POLITECNICO DI TORINO
Repository ISTITUZIONALE

A Review of Existing Sources for the Design of an Archaeological Underwater Cultural Heritage Database of Puglia Region (Italy)

Original
A Review of Existing Sources for the Design of an Archaeological Underwater Cultural Heritage Database of Puglia Region (Italy) / Spreafico, A., Colucci, E., Chiabrando, F., Auriemma, R.. - In: INTERNATIONAL ARCHIVES OF THE PHOTOGRAMMETRY, REMOTE SENSING AND SPATIAL INFORMATION SCIENCES. - ISSN 2194-9034. - XLVIII-4-2024:(2024), pp. 445-452. [10.5194/isprs-archives-xlviii-4-2024-445-2024]

Availability:
This version is available at: 11583/2994603 since: 2024-11-20T11:03:29Z

Publisher:
ISPRS

Published
DOI:10.5194/isprs-archives-xlviii-4-2024-445-2024

Terms of use:

This article is made available under terms and conditions as specified in the corresponding bibliographic description in the repository

Publisher copyright

(Article begins on next page)

19 November 2026

A Review of Existing Sources for the Design of an Archaeological Underwater Cultural Heritage Database of Puglia Region (Italy)

Alessandra Spreafico[1], Elisabetta Colucci[1], Filiberto Chiabrando[1], Rita Auriemma[2]

[1] Laboratory of Geomatics for Cultural Heritage (LabG4CH), Department of Achitecture and Design (DAD), Polytechnic University of Turin, Viale Pier Andrea Mattioli, 39, Torino (TO), Italy – (alessandra.spreafico, filiberto.chiabrando, elisabetta.colucci)@polito.it

[2] Department of Cultural Heritage, University of Salento, Via Dalmazio Birago, 64 - LECCE (LE), Italy - rita.auriemma@unisalento.it

Keywords: WebGIS, Geodatabase, Underwater Cultural Heritage, Tourism, GIS, Data Model.

Abstract

Underwater cultural heritage (UCH) in Italy is under-documented despite its significance. Creating a comprehensive UCH database is essential but faces challenges, such as complex documentation processes, data interoperability, and international standard adherence. This paper examines data models, standards, and the use of webGIS and databases for underwater cultural heritage documentation in Italy and globally. International documents like the 1996 ICOMOS Charter and the 2001 UNESCO Convention emphasize in-situ preservation. However, documentation efforts remain scattered, lacking a unified database. GIS technologies are vital for managing and analyzing UCH data but are underutilized for public access and tourism. Projects like *Andar per Mare* and *Archim3des* in the Puglia region aim to promote underwater cultural heritage using webGIS platforms. However, existing sources like *CartaPulia* face limitations, including a lack of standardization, specialized fields for underwater cultural heritage characteristics, and language barriers. The proposed solution involves creating a new data model based on standards, resulting in a bilingual geodatabase. This geodatabase will support scientific and tourism-focused webGIS applications, enhancing accessibility and promoting Italy's underwater cultural heritage. A unified database will prevent duplication, facilitate discoveries, and promote Italy's cultural heritage.

1. Introduction

With its rich Cultural Heritage (CH), Italy boasts a trove of submerged historical treasures. Yet, despite the abundance of underwater cultural heritage (UCH), attention towards cataloguing and documenting it remains scarce (Calantropio & Chiabrando, 2023). This oversight contrasts sharply with the complexity and significance of these submerged archaeological sites, relics, and isolated findings. Creating a comprehensive UCH database is imperative to preserve and promote these invaluable assets. However, challenges abound, from the intricacies of documentation to ensuring data interoperability and adherence to international standards. The UCH documentation presents significant challenges due to the intrinsic difficulties of data acquisition in submerged environments. This has led to develop innovative digital technologies for data acquisition, for UCH localization and storage (Nocerino et al., 2023). In particular, structuring DB and publishing WebGIS facilitates conservation efforts. Archaeologists have traditionally used these methods, but other users have also adopted them for tourism promotion. Structured data collection and sharing are crucial, requiring standardized methodologies to ensure accuracy and accessibility, as discussed in the following paragraphs. A notable example highlighting the importance of various technologies to manage UCH is the research by Tommy Gambin (Agius & Gambin, 2014), which emphasizes their role in preserving and promoting submerged resources. These efforts demonstrate the potential to make UCH into a significant tourist attraction, provided data acquisition and documentation complexities are meticulously addressed. This paper delves into the state of the art regarding data models, standards, and thesauri for UCH documentation. It also explores the utilization of webGIS and databases for UCH documentation. Finally, it examines the available sources for developing a single webGIS for UCH of Puglia Region, highlighting their limitations and potential.

2. State of the Art

2.1 Underwater Heritage Documentation

UCH is the subject of international documents defining its value and protection, particularly pointing at in-situ preservation, such as the 1996 ICOMOS Charter on the Protection and Management of Underwater Cultural Heritage and the 2001 UNESCO Convention on the Protection of Underwater Cultural Heritage. Over the years, several national and international initiatives related to UCH protection have emerged (Calantropio & Chiabrando, 2023). Nevertheless, their documentation is not generally adopted by developing a single database, leaving space for many scattered national initiatives. Some examples of national databases are the Australian National Shipwrecks Database Heritage (AUCHD)[1] and the Shipwreck Asia database[2]. Other projects are related to a specific type of UCH, like the Bermuda 100 Challenge[3], which aims to document 100 or more historic shipwrecks in Bermuda to enhance protection and in-site and virtual tourism.

2.2 GIS and WebGIS for Heritage Valorization

GIS (Geographic Information Systems), webGIS, and geodatabases (geoDB) are crucial in managing CH data (Spreafico & Chiabrando, 2024). These technologies allow for the spatial representation of archaeological sites and their query and filtering, enabling researchers to analyze their distribution patterns and better understand their historical significance. Attracting tourists, UCH is the subject of specific websites promoting itineraries to visit it. Some websites are EU-funded

[1] https://researchdata.edu.au/national-shipwreck-database/689517#:~:text=Brief%20description-,The%20Australian%20National%20Shipwrecks%20Database%20includes%20all%20known%20shipwrecks%20in,Commonwealth%20or%20State%2FTerritory%20legislation. (Retrieved 19th May 2024).

[2] https://www.shipwreckasia.org/ (Retrieved 19th May 2024).

[3] https://chei.ucsd.edu/bermuda-challenge/ (Retrieved 19th May 2024).

projects – like Dive in History[4] - but are not accompanied by webGIS applications to locate these itineraries and UCH, missing to help people in spatialize data. Some webGIS for UCH are mainly conceived for archaeologists, such as the Eamena database and SeArch (Decock et al., 2016; Vandenbulcke et al., 2016). A few international initiatives exist, such as the Wreck Site[5] - the world largest online database for shipwrecks - and Managing Cultural Heritage Underwater (MACHU) GIS[6], a project sponsored by the European Union's Culture 2000 programme. This project collects different data connected to UCH and related to site research, environment, legislative information, and historic maps, sharing them through an online platform supported by GIS capabilities. Still, access is limited because of the presence of sensitive data. Many of these databases do not provide spatialization of the UCH and use the national language; hence, the issue of sharing data in a common language arises (Brouwers, 2015). Only the SITI platform for the Archaeological Chart of the Friuli Venezia Giulia region in Italy includes UCH (Cossa, 2012). Despite all the efforts, a single database for UCH with spatial information and using common standards and terminology does not exist.

2.3 Standards and Data Model

As mentioned before, the documentation of UCH presents unique challenges due to its submerged nature and the dynamic environment in which it resides. Various data models, standards, and thesauri have been developed to address these challenges and facilitate the systematic recording and management of UCH.
In the Italian panorama, efforts to catalogue underwater heritage have been fragmented, with limited standardization across regions. While initiatives like the *CartaPulia* (explained in paragraph 3.2.1) have made strides in mapping underwater archaeological sites, the lack of a unified approach hampers comprehensive documentation efforts.

Internationally, organizations like UNESCO have advocated for developing and adopting standardized frameworks for underwater heritage documentation. The use of data models enables interoperability and enhances the accessibility and reusability of data. In discussing the documentation of CH, primary standards can be highlighted: the CIDOC Conceptual Reference Model (CIDOC-CRM) and the Getty Art and Architecture Thesaurus (AAT). The CIDOC-CRM, developed by the International Committee for Documentation (CIDOC) of the International Council of Monuments and Sites (ICOM), serves as the core ontology for managing CH information. Recognized as the ISO 21127 standard, it facilitates the exchange and integration of information across diverse data sources. Initially, the CIDOC-CRM[7] was designed to represent the knowledge associated with museum objects. Both CIDOC-CRM and Getty AAT are instrumental in the digitization and documentation efforts within the CH sector, offering robust tools for preserving and sharing our collective heritage in an accessible and systematic manner. Moreover, the ISO 21127:2014 (Information and Documentation) is the reference Ontology for the Interchange of Cultural Heritage Information.

The standards for cataloguing CH in Italy are developed by the ICCD (Istituto Centrale per il Catalogo e la Documentazione) and include descriptive models (*Schede*), terminological tools, and methodologies. These standards ensure uniformity and consistency in cataloguing CH across Italy - in line with the Italian cultural heritage and landscape law (*Codice dei Beni culturali DLgs 42/2004*) -, facilitating information sharing, interoperability, and preservation efforts. Over the years, 30 descriptive models are tailored to cover different CH assets, such as architecture (*Scheda A*), anthropological findings (*Scheda AT*), drawings (*Scheda D*), photography (*Scheda F*), works of arts (*Scheda OA*), and archaeological sites (*Scheda SI*).

Standardizing spatial data models is also crucial. In the field of geo-information, the primary widely used standards are CityGML[8] for urban areas, an international standard by the Open Geospatial Consortium for representing multiscale 3D information about city objects, and the INSPIRE[9] data model, mandated in Europe by 2020, which aims for interoperable cartography across the continent.

But why are all these standards and ontologies so helpful? Because they ensure that everyone speaks the same language and that data is structured uniformly for sharing. Adopting these standards is essential for solving the issues of format conversion and semantic, technical, and geometric interoperability. Hence, this research aims to develop a unified database from diverse sources to address interoperability and semantics problems and to share a common structure.

3. Methodology: Underwater Cultural Heritage Database of Puglia Region

3.1 *Andar per Mare* and Archim3des projects

Andar per Mare is a project launched in 2023 by the University of Salento and Puglia Region to promote UCH of Puglia for tourism, letting people explore less-known sites. A dedicated website will guide visitors through the available UCH and combine them with recreation, culture, and accommodation services, thanks to a webGIS. Besides this project, *Archim3des* - a project funded by the Italian government - will develop a webGIS platform for archaeologists and integrate it with data coming from advanced 3D metric surveys. This platform will serve for documenting a selection of UCH of the Puglia region. Since both projects refer to the same UCH sites, they will pull out data from the same database.

3.2 Existing sources

3.2.1 CartaPulia

A few sources containing data about UCH of the Puglia region already exist but have some limitations. The *CartaPulia*[10], launched by the Puglia Region (Italy), represents a significant effort to document UCH along the archaeological sites of Puglia. The *CartaPulia* is based on a PostgreSQL database and uses Goeserver to share data on its online platform (Figure 1).

[4] https://www.diveinhistory.com/root.en.aspx (Retrieved 19th May 2024).
[5] https://www.wrecksite.eu/ (Retrieved 25th May 2024).
[6] https://english.cultureelerfgoed.nl/topics/maritime-heritage/machu (Retrieved 19th May 2024).
[7] http://www.cidoc-crm.org/ (Retrieved 25th May 2024)
[8] https://www.ogc.org/standard/citygml/ (Retrieved 25th May 2024)
[9] https://knowledge-base.inspire.ec.europa.eu/tools/inspire-data-models_en (Retrieved 25th May 2024)
[10] http://cartapulia.it/ (Retrieved 19th May 2024)

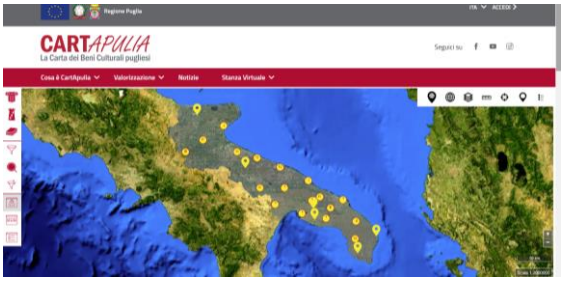


Figure 1. The Cartapulia website.

Utilizing GIS technology, the *CartaPulia* provides a spatially referenced inventory of submerged CH sites, including shipwrecks, ancient ports, and isolated findings. However, the *CartaPulia* faces several limitations that hinder its effectiveness as a comprehensive UCH database. Firstly, the database has a complex relational model that relates the cultural site with many other entities (geographical location, owner, dating, and historical news) and its data export generates multiple tables for each CH as many as related table the CH has. The *CartaPulia* is available only in Italian and lacks standardized data models and metadata schemas. These aspects make integrating with other databases and sharing data across platforms challenging. Secondly, the data structure is conceived for archaeological sites in general and does not allow inserting fields that specify the UCH characteristics, such as depth, route, or shipload. Finally, in the *CartaPulia* there is no specific filter to visualize only the UCH amongst the numerous archaeological sites.

3.2.2 Underwater Archaeology Chart

Over the years, the University of Salento has developed the Underwater Archaeology Chart of the Puglia region (Cossa et al., 2010; 2012) as result of the merging of information extracted from texts - such as the *Forma Maris Antiqui* (Auriemma, 2004) - and data coming from thirty years of underwater archaeological excavations. This database is developed with File Maker Pro, a low-code database application. Even if it is detailed in documenting the relics, this chart is based on a database without spatial information, no cataloguing standards have been followed, no technical specification is provided to understand the fields names and content, and no consistency is guarantee over the data, making difficult the data machine query. An attempt to spatialize these data was made several years ago and then abandoned (Figure 2) because the webGIS was connected to individual shapefiles and they should be substituted to update the data. Hence, the present research focuses on harmonizing all the existing data, following international and national standards, to develop an Archaeological Underwater Cultural Heritage database of the Puglia Region.

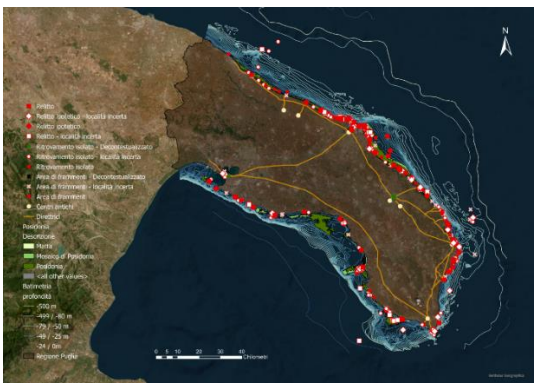


Figure 2. The first map of the Underwater Archaeology Chart.

3.3 Data Harmonization

Part of the data stored in the Underwater Archaeology Chart were loaded in the *CartaPulia* database, then editing was applied to the Underwater Archaeology Chart generating a misalignment of the data. Besides, some archaeological sites are catalogued in *CartaPulia* and not in the Underwater Archaeology Chart. This data exchange generated more confusion about which data is more reliable and up-to-date than others today. The present research considers the Underwater Archaeology Chart the most reliable for the non-geometrical data content and uses the localization provided by the *CartaPulia* to overcome lack of geo-localization in the Underwater Archaeology Chart. The joining in GIS software between the textual data of each UCH and its localization was passible thanks to a common field, the identification code. The data will be inserted into a new geodatabase created with ArcGIS Pro 3.3 in PostgreSQL 15.4, then the data content will be checked to guarantee data consistency. Instead of working on shapefiles uploaded on a GIS server and periodically updated - as done for the first map of the Underwater Archaeology Chart (Figure 2) -, the usage of a single geodatabase stored on an external server will permit data loading and editing in the original source, avoiding periodical manual or semi-automatic procedures to update the data contents. Besides, the geodatabase on an external server permits access to different editors through an internet connection. Editors will have direct access to the geodatabase, and their edits will be immediately visible to everyone. Documentation for all the entities of the geodatabase will be provided, including mapping schemas onto other standards, particularly the ICCD Archaeological Sites card (*Scheda SI*), as explained in the following section.

4. Results

4.1 The Data Model

A new data model has been created, tailored to UCH but based on a national standard, compliant with international standards, and with shared terminology, starting from the available sources. A well-designed database, crucial for constructing a GIS, must include application-independent schemas and explicitly provide all necessary information for future implementations or data interpretation. Databases offer various data retrieval and presentation tools, which geodatabases enhance by incorporating spatial aspects. The core information managed in a geographic database is the location of objects within a specific geographic space. Structuring complex databases requires expertise, while simpler territorial information systems can be developed with essential knowledge, including defining a conceptual data model. The ANSI/X3/SPARC standard (1975) outlines the modeling phases: the external model describes the application domain, the conceptual model formalizes entities and relationships, the logical model adapts the conceptual model for system implementation, and the internal model details the software and hardware implementation. The Entity-Relationship model, commonly used for the conceptual model, identifies objects, their properties, and relationships, and graphically represents entities and their attributes, associations, and cardinalities.

Figure 3 shows the E-R models developed from the present geospatial DB. The full conceptual model of the geodatabase is composed of six entities.

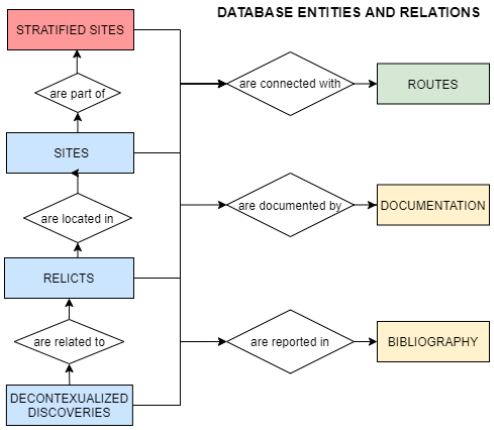


Figure 3. E-R model for the UCH D.

Besides, additional entities will enrich the web application but will not be inserted in the geodatabase because they extend the UCH knowledge but are not UCH themselves (Figure 4).

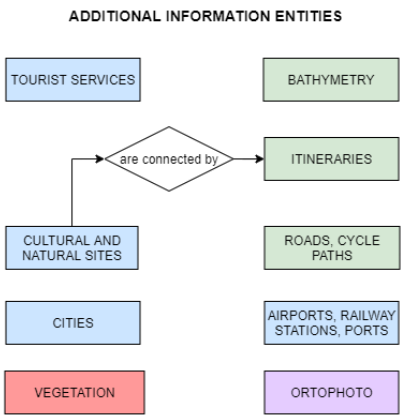


Figure 4. E-R model for the UCH DB: the core of the geodatabse, and (right) additional entities enriching the geodatabase. Colors identify the type of data: in red polygons, in blue points, in yellow alphanumeric or external data, in green lines, in purple the raster.

4.2 The DB proposal

This geodatabase will serve as a data source for developing different webGIS applications, one for the *Archim3des* project and several for the *Andar per Mare* project. The *Archim3des* project is conceived for scientific purposes with detailed information, while the *Andar per Mare* project aspires to reach a non-expert audience for tourism purposes. The database will be bilingual (Italian and English) to allow data exchange with the international community and understanding from Italian citizens, the main users of the webGIS for tourism purposes. *Andar per Mare* project will use only some entities of the geodatabase (Sites) and additional entities (Places of Cultures and Nature, and Itineraries), while the *Archim3des* project will display all the entities contained in the conceptual model. Currently, the internal model was developed for the *Andar per Mare* project, while for the *Archim3des* project the internal model is still under development. Fields specifications for Sites (Table 6) and Places of Culture and Nature (Table 7) entities for the *Andar per Mare* project are reported below.

The specification reports the Italian name and English translation, the description of each field in Italian and English, the data type (text, list, long integer, double), and the mapping to the ICCD field (*Schede SI*). Only some fields have a correspondent field in English because some of them do not need a translation, like Coordinate X, Webpage, and Municipality. Giving the different level of audience, the internal model of the database contains more general fields for touristic purposes (like Itinerary and Accessibility), while technical fields will be added for the *Archim3des* project (like Depth where the site/relic/de-contextualized discovery is located).

The lists are functional to make the database consistent avoiding mistakes in writing repetitive term. Lists of terms are provided for the fields: Provinces (Table 1), Itineraries (Table 2), Accessibility (Table 3), Location (Table 4), Definition (Table 5).

Italian term	**English term**
Provincia di Bari	Province of Bari
Provincia di Barletta-Andria-Trani	Province of Barletta-Andria-Trani
Provincia di Brindisi	Province of Brindisi
Provincia di Foggia	Province of Foggia
Provincia di Lecce	Province of Lecce
Provincia di Taranto	Province of Taranto

Table 1. List of terms for Provinces

Italian term	**English term**
Paesaggi che cambiano: insediamenti, porti, approdi dal II millennio all’età moderna	Changing Landscapes: Settlements, Ports, and Landings from the 2nd Millennium to the Modern Age
Torri e fari	Towers and lighthouses
Relitti e carichi: i miliari delle vie del mare	Relics and Cargo: The Milestones of Sea Routes
Il mare e il sacro: il cammino dei santuari costieri di Puglia	The sea and the Sacred: The Path of Coastal Sanctuaries in Puglia
L’alta profondità: rendere visibile il patrimonio invisibile	The Great Depths: Making the Invisible Heritage Visible
La cultura del mare e il patrimonio immateriale: saperi, tradizioni, connessioni e mobilità	Sea Culture and Intangible Heritage: Knowledge, Traditions, Connections, and Mobility

Table 2. List of terms for Itineraries

Italian term	**English term**
Si	Yes
No	No

Table 3. List of terms for accessibility

Italian term	**English term**
Bene subacqueo	Underwater heritage
Bene costiero	Coastal heritage
Bene misto	Mixed heritage

Table 4. List of terms for location

Italian term	**English term**
Museo	Museum
Bene monumentale / culturale	Monumental/cultural heritage
Bene / Parco naturalistico	Naturalistic heritage/park
Area marina protetta	Marine protected area
Info point	Info point

Table 5. List of terms for Definition.

4.3 The web applications

The *Andar per Mare* and *Archim3des* projects will rely on this geodatabase for displaying the contents in dedicated webGIS applications, but will display different fields and entities, according to the different needs. The *Andar per Mare* project will exploit several webGIS applications, one more general for displaying the UCH of Puglia region and one for each UCH to display the single UCH with its related Places of culture and nature. The webGIS for UCH of Puglia (Figure 7) displays the UCH locations through points on the map, and in the section below an image gallery shows the descriptive information for each UCH (Denomination, Municipality, Image) with a button to access the webpage of each single UCH.

The map and the gallery are connected: when the user click on an image in the gallery, the map zooms and pans on the selected UCH, and vice versa when an icon on the map is selected, the image is highlighted in the image gallery. A textual filter (Figure 6) allows zooming on different provinces on the map, to navigate according to geographical areas. This map will be embedded into the homepage of a website for promoting the UCH of Puglia. The second type of webGIS represent the single UCH, enabling the user to discover the spatial relation between the UCH and the surrounding area. In Figure 7 the UCH of Egnazia is reported as sample. This webGIS will be embedded in the *Andar per Mare* website where the UCH is described, combining the web application with an in-depth textual description of the UCH, its itineraries, and other tourist information.

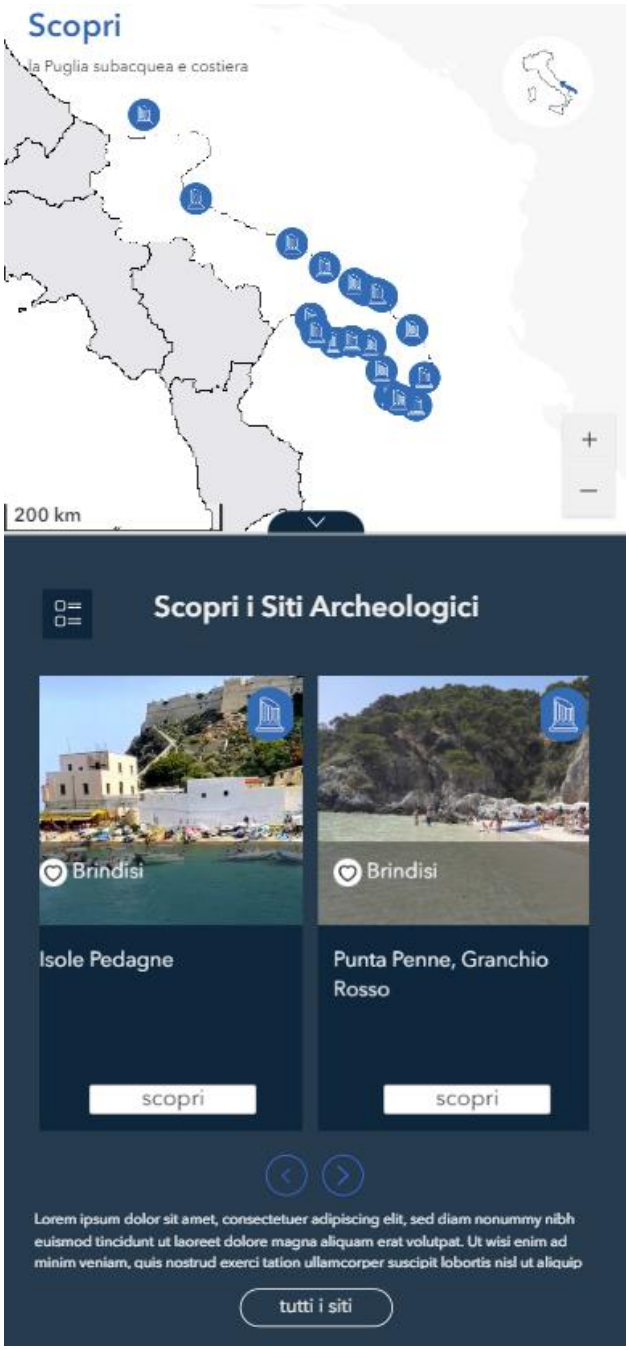


Figure 5. The webGIS for UCH of Puglia Region for *Andar per Mare* project.

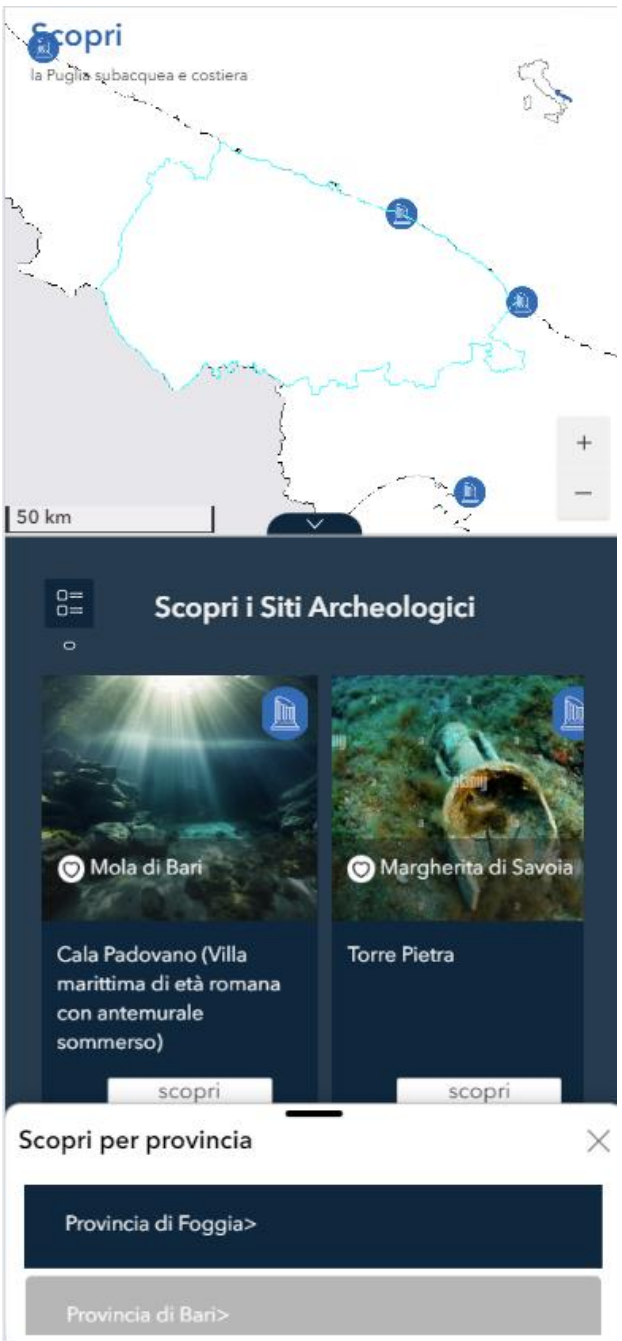


Figure 6. Filter for navigating through provinces.

a. Field Name		b. Description		c. field Typology	d. Mapping on ICCD
Italian	**English**	**Italian**	**English**		
Objectid	Objectid	Codice progressivo inserito dal software	Progressive number inserted by the software	Long integer	-
Denominazione	Denomination	Nome specifico del singolo sito in italiano	Specific name of the single site in Italian	Text	Denominazione e numero sito (OGTN)
Denomination	-	Traduzione inglese del campo Denominazione	English translation of the Denominazione field	Text	-
Comune	Municipality	Nome del comune dove si trova il sito	Nome of the municipality where the site is located	Text	Comune (PVCC)
Provincia	Province	Provincia in cui risiede il sito in italiano. Termine scelto da una lista di termini	Province in Italian where the site is located. To be selected from a list of terms	List	Provincia (PVCP)
Province	-	Traduzione inglese del campo Provincia	English translation of the Provincia field	List	-
Coordinata x	X Coordinate	Coordinata X del sito in metri con massimo 5 decimali, sistema di riferimento WGS84UTM33N (EPSG:32633). Questo campo sarà usato assieme al campo y per generare la geometria, non sarà visibile al pubblico	X coordinate of the site in meters with a maximum of 5 decimal digits, WGS84UTM33N (EPSG:32633) reference system. This field and the Y coordinate field will be used to generate the geometry. This field will be not visible to the public in the web application	Double	Coordinata X (GPDPX)
Coordinata y	Y Coordinate	Coordinata Y del sito in metri con massimo 5 decimali, sistema di riferimento WGS84UTM33N (EPSG:32633). Questo campo sarà usato assieme al campo x per generare la geometria, non sarà visibile al pubblico	Y coordinate of the site in meters with a maximum of 5 decimal digits, WGS84UTM33N (EPSG:32633) reference system. This field and the X coordinate field will be used to generate the geometry. This field will be not visible to the public in the web application	Double	Coordinata Y (GPDPY)
Accessibilità	Accessibility	Accessibilità del sito da parte di un utente senza disabilità motorie. Campo si/no	Accessibility of the site from a user with no motor disabilities. Yes/no field	List	-
Accessibility	-	Traduzione inglese del campo Accessibilità	English translation of the Accessibilità filed	List	-
Posizione	Location	Si riferisce alla posizione del sito rispetto al livello del mare, il termine è scelto da una lista di termini	It refers to the site location in respect to the sea level, the term is selected from a list of terms	List	Definizione (OGTD)
Location	-	Traduzione inglese del campo Posizione	English translation of the Posizione field	List	-
Itinerario	Itinerary	Nome dell'/degli itinerario/i di appartenenza del sito. Un sito può appartenere a più di un itinerario. Il campo è compilato sulla base della relazione M:N con l’entità Itinerari	Name of the itinerary(ies) to which the site belongs. One site can belong to more than one itinerary. The field is filled in on the basis of the M:N relation with the Itinerary entity	Text	-
Itinerary	-	Traduzione inglese del campo Itinerario	English translation of the Itinerario field	Text	-
Note	Notes	Campo riservato agli editori per inserire appunti, non sarà visibile al pubblico nella applicazione web	Field reserved to editors to insert notes, this will not be visible to the public on the web application	Text	-
Immagine	Image	Percorso completo con il nome del file dove risiede l'immagine rappresentativa del sito. Il pubblico non vedrà il percorso e nome del file, ma l'immagine	Full path with file name where an image representing the site is located. The public will not see the path and name of the file, but the image of the site	Text	-
Pagina web	Webpage	URL della singola pagina web di Andar per Mare dove il sito è descritto	URL of the single Andar per mare webpage where the site is described	Text	-
Icona	Icon	Percorso completo con il nome del file dove risiede l'icona che rappresenta il sito. Il pubblico non vedrà il percorso e nome del file, ma l'immagine dell'icona	Full path with file name where the image representing the site type is located. The public will not see the path and name of the file, but the icon image	Text	-
Data creazione	Creation date	Data di creazione del record, inserito automaticamente dal software	Date of the creation of the record, automatically inserted by the software	Date	Data (CMPD)
Data aggiornamento	Edit date	Data di ultimo aggiornamento del record, inserito automaticamente dal software	Date of the latest update of the record, automatically inserted by the software	Date	Data (AGGD)
Nome creatore	Creator name	Nome dell’utente che ha creato il record, inserito automaticamente dal software	Nome of the user who created the recod, automatically inserted by the software	Text	Nome (CMPN)
Nome editore	Editor name	Nome dell’utente che ha effettuato l’ultima modifica, inserito automaticamente dal software	Nome of the latest user who modified the record, automatically inserted by the software	Text	Nome (AGGN)

Table 6. Internal model for the Sites entity for the *Andar per mare* project.

This contribution has been peer-reviewed.
https://doi.org/10.5194/isprs-archives-XLVIII-4-2024-445-2024 | © Author(s) 2024. CC BY 4.0 License.

a. Field Name		b. Description		c. field Typology	d. Mapping on ICCD
Italian	**English**	**Italian**	**English**		
Objectid	Objectid	Codice progressivo inserito dal software	Progressive number inserted by the software	Long integer	-
Denominazione	Denomination	Nome specifico del singolo luogo della cultura o natura in italiano	Specific name of the single place of culture or nature in Italian	Text	Denominazione e numero sito (OGTN)
Denomination	-	Traduzione inglese del campo Denominazione	English translation of the Denominazione field	Text	
Comune	Municipality	Nome del comune dove si trova il luogo	Nome of the municipality where the site is located	Text	Comune (PVCC)
Provincia	Province	Provincia in cui risiede il sito in italiano. Termine scelto da una lista di termini	Province in Italian where the site is located. To be selected from a list of terms	List	Provincia (PVCP)
Province	?-	Traduzione inglese del campo Provincia	English translation of the Provincia field	List	
Indirizzo	Address	Indirizzo utile per localizzare il luogo, nella forma ‘via (o viale, piazza, ecc.), numero civico’	Address useful to locate the place entrance, in the form of 'via (or viale, piazza, etc.), number'	Text	Indirizzo (PVCI)
Coordinata x	X Coordinate	Coordinata X del sito in metri con massimo 5 decimali, sistema di riferimento WGS84UTM33N (EPSG:32633). Questo campo sarà usato assieme al campo y per generare la geometria, non sarà visibile al pubblico	X coordinate of the site in meters with a maximum of 5 decimal digits, WGS84UTM33N (EPSG:32633) reference system. This field and the Y coordinate field will be used to generate the geometry. This field will be not visible to the public in the web application	Double	Coordinata X (GPDPX)
Coordinata y	Y Coordinate	Coordinata Y del sito in metri con massimo 5 decimali, sistema di riferimento WGS84UTM33N (EPSG:32633). Questo campo sarà usato assieme al campo x per generare la geometria, non sarà visibile al pubblico	Y coordinate of the site in meters with a maximum of 5 decimal digits, WGS84UTM33N (EPSG:32633) reference system. This field and the X coordinate field will be used to generate the geometry. This field will be not visible to the public in the web application	Double	Coordinata Y (GPDPY)
Definizione	Definition	Tipologia del sito in italiano scelta da una lista di termini	Type of site in Italian selected from a list of terms	List	Definizione (OGTD)
Definition	-	Traduzione inglese del campo Definizione	English translation of the Definizione field	List	-
Itinerario	Itinerary	Nome dell'/degli itinerario/i di appartenenza del sito in italiano. Un sito può appartenere a più di un itinerario. Il campo è compilato sulla base della relazione M:N con l’entità Itinerari	Name of the itinerary(ies) to which the site belongs in Italian. One site can belong to more than one itinerary. The field is filled in on the basis of the M:N relation with the Itinerary entity	Text	-
Itinerary	-	Traduzione inglese del campo Itinerario	English translation of the Itinerario field	Text	-
Note	Notes	Campo riservato agli editori per inserire appunti, non sarà visibile al pubblico nella applicazione web	Field reserved to editors to insert notes, this will not be visible to the public on the web application	Text	-
Immagine	Image	Percorso completo con il nome del file dove risiede l'immagine rappresentativa del sito. Il pubblico non vedrà il percorso e nome del file, ma l'immagine	Full path with file name where an image representing the site is located. The public will not see the path and name of the file, but the image of the site	Text	-
Pagina web	Webpage	URL della singola pagina web di Andar per Mare dove il sito è descritto	URL of the single Andar per mare webpage where the site is described	Text	-
Icona	Icon	Percorso completo con il nome del file dove risiede l'icona che rappresenta il sito. Il pubblico non vedrà il percorso e nome del file, ma l'immagine dell'icona	Full path with file name where the image representing the site type is located. The public will not see the path and name of the file, but the icon image	Text	-
Data creazione	Creation date	Data di creazione del record, inserito automaticamente dal software	Date of the creation of the record, automatically inserted by the software	Date	Data (CMPD)
Data aggiornamento	Edit date	Data di ultimo aggiornamento del record, inserito automaticamente dal software	Date of the latest update of the record, automatically inserted by the software	Date	Data (AGGD)
Nome creatore	Creator name	Nome dell’utente che ha creato il record, inserito automaticamente dal software	Nome of the user who created the recod, automatically inserted by the software	Text	Nome (CMPN)
Nome editore	Editor name	Nome dell’utente che ha effettuato l’ultima modifica, inserito automaticamente dal software	Nome of the latest user who modified the record, automatically inserted by the software	Text	Nome (AGGN)

Table 7. Internal model for the Places of culture and nature entity for the *Andar per mare* project.

This contribution has been peer-reviewed.
https://doi.org/10.5194/isprs-archives-XLVIII-4-2024-445-2024 | © Author(s) 2024. CC BY 4.0 License.

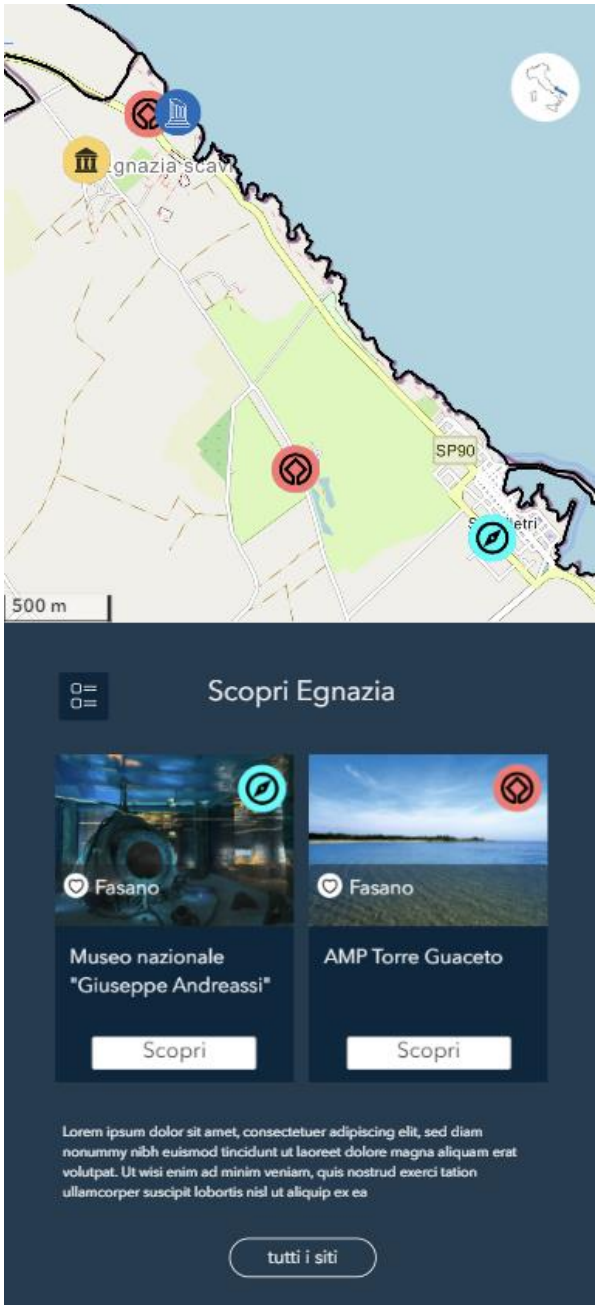


Figure 7. The webGIS for the single UCH of Egnazia for *Andar per Mare* project.

5. Conclusions and Future Perspectives

With this paper we propose a review of the existing sources for the development of a geodatabse for Underwater Cultural Heritage for the Puglia region (Italy). A single geodatabase will serve for two projects, the touristic *Andar per Mare* and the scientific *Archim3des* for developing webGIS multiple platforms. Creating a unified and standardized database for UCH is essential to avoid duplicates and facilitate the insertion of discoveries. Furthermore, a consistent database can preserve and promote Italy's rich cultural legacy. Up to now, the geodatabase has reached the internal model only for the *Andar per Mare* project, while for *Archim3des* is still under development. Considering the technical issues for the creation of the geodatabase and the web applications, both developing should be undertaken in parallel.

In fact, the data visualization on the webGIS influences the database structure. Given the complexity and variety of UCH, the geodatabase is still under development. Defining specific fields to describe the UCH and finding corresponding mapping onto ICCD standards request time to create the internal model. Only when the internal model is completed, the geodatabse will be implemented. To guarantee large interoperability, the geodatabse fields will be mapped to other standards like CIDOC-CRM and international thesauri like Getty AAT will be extensively used.

Acknowledgements

Authors acknowledge Università del Salento team (Antonella Antonazzo, Cristiano Alfonso, Donata Bologna), Regione Puglia, 3juice company (Andrea Crevola), and all team members of *Andar per Mare* and *Archim3des* project. This contribution was realized within the framework of the ARCHIM3DES – ARchaeological and Cultural Heritage documentation In Marine environment using advanced 3D mEtric Survey techniques (20223W24AB) PRIN 2022-2024 project, funded by the European Union, Next Generation EU.

References

Agius D. A. & Gambin T. (edited by), 2014: Ships, Saints and Sealore: Cultural Heritage and Ethnography of the Mediterranean and the Red Sea. Archaeopress Archaeology, Oxford.

Auriemma R., 2004: *Salentum a salo 2. Forma Maris Antiqui*, Collana del Dipartimento di Beni Culturali dell’Università di Lecce, Settore Storico-Archeologico. Mario Congedo Editore, Galatina.

Brouwers, W., 2015. Mapping Underwater Cultural Heritage: Exploring and Presenting Underwater Cultural Heritage. *Under-water Cultural Heritage from World War I*, 206.

Cossa, A., Auriemma, R., & Gull, P., 2012. La carta Archeolog-ica Subacquea della Puglia Meridionale. Il sistema informativo in rete. *Atti del XIII Convegno Utenti ESRI*, 1-12.

Cossa, A., Zaccarelli, N., Auriemma, R. G. P., & Alfonso, C., 2010. La Forma Maris del Salento e il progetto WebGIS subacqueo in. Atti del I Convegno Internazionale di Archeologia subacquea del mare Adriatico e del mare Ionio. Ricerca, tutela e valorizzazione dei relitti.

Calantropio, A., & Chiabrando, F. 2023. The Evolution of the Concept of Underwater Cultural Heritage in Europe: A Review of International Law, Policy, and Practice. *Heritage*, 6(12), 7660-7673. https://www.mdpi.com/2571-9408/6/12/403

Decock, Michiel, et al., 2016. Development of an efficient ap-proach of archaeological heritage in the intertidal zone of the Bel-gian North Sea." *8th International congress on Archaeology, Computer Graphics, Cultural Heritage and Innovation* (ARQUEOLÓGICA 2.0). Universitat Politécnica de Valéncia.

Nocerino, E., Del Pizzo, S., Lambertini, A., Troisi, S., & Vittuari, L., 2023. MANATEE Project: Monitoring and Mapping of Marine Habitat with Integrated Geomatics Technologies. In 2023 *IEEE International Workshop on Metrology for the Sea; Learning to Measure Sea Health Parameters* (MetroSea), La Valletta, Malta, 2023, 181-186.

Spreafico, A., & Chiabrando, F. 2024. 3D WebGIS for Ephemeral Architecture Documentation and Studies in the Humani-ties. *Heritage*, 7(2), 913-947.

Vandenbulcke, Annelies, et al., 2016. Preservation of the ar-chaeological heritage of the north sea using webGIS. *Interna-tional Multidisciplinary Scientific GeoConference: SGEM 3*: 375-382.