

D.5.2.1 - INTERNAL QUALITY CHECK OF DRAFT ACTION PLANS

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The Department of Tourism, Economy of Culture and Community Enhancement of Puglia Region, in cooperation with the three regional Universities, Foggia, Bari and Salento, has performed the internal quality check on partners' draft action plans and on the tools tested in pilot actions (WP4). The document summarises key findings and forms the basis for finalising action plans.

1. Internal quality check on partners' draft action plans

• LP – ERPAC

ERPAC FVG, according to the Regional Law 2/2016, is appointed to promote the development of projects of significant regional interest for the enhancement of cultural heritage and to participate in initiatives carried out in collaboration with bodies and sector organizations operating at European and international level, also for the purposes of accessing Community funding on the subject.

On 2021, ERPAC signed a **Programmatic Agreement** with Regional Secretariat and Superintency Archaeology, Fine Arts and Landscape of Ministry of Culture, aiming at establishing a collaboration for the *in situ* and remote exploitation of the Roman Grado 2 shipwreck as well as at the enhancement and dissemination of the regional underwater heritage.

In particular, pursuant the art. 6 – *Enhancement of the underwater cultural heritage: stakeholder involvement activities*, the parties collaborate in identifying good practices and designing protocols or guidelines aimed at the protection, but also the management of the submerged site, also through the involvement of the community and local actors (in particular diving centers, diving and cultural associations, etc.) who can conduct guided tours and carry out site monitoring and maintenance activities.

A "heritage education"/diving training project has been carried out on the basis of this Agreement, aimed at making diving members and other possible stakeholders to know both the Grado 2 site and other submerged sites in the Region and to formulate a possible enjoyment of them through the same clubs.

- ***PP3 - City of Kaštela***

The vision pursued by PP2 is to establish the Museum of the City of Kaštela as the regional Centre for underwater cultural heritage. As such the Museum can organize and perform diving training and education courses, and certify future divers in collaboration with diving clubs. Moreover, as a Center, it will be responsible for arranging blue trails in diving sites and it could perform tourist diving tours to those sites during the tourist season. For that purpose, the Museum would acquire a boat for tourist transportation and necessary diving equipment and/or glass-bottom boats for monitoring the seabed from above. The sites where diving is not allowed will be represented in the Museum using AR/VR technologies (virtual dives, on-land exhibitions). The activities will be versatile (day diving tours, snorkeling for children, night diving experience, etc.) and adapted to a wide range of visitors (students, children, people with disabilities, etc.) with adjustable prices/fees. To perform aforementioned activities, new employees should be employed, i.e., diving instructors, skippers (or another person who steers the boat), and diving tour guides.

Thus, the Museum will be a leading institution in the implementation of the projects on the topic of the underwater cultural heritage of Kaštela Bay and the SDC region prepared and advocated by the Managing Authority.

- ***PP4 - Puglia Region***

Over half a century of uninterrupted underwater research is the **record** which Puglia can boast of over other regions. Thanks to its continuous and passionate commitment which has culminated in **national and international projects** conducted by the Region's universities, vast stretches of coastline and the seabed have been systematically investigated. The methodology adopted is the holistic, contextual, diachronic, multi and trans-disciplinary approach to the global archaeology of coastal and underwater landscapes or, more precisely, **seascapes**.

Puglia was one of the first regions to develop a regional cultural heritage information system (SIRPaC, now known as **CartApulia**), an indispensable tool for the protection, planning and development of the region's cultural heritage, and it has catalogued thousands of sites of cultural interest, including **coastal and underwater sites**.

The Puglia Region – Department of Tourism, Economy of Culture and **Community Enhancement** – has collected this precious legacy and in recent years has organised and promoted actions aimed at the knowledge, enhancement and accessibility of the underwater heritage, through the creation of the

Euro-Mediterranean Seascapes Archaeology Center – ESAC, linked to Libraries and Museums Hubs of Apulia Region. Its areas of interest are research and cataloguing, conservation and restoration, training, dissemination and communication, international planning, promotion and use and, in general, the use of incentives in order to promote cultural policies for the underwater heritage and the blue economy. The governance of the Centre is the fruit of an **agreement** between the Regional Department, the three Universities and the National Superintendency for the Underwater Cultural Heritage on a participatory process of knowledge and heritage enhancement through specific projects and concrete measures.

Regarding the Draft action plans on the valorisation and the increased accessibility of Torre S. Sabina underwater heritage, they foresee that the involved parties could put in place a **participatory process** through a series of Thematic Tables and Services Conferences; during the process, the parties share the various roles and duties and establish a roadmap according to subsequent steps.

2. Tools tested in PA

UnderwaterMuse pilot actions applied on those sample areas a methodological and technological protocol based on **research/knowledge**, **documentation/cataloging**, **conservation/restoration**, **enhancement/communication/accessibility** chain, using traditional and innovative tools, such as the holistic/contextual/diachronic/transdisciplinary vision of the *global archeology of landscapes*, in this case coastal and underwater or, better, “water scapes”.

In this framework, the contribution of different techniques and innovative technologies was crucial; **methodologies and tools shared and used in the various pilot projects** were **Areal mapping** (topographic survey; UAV/drone ortophoto and photogrammetry), **Underwater survey** (direct/auto-optic; metal detector; Multibeam; Side Scan Sonar; Sub bottom profiler; ROV; underwater photogrammetry; video-photo documentation), **Excavations** (stratigraphic excavation and documentation; finds recovery; sampling, flotation and sieving; archeometric analyses; archaeozoological and palaeobotanical analyses; washing, consolidation and restoration of recovered materials, etc.), **GIS implementation** (UnderwaterMuse portal; interoperability with CartApulia-Puglia regional cultural heritage GIS; SIGECweb/VIR-National MiC digital archives; SiRPaC FVG - Geographic Information System of the Cultural Heritage of Friuli Venezia Giulia; etc.), **Data/metadata implementation and elaboration** (cataloging; archaeological materials study; spatial and regressive analysis; periodization and interpretation of sites and historical events).

New digital technologies must be considered, not only as an instrument for obtaining 3D models, but as a research method for survey, documentation, research and dissemination. Digital and virtual data represent a powerful source of information for analyzing and studying archaeological sites, especially when the site itself is hardly accessible.

The **photogrammetric technique** played an important role: the sites have been documented with digital photogrammetry with a professional reflex Nikon, a compact camera Olympus Tough TG-6, a Nikon Coolpix W300 and an action camera GoPro, following both different acquisition schemes (nadir and oblique) useful for obtaining complete 3D and 2D documentation. The cameras could shoot images and video 4K and the employment of the different cameras and record types are linked to the underwater archaeological and environmental contexts. In some cases, especially in the Venice Lagoon, this operation was a real challenge because of the very low visibility (from 0.50 to 150 cm) and of the strong tidal current which made any operation very complex (Costa 2022). The image or video acquisition phase followed the rules of the multi-image digital photogrammetric survey which is considered the most advantageous documentation technique to obtain a detailed and accurate 3D model (Drap et al., 2007; McCarthy and Benjamin, 2014). Different photogrammetric strips were realized: nadiral images orthogonal to the site, in the same way as in aerial photogrammetry, and radial and oblique images at 45° to cover the vertical portion of the site, taking care to obtain complete coverage of the archaeological items with an overlapping of the images at around 60% between photos and 20% between the strips. All the images were aligned with Agisoft Photoscan/Metashape software, realizing a singlewide photogrammetric block. The system can offer precise measurement, but its accuracy is always related to the camera calibration and the topographic survey.

Multi-image photogrammetry must be supported by a topographic survey to acquire 3D coordinates of ground control points (GCP); in order to roto-translate and geo-reference the model in a reference system, and to attain accuracy suitable for the application, W/B targets were placed on the structures and were surveyed using a trilateration computed as a 3D topographic network, following the DSM (Direct Survey Method) technique (Rule 1989) or, thanks to the low depth and the nearness to the coast, with a total station or DGPS to achieve further control and accuracy (Beltrame, Costa 2017, Balletti et al. 2015, Costa 2022).

In Torre S. Sabina, for example, according to the position of the beached wreck (depth of about 3 m) before the image acquisition, some W/B targets were placed on the seabed and measured using via a topographic approach using a 4 m long pole and a prism, measured via total station side shot acquisitions from the shore. One scuba diver handled the prism to make it vertical before the total station measurements, with the help of an adjustable structure created *ad hoc*.

Given the importance of the legacy data of the Torre Santa Sabina shipwreck, it was interesting to compare the data obtained and the processing techniques followed in the 2020/21 acquisition campaign with a previous survey campaign carried out in 2007. After a pre-processing phase of the images acquired with a Nikon D50 with underwater housing, which showed severe chromatic aberration, we moved on to the generation of a 3D model through a free-net adjustment, using the metric rulers of the archaeological grid that was been set for a manual direct survey. Subsequently, it was necessary to manually link the two ortho-images on the same reference system, using a small overlapping part. This made it possible to produce a complete orthomosaic and a DEM to facilitate an understanding of the shape and extent of the wreck in that excavation phase (see Calantropio et al. 2021 with bibliography).

Concerning the **photogrammetric survey performed using UAS**, it was possible to document the sites and their immediate surroundings thanks to the generation of metric products (orthophotos, digital surface models, and 3D models) obtained via photogrammetric techniques based on SfM (Structure From Motion) algorithms. This was done for the various sites investigated along the Adriatic and Ionian coasts of Salento, allowing for a general overview and subsequent study of specific structures and deposits (see, for example, the beached Roman wreck of Torre Santa Sabina, the late Republican submerged pier in S. Giovanni locality - Le Cesine Nature Reserve, the Roman Imperial necropolis in Torre Chianca in MPA Porto Cesareo).

The use of digital photogrammetry techniques applied to the archaeological survey of underwater sites can consistently speed up the survey operations without neglecting the gathered data's quality and reliability. The implementation of these procedures also provides better conditions for the operators, due to the reduction of the overall diving time. Critical aspects of applying this methodology are mainly related to the preliminary assessment of the camera calibration.

Other strategic tool tested in the pilot action of the project was the **Dry diving methodology** related to VR/AR applications.

The gained experience shows that the actual **multi-image digital photogrammetry** is an excellent solution to obtain a three-dimensional model of the underwater archaeological sites. In addition to the importance of a virtual artefact for scientific investigation, this kind of representation of an archaeological site has been used to create a virtual reality promoting knowledge of underwater cultural heritage to a wide public. The creation of the 3D model also allows those who cannot or do not want to dive to use an application that perfectly simulates a virtual dive on the site (Costa, Manfio 2020).

To recreate the **virtual reality of the archaeological sites**, Unreal 4 Engine software has been used, a cross-platform developed by Epic Games. The first step of the process concern uploading the 3D

elaboration of the archaeological site and of the bottom created on the bathymetry to give to the site the correct environment.

The second step concern the creation of the virtual scene of the underwater environment: animated elements, such as fishes, and static items, such as flora and autochthonous seagrass and seaweed plants have been elaborated and texturized through 3D CAD software, uploaded in UE4 and scattered with the Foliage technique.

During the final step, in order to make the virtual underwater scenario more visually realistic, some graphical effects could be applied, such as refraction, fog, caustics; furthermore, the depth, the visibility of the water and the speed and movement of the diver have to be recreated following the real condition of the diving to maintain the nearness to the reality (Costa, Manfio 2020).

In addition, some pop-up and info point have to be created to highlight peculiar characteristics of the archaeological site and to make more interesting and educational the virtual immersion on the wreck: during the “dive”, the people could find some written instruction to follow, both for the navigation and for the opening of the info point.

This kind of interface can be upload on a web site to allow the fruition by the public and can be used with **3d visors** (Oculus Quest 2, for example), to create **multimedia designed stations** in museum, as in Caorle Museum. The ability to create immersive experiences to be implemented in museum's environments allows to share knowledge about sites and the past, as it happened also in Kaštela and Castromediano Museum.