



#MAP THE GULF

THE GULF OF OROSEI

REPORT

2022

Introduction

Only few maps or complete surveys of the caves in the Gulf of Orosei exist and are published. We want to perform a complete, accurate survey of the main systems using modern technologies and make all our work public for the benefit of the local & international community.

Our goal is to preserve the biodiversity by exploring, mapping, and digitising (3D-Model) the habitat to make it publicly “visible”. We involve outdoor enthusiasts such as cave divers and cave climbers to map the ecosystem. Our objectives are to increase knowledge about the species and the habitat of the caves and to implement measures for preservation from pollution and excessive urbanization. Professionally prepared information for the public will be displayed at events, in a video documentary and in museums (VR-journeys).

To quote Richar Louv:

“We cannot protect something that we do not love, we cannot love what we do not know”.

By creating public awareness, we preserve and transform the karst caves of Orosei into a natural reserve and make them a pioneer for further caves.

The Environment

The Gulf of Orosei

The Gulf of Orosei coastline hosts hundreds of caverns and caves (dry and flooded), with some of the longest anchialine underwater cave systems of Europe.

These springs are fresh water rivers with intrusion of saltwater from the sea. Multiple decorations and speleothemes testify to the varying water levels during different ice ages and prove such environments were once dry; multiple branching passages, sumps and long shallow galleries make these caves one of the premiere cave diving destinations in Europe and a maze still to be discovered and explored.

As the biggest anchialine cave systems of the Mediterranean, they are underground freshwater rivers running from the mountains to the sea, where they create a unique habitat for >3,000 species. The caves represent a vital source of local groundwater (10.000 residents and 30.000 tourists). Carbonates such as Karst are the largest carbon reservoirs on earth. Every year >75,000 people visit the region: tourists sail to the caves, disturb wildlife, and pollute the caves. There is a lack of measures and regulations that protect the area from anthropologic influences.



The Mediterranean coastline presents a high number of marine caves of different types, with a vast array of peculiar characteristics, dimensions and geomorphology, from Mediollittoral caves and overhangs to anchialine caves.

The Gulf and Supramonte limestone plateau. Vertical white cliffs and a maze of underground passages.

The Environment

The Gulf of Orosei

Marine caves are protected by the EU Habitats Directive (92/43/EEC) under the name “Submerged or partially submerged sea caves” (Habitat code 8330).

Semi-dark and dark cave communities have been included in two Action Plans by United Nations Environment Programme MAP-RAC/SPA (2008 and 2015 respectively) and are considered as sensitive reservoirs of biodiversity requiring protection. However, the scientific community still has scarce information about these important habitats. Also on the European Red List of Habitats publication, marine caves and underground water habitats are listed as Data Deficient.

The main reason for the lack of knowledge about marine caves is that they are very difficult to access and study.

On top of the skills and gear required to scuba dive in the sea, entering these caves poses divers into a much more challenging environment. Lack of a breathable source, lack of light and a physical ceiling are the hazards characterising any underwater cave; specific locations can force cave divers to deal with limited visibility, restricted passages or high water flow. The result is that the number of individuals with the skills required to safely navigate such caves while carrying out research or scientific work is extremely limited.

Main Springs:

- Grotta del Bue Marino
- Bel Torrente
- Risorgenza di Cala Luna
- Utopia and Euforia
- Grotta del Fico



Mission Objectives



Survey and Map

Cave surveying and cartography, i.e. the creation of an accurate, detailed map, is one of the most common technical activities undertaken within a cave and is a fundamental part of speleology or cave diving. Surveys can be used to compare caves to each other by length, depth and volume, may reveal clues on speleogenesis, provide a spatial reference for other areas of scientific study and assist visitors with route-finding.

There are two primary reasons why cave maps are needed: research and management.

Mapping, or cartography, is really the first step in researching a cave. All subsequent data about a cave can be related to survey stations. It is important to know the location of where things are inside of a cave. By utilizing a cave map, we know exactly where a mineral, fauna population, air current, new lead, paleontological remains or prehistoric artifacts are located, and therefore where future research efforts could take place.

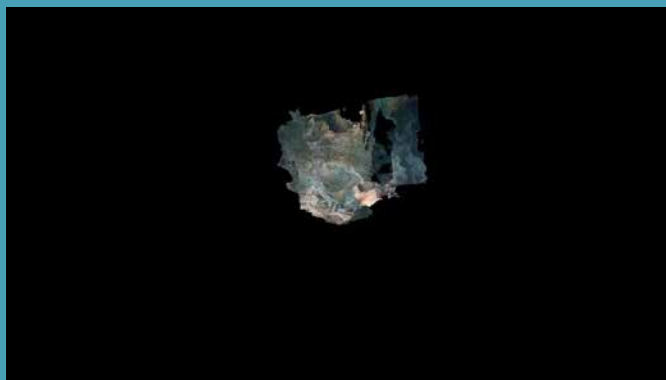
The maps also help us in the management of caves and the whole area. The local municipalities are tasked with managing natural resources so they will remain unimpaired now and for future generations. Mapping the cave systems allows them to see what parts of a cave might be vulnerable to a highway chemical spill, or where trail improvement plans should use additional caution because of the location of historic artifacts. Similarly, knowing where caves lie helps us to manage projects that take place outside of the cave, too. Traditionally, cave surveys are produced in two-dimensional form due to the confines of print, but given the three-dimensional environment inside a cave, modern techniques using computer aided design are increasingly used to allow a more realistic representation of a cave system.

Mission Objectives



Documentation & VR

Documenting the expedition is key to create awareness about this cave systems and its importance for the local community. On top of mapping, our team also has the knowledge and technologies to perform the photogrammetry of the most beautiful passages of the cave in order to build a 3D model that can be played with VR headsets. The VR experience is of great importance to involve a wider public, including the younger generations. According to a Stanford University study (Nov 30, 2018), "Virtual reality could serve as powerful environmental education tool". The concept is to turn climate change from something obscure, abstract, or existing only in text, into something directly accessible that can - virtually at least - be experienced. The hope is that this will greatly increase motivation for people to take action for the conservation and protection of the delicate karst ecosystem. VR is also extremely useful for the geologists to virtually access areas of the cave that they would not be able to see and study otherwise.



For scientific purposes, the model can be geo-referenced and can be scaled and calibrated by a variety of methods to allow measurements and further analysis of the cave environment and surrounding landscape. For publication purposes to the wider public, the model can be exported to graphical design or 'animated' with VR and gaming softwares. Annotating the model and any artifact inside it with information can entertain and educate the visitors in virtual reality.

Mission Objectives



Public Awareness

Caves and karst are invaluable resources. Karst aquifers (source: FAO) are expected to supply over 75% of the drinking water in the Mediterranean area, while in Italy, aqueducts currently supply over 40% of the water that flows from our taps. These environments are home to many of the most diverse, important, and rare ecosystems on the planet, supporting ecological diversity above and below the earth. The world's most significant cultural and archaeological sites are often found in karst and non-karst caves. However, these are highly complex environments that are still poorly understood and difficult to model. Few scientists and researchers are adequately trained to study or manage them properly. Many governments do not recognize caves and karst at all, or fail to understand their importance.

Our expedition focuses on this aspects, with the main purpose of creating awareness amongst the local, national and international community about the existence and value of the karst system hiding inside the Supramonte plateau.

This is even more important when considering that the surrounding area is subject to serious anthropic pollution, connected with the huge amount of tourists visiting the area each summer.

Mission Objectives



Scientific Background

The anchialine caves of the Gulf of Orosei are systems of extreme importance as they represent both the marine caves environment and the terrestrial groundwater one. Unfortunately these caves are exposed to threats coming from both the terrestrial and marine worlds, including: urbanization, agriculture, pollution, coastal and harbor development, water temperature rise.

Despite the fact that the Water Framework Directive (2000/60/ EC) and the Groundwater Directive (2006/118/ EC) mention groundwater habitats as very important for biodiversity and human use, no data is available from most countries on underground watercourses. Also on the European Red List of Habitats publication, marine caves and underground water habitats are listed as Data Deficient. Our project aims at closing this information and knowledge gap in the study area of the Gulf of Orosei, by providing a detailed survey of the caves. We are open to collaborations with researchers wishing to investigate specific topics in subjects like geomorphology, sediment analysis, hydrogeology, climate change, etc.

References:

Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy;

Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration;

Ramsar Convention on Wetlands. (2018). Global Wetland Outlook: State of the World's Wetlands and their Services to People. Gland, Switzerland: Ramsar Convention Secretariat;

European Red List of Habitats (ISBN 978-92-79-61586-3; ISBN 978-92-79-61588-7).

Main Sponsors:

| **Global Underwater Explorers** | **Halcyon Europe** |
| **K01 Diving** | **Scaleo** | **Scubalandia** | **Scurion** | **Suex** |



Activity Report

2022

During summer 2022 we carried out 4 sessions dedicated to re-survey and survey of Grotta del Fico and Risorgenza di Cala Luna. One extra session was focused on Utopia, which was deeper than the forementioned caves and required the use of rebreathers. Due to the fact that the maps of the caves in the Gulf of Orosei are often not complete or not updated, we started a process to regularly collect data and produce maps of the most traveled caves.

Grotta del Fico: multiple teams collected data during various week, collected survey data using MNemo devices, running survey lines and removing old lines from the cave. During this process the team created a protocol to put together the data gathered with multiple tools and different technologies. The most articulated form of survey

encompassed the use of MNemo tools and measurement of distance from stations to side walls with fiberglass tape. Once the basic polygon line was represented, the team started to map walls with inwater work by free hand drawing to scale. Once on land these sketches were detailed with the support of dedicated video footage. This allowed for a very precise cartography and a very detailed drawing, as most refinement could be done after the dives. Processing this data was only possible due to the fact each station of the polygon line had been marked with a unique name and could be identified and referenced in the video. For cross sections the team used a basic technique shooting pictures at each station, with a specific tool that allowed to precisely define the contour of the cave at each station.



Activity Report

2022

The second set of tools used by the team has been the Suex Drive system, which allowed the use of Suex DPVs and Sinapsi; this tool allows divers to move into the cave and scooter through it while capturing information about depth, compass heading and inclination, recording the data every two seconds. In this case the in-water work has proved to be relatively simple, while the post processing part of the work has been more complex. The amount of data, one station every two seconds, and the different type of format required a conversion macro and some refinement work to allow the elected survey software to manage all the information correctly. Initially the

team used Ariane's Line to come up with a very basic survey and evaluate correctness of the gathered data, but for the final output and map the software used is cSurvey.

The choice of survey software has been dictated by the decision of representing the cave both in plan and profile view. This could seem a trivial point, but on the contrary, as most European caves have a sub vertical profile and very often present shafts and chimneys, the profile view is mandatory to properly allow understanding the behaviour and development of the underground passages.

The last method used has been photogrammetry, not simply creating a small but very detailed model of



Activity Report

2022

the cave, but specifically working on a reusable protocol that could lead to replicable projects. This did not encompass only a specific way of collecting photos but also connecting the model with the surveying order to verify precision of the 3D representation in comparison to the polygon line.

Cala Luna: in this site the efforts focused on two main aspects:

- Completing the profile view and cartography of the section mapped by the original explorers
- Continuing the exploration after the no mount restriction leading to sump2 and sump3

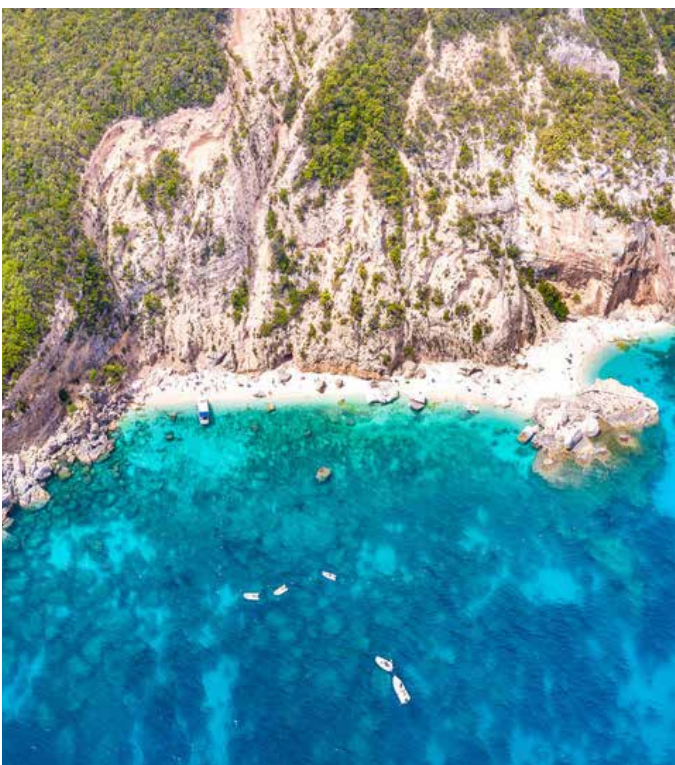
The first task was carried out using multiple techniques, filming each

survey station and cross section was extremely useful and allowed for much faster collection of the data.

The exploration after the restriction focused on S4, reachable after about 650 meters of dry cave. This section is not technically very challenging but requires ropes to lower the gear next to S4 due to a quite exposed clay slope.

Unfortunately S4 did not prove to be an ongoing passage but, during the operations, small critters were identified, leading to the hope of finding a chimney nearby that could connect to the surface.

Further exploration of S3 requires sidemount rebreathers and a longer bivouac in the cave, both planned for 2023.



Project Data

1

TEAM

The project involved an international team of divers (coming from Italy, Germany, Switzerland, Austria, United Kingdom, Switzerland, France and The Netherlands).

2

TIME

- Four mapping sessions were carried out between April and September 2022.
- In total the team carried out 120 man dives for a total of 196hrs spent underwater in the cave.
- Due to the variety of the caves surveyed, the varying skill levels of volunteers and specific goals of the dives, the team used both open circuit and rebreathers. Cala Luna exploration and survey did not require base camp inside but 15+ hours each exploration.

3

MAPS

- Complete survey of the first sump of Grotta del Fico
- Re-survey of Cala Luna to obtain the profile view.
- Both maps are being produced digitally and will be published through official cave database.

4

3D MODEL

- Short 3D model of Grotta del Fico
- Protocol to achieve detailed results and matching polygon survey



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