/regulation issues. • Level of stakeholder participation in services and activities related to site. • Level of satisfaction of visitors of the AR diving system. • Level of satisfaction of the guided diving trail.
Financial (including Sustainable Tourism)	<ul style="list-style-type: none"> • Net revenues. • Operating costs. • Cash flow to cover site needs. • Number of visitors (divers/other activities) per year/period. • Origin of visitors (local, international).

The roadmap also focuses on the management and operation of an underwater site and introduces an operational model for the establishment and viable operation of an AUCHS. It is more like a general framework that can be adjusted accordingly, based on the national legislation and the specific features of the country and the management status of the site. It provides a checklist of the responsibilities, regulations, and the institutional, protection, or communication issues that need to be considered by the managing bodies. These include the responsibilities of all relevant stakeholders, the operational regulations and staff duties, budget and management of revenues, the operating period, the design of diving trail and provision and maintenance of equipment and facilities, the protection policies of the ecosystem, communication strategies, and a suggested pricing policy, etc.

3.5. Integration of AR and VR Technologies

The digitalization of AUCHS allows a wet and dry dive visit at the site, allowing wide promotion among the diving community and the public. Therefore, the integration of AR and VR technologies is a key element of the BLUEMED model, since not only do they enhance the physical dive at the actual site, but they also offer the possibility of a virtual dive for non-divers. Since a 3D model of the site is a precondition for developing the AR diving system and the VR applications, the roadmap offers a guide for the development

of the applications and the planning, which depends on whether a 3D model of the site is already available or not. The roadmap refers to the experts that need to be involved in this process, including underwater archaeologists to provide the cultural information, marine scientists to collect information about the biodiversity and the marine environment, and ICT and CCI experts to design and develop the apps. In addition, it includes the necessary tasks and actions, regarding both the field work and the computer analysis process, in terms of digital material, interface, functionality, and storytelling. The roadmap also considers the maintenance of the applications and the functionality of the technical equipment (e.g., screens, headsets).

3.6. Knowledge Awareness Centers

Four KACs have been established within BLUEMED in the three countries of the project, all located close to the respective pilot sites. Even though KACs have the common goal of promoting underwater cultural and natural heritage, the management framework for each KAC is different, as they follow the national regulations and local parameters. For example, in Italy and Croatia all the activities related to the site (diving excursions, bookings, departure/arrival, etc.) can be managed by the KACs, but this is not the case in Greece, since different bodies are responsible for the management of the sites (Ministry of Culture) and the KACs (municipality).

Therefore, the roadmap provides a checklist of the technical and policy requirements for the realization of KACs. It considers spatial planning issues (easy accessibility, high tourist visibility), space settings (space requirements, reception, and other spaces, such as a conference room and exhibition space), staff training, and other amenities (accessibility for people with special needs, etc.). In terms of the exhibition planning and content, this considers the different field experts, including museologists, archaeologists, that need to be involved in the implementation of the KAC, and the design of the exhibitions and the virtual tours. The KAC management model measures sustainability and KPIs, based on which the operational performance and the impact of the KAC on the local socioeconomic context and the environment are evaluated.

KACs also need to consider technical specifications regarding the VR apps (equipment, e.g., monitors, touchscreens, and headsets) and the design of the exhibitions, which involves the content, technical solutions for the necessary installations, and the visitor flow (regarding the available space, the placement of physical exhibits or replicas etc.). The innovative applications that the KACs host are an efficient and appealing means to raise awareness among younger audiences, since teenagers and younger children are familiar with using such apps and are greatly attracted to new technologies.

4. The Implementation of the BLUEMED Model in Alonissos, Greece

The BLUEMED project proposed a model for the operation of AUCHS in Greece, as until recently there was no possibility of diving at underwater archaeological sites within Greek waters. The model was based on the national legislative framework in force and proposed that the managing authority of the AUCHS site would be the Ephorate of Underwater Antiquities of the Ministry of Culture and that the local diving centers could accompany the divers during their visits to the site.

During the implementation of the project, a series of activities were conducted at the Greek pilot sites (see Section 2.1), to examine and define how the four selected pilot sites would be accessible to divers in a responsible way. The goal was also to collect the necessary data to develop the AR diving system for the pilot sites and the VR system to be installed at the KACs. These activities included underwater surveys and cleaning at the sites to define the diving trail, documenting the current state of wrecks, identifying points of interest for divers, determining the points of arrival and departure of the divers, selecting the location of mooring buoys, and examining the technological solutions for the development of a monitoring system. In addition, photogrammetric 3D mapping was conducted, as well as mapping and exploration of the biodiversity of the sites. Visits with the participation of

underwater archaeologists and dive masters from the local diving centers gave feedback for the optimal design of the diving routes. The Ephorate of Underwater Antiquities, as the responsible authority of the sites, also organized several information events and carried out training courses for professional and amateur divers in the area to raise awareness among the local communities.

In the frame of the BLUEMED project, and under the responsibility of the Ephorate of Underwater Antiquities of the Ministry of Culture and Sports, the pilot opening of the shipwreck of Peristera as an AUCHS was realized in summer 2020, and Peristera became the first accessible underwater archaeological site in Greece to open for visitors. The first opening period was from 3 August until 2 October 2020, when amateur scuba divers and free divers were able to visit the site accompanied by local diving centers. Only guided diving is allowed at Peristera, accompanied by licensed diving centers; therefore, to plan a diving tour one needs to contact the local diving centers, which are certified and trained by the managing authority. The operation of the site has secured funding from the Regional Operational Program of Thessaly until 2023.

Within BLUEMED, a KAC was established in Chora in Alonissos, along with a second one in Amaliapolis, a coastal town near the pilot sites on the mainland. The municipality is the responsible authority for the operation of the KAC, which is in accordance with the operational framework suggested by BLUEMED. The KAC opened for the public in the summer of 2020 with a large attendance of visitors during the first period of operation and several school visits.

BLUEMED is a follow up to a series of initiatives that took place in Alonissos and in the surrounding area from 2006, for the promotion and responsible valorization of the local UCH and the unique marine environment. The Northern Sporades area in Greece combines unique underwater cultural and ecological features, including ancient and modern shipwrecks of great archaeological and historic value, and the National Marine Park of Alonissos Northern Sporades, the largest marine park in the Mediterranean, with rare endemic and endangered species, such as the monk seal *monachus monachus*. An initial development was the award of the Ano Magniton Nisoi project, which introduced the idea of the in situ promotion of the ancient shipwreck of Peristera, in Alonissos. The 'Operational Plan for the Creation of Underwater Museums & Diving Parks in the Sporades Islands & Western Pagasitikos', as a follow up project, included more UCH sites in a wider region and aimed at establishing the location as a thematic tourist destination.

All efforts have been based on the collaboration among local stakeholders and the support of the competent public authorities, and they aimed at raising public awareness on UCH and enhancing blue growth in the area.

5. Conclusions

This paper has presented a roadmap that was developed within the BLUEMED project for the adoption of the BLUEMED model, an innovative approach for the sustainable management and protection of accessible underwater cultural and natural heritage sites, through their responsible promotion and raising public awareness.

By increasing accessibility of the underwater natural and cultural assets, not only among divers, but also among the public, and with the integration of innovative technologies such as AR and VR applications and the operation of Knowledge Awareness Centers, the areas that implement the BLUEMED model benefit socioeconomically from the increased interest generated in the area and the enhancement of underwater cultural tourism; with competitive advantages in the long term, especially if combined with high quality services and tourism infrastructure in the area [46].

The roadmap is a concrete and easy-to-follow guide that elaborates on the requirements for the implementation of the BLUEMED model. It considers various parameters (environmental, cultural, social, economic) in an area (locality), as well as the policy and technical aspects of an action plan. Using either a bottom-up or a top-down approach, it is

a multidisciplinary and cross sectoral approach that builds upon the active involvement of local communities, stakeholders, and competent authorities and policy makers.

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