RECODING THE NAUTICAL ARCHAEOLOGY: VIRTUAL MUSEUM OF UNDERWATER CULTURAL HERITAGE

A DISSERTATION
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IN ART, DESIGN AND ARCHITECTURE

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March, 2011

APPROVAL PAGE

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ABSTRACT

RECODING THE NAUTICAL ARCHAEOLOGY:
VIRTUAL MUSEUM OF UNDERWATER CULTURAL HERITAGE

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The preservation of underwater cultural heritage requires the availability and access to data produced by nautical archaeology alongside tools for analysis, visualization and communication. Although numerous archaeological surveys and excavations have been carried out in the past decades in Turkey, there is no publicly available information system integrated to nautical archaeology. This dissertation proposes a framework of a virtual museum of underwater cultural heritage (VM). VM incorporates the practices of collection, preservation, research, visualization and exhibit, thus offers new approaches to the preservation of cultural heritage.

In this dissertation, a web-based information system has been developed for a model of virtual museum using the data collected during underwater surveys conducted on the coastal region of Kaş, Turkey in 2007-2010. Divers from a variety of professional backgrounds followed the practice of *in situ* preservation, collecting visual, geographical and descriptive data using structured datasheets. Through the analysis of these non-destructive methods, an information system and a data collection methodology are developed aiming the contribution of all interested parties in a collaborative manner. The system currently contains information on c.600 finds in the form of sketches, measurements, drawings, photographs of finds. Combined with Google Maps, the database illustrates the initial technological steps towards the development of a virtual museum.

Divers, archaeologists and other interested users of this information system participate in the musealization of information through separately applied analysis, visualization and communication tools by open software programs. These initial steps demonstrate the methods for the automation of data analysis and visual documentation, the visualization of information and the communication of this knowledge. Futuristic concepts of automated, immersive and interactive design redefine the virtual museum of underwater cultural heritage as well as offer different approaches to the discipline of nautical archaeology.

Keywords: Nautical archaeology, underwater cultural heritage, database, digital/ virtual museum, information system, *in situ* preservation, museology, Kaş.

ÖZET

DENİZEL ARKEOLOJİYİ YENİDEN KODLAMA: SUALTI KÜLTÜR MİRASI SANAL MÜZESİ

Güzden Varinlioğlu
İç Mimarlık ve Çevre Tasarımı Bölümü Doktora Çalışması
Danışman: Prof. Dr. Bülent Özgüç

Sualtı kültür mirasının korunması, denizel arkeoloji verilerine ulaşılabilirliğin yanı sıra analiz, görselleştirme ve iletişim araçlarına da sahip olmayı gerektirir. Türkiye'de son yüzyılda çok sayıda arkeolojik kazı ve yüzey araştırması yapılmış olmasına rağmen, denizel arkeolojiye entegre edilmiş halka açık bir bilişim sistemi yoktur. Bu tezde, sualtı kültür mirası sanal müzesinin çerçevesi ortaya konulmaktadır. Toplama, koruma, araştırma, görselleştirme ve sergi uygulamalarını içeren sanal müze, sualtı kültür mirasının korunmasında yeni olanaklar sağlar.

Bu tezde, 2007-2010 yıllarında Türkiye'nin Kaş kıyı kesiminde yapılan yüzey araştırmalarında toplanan verilerden yola çıkılarak internet temelli bilişim sistemi, sanal müze önerisi ortaya koymak üzere geliştirilmiştir. Çeşitli meslek gruplarından dalıcılar, yerinde koruma yöntemi ile görsel, coğrafi ve tasviri veriyi yapısal veriformları kullanarak topladılar. Tahribatsız koruma yöntemleriyle, ilgili tüm kullanıcıların katkılarıyla, işbirliğine dayanan bir bilişim sistemi ve veri toplama yöntemi geliştirilmiştir. Mevcut olarak sistem 600'dan fazla buluntunun eskiz, ölçüm, çizim ve fotoğraf bilgisini içermektedir. Google Maps bağlantılı veritabanı, sanal müze oluşturma yolunda ilk teknolojik aşamaları ortaya koymaktadır.

Sistem kullanıcıları, bilginin analizi, görselleştirme ve iletişimi, yani müzeleştirilmesi sürecine, açık kaynak kodlu programlar yardımıyla katıldılar. Bu temel aşamalar, veri analizi ve görsel kayıt yöntemleriyle verinin otomasyonu, bilginin görselleştilmesi ve son aşama olarak bilgi birikiminin iletim metodlarını anlatmaktadır. Özdevinimli, çevreleyici ve etkileşimli araçlar ile çağ ötesi kavramsal tasarım, sadece sualtı kültür mirası sanal müzesini değil, sualtı arkeolojisini de yeniden tanımlamaktadır.

Anahtar kelimeler: Denizel arkeoloji, sualtı kültür mirası, veritabanı, sayısal/sanal müze, yerinde koruma, müzecilik, Kaş.

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While tutoring a friend for his graduation from *açık lise*, I calculated in which year I am. After 27 years of studentship, eight years of PhD, with hundreds of people met in the field, thousands of money raised, and spent, millions of "stories" lived, this long-lasting project is ready.

On this long voyage to the unknowns of academics, and to the sea, I owe thanks to hundreds of people that joined me without asking me where we were going. As presented in participants' list in the Appendix E, I would like to thank all of them who shared their bubbles with me.

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LIST OF ABBREVIATIONS

AIA	American Institute of Architects
AJAX	Asynchronous JavaScript XML
AKMED	Suna-İnan Kıraç Research Institute on Mediterranean Civilizations
CAD	Computer Aided/Assisted Design
DOM	Document Object Model
EDM	Electronic Distance Measurement
EU	European Union
GIS	Geographic Information System
GPS	Global/Geographic Positioning System
GUI	Graphic User Interface
HABS	Historic American Buildings Survey
HAER	Historic American Engineering Records
HALS	Historic American Landscapes Survey
ICAHM	International Committee for the Management of Archaeological Heritage
ICOM	International Council of Museums
ICOMOS	International Council on Monuments and Sites
INA	Institute of Nautical Archaeology
JPEG	Joint Photographic Experts Group
LoC	Library of Congress
MoCT	Ministry of Culture and Tourism
NADL	Nautical Archaeology Digital Library
NAS	Nautical Archaeology Society
NGO	Non-Governmental Organization
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
PHP	PHP Hypertext Preprocessor/ Personal Home Page
RDBMS	Relational Database Management System
ROV	Remotely Operated Vehicle
SAD	Sualtı Araştırmaları Derneği (Underwater Research Society)
SCUBA	Self Contained Underwater Breathing Apparatus
SSS	Side Scan Sonar
SOA	Shipwrecks of Anatolia
TAMU-CHC	Texas A&M University, Centre for Heritage Conservation
TAMU-NAP	Texas A&M University, Nautical Archaeology Program

TAY	Türkiye Arkeolojik Yerleşimleri (Turkish Archaeological Settlements Project)
TÜBİTAK	Türkiye Bilimsel ve Teknolojik Araştırmalar Kurumu (Scientific and Technological Research Council of Turkey)
UCH	Sualtı Kültür Mirası Projesi - SKM (Underwater Cultural Heritage Project)
UNCLOS	United Nations Convention on the Law of Sea
UNESCO	United Nations Educational, Scientific, and Cultural Organization
VENUS	Virtual Explorations of Underwater Sites
VCM	Virtual Museum of Canada
VIZIN	Institute for the Visualization of History
VM	Virtual Museum
VR	Virtual Reality
VRML	Virtual Reality Modeling Language
WWW	World Wide Web
XHTML	eXtensible Hypertext Markup Language

CHAPTER 1

1. Introduction

The widespread use of information technologies brought new challenges to the preservation of cultural heritage as well as to museology. A new concept of virtual museum has emerged from a need to acquire, store, research, communicate and exhibit the digital heritage data. Drawing parallels between virtuality and underwater environment, this dissertation aims to explore the conceptual framework for creating a virtual museum of underwater cultural heritage. The objectives of the study are to formulate a methodology for the collection of data on underwater cultural heritage using the non-destructive principles of *in situ* preservation, and explore the methods of transferring, storing and sharing the collected data in the digital domain. The information system which is designed to store various types of data, also allows collaborative analysis, visualization and communication. Furthermore, at a conceptual level, the digital technologies of the future are explored to promote a framework of a virtual museum and to develop a tool for the nautical archaeology.

Archaeology is a discipline concerned with the past. Its objectives are to explain the origins and development of human culture and history using the remains on the land as evidence. Nautical archaeology, a recent sub-discipline, has emerged in the early 1960's with the excavation and publication of the Cape Gelidonya Shipwreck by George Bass (1967), following the development of SCUBA equipment and underwater surveying tools and equipment. Nautical archaeology, also called "archaeology underwater", such in Turkey, followed the track of land archaeology. Land or nautical archaeologists, like a detective, collect data through excavation and survey (NAS, 2009: 2). Data collection methods sometimes bother the archaeologist, because paradoxically they involve "partially destroying the site that is the object of research without ever being able to recapture the whole of the information it contains" (Forte, 1997: 9). Based on Forte's remark on the destruction of archaeological data sources, this dissertation proposes a critical appraisal of this irreversible process of data collection by emphasizing the preservation of cultural heritage. Without disturbing the material remains found underwater, this study explores new methods of data acquisition as an alternative to conventional destructive methods used in the discipline of nautical archaeology.

Archaeology studies cultural heritage, depending on how and where the remains are found. Cultural artifacts detached from their original context, are either transformed to a museum object, or when kept in their original place, they deteriorate caused by aggressive urban expansion and development, destruction caused by looting, and general neglect (Kalay, 2008: 1). Similarly, underwater cultural heritage has been under escalating threat due to the extensive number of divers and underwater exploration techniques that gave rise to destruction of wrecks and immersed sites (UNESCO, 2001). Darkness, low temperature and low oxygen rate, characterizing the underwater environment offer ideal preservation conditions for non-organic cargo remains, anchors, ceramics etc. In Turkey, mostly visited by recreational divers rather than nautical archaeologists, these cargo remains offer important clues about the past even without having to be removed from their original context. Nevertheless, in Turkey the priority is largely given to excavations, as a result of which unearthed artifacts are removed from their original contexts and transferred to museums. The museum is considered to be the ideal place for the highest level preservation of this "salvaged" cultural heritage.

The International Council of Museums (ICOM) founded in 1946 defines the museum as "a non-profit, permanent institution in the service of society and its development, open to the public, which acquires, conserves, researches, communicates and exhibits for the purposes of education, study and enjoyment" (ICOM, 2007). These activities of musealization include the collection, conservation and research of museum objects through exhibition for a better communication with the public. However, separated from its context, isolated from its meaning; the cultural heritage is enclosed in a single place, which may be termed a heterotopian space. Foucault defines the museum as a space of difference, a space that is absolutely central to a culture but in which the relations between elements of a culture are suspended, neutralized, or reversed (Foucault, 1998: 178). Like other cultural institutions such as libraries, the museum as a product of the Enlightenment, imposes universal categories, classifications, and order on cultural artifacts. Once an object is detached from its original context and placed in a museum environment, the archaeologists categorize, classify, and derive meaning in order to impose a new order on artifacts. This dissertation explores the museum practices of acquiring, preserving and researching of cultural objects in the virtual domain taking into consideration Foucault's criticism of the museum.

Nowadays, virtuality is mostly associated with computer technologies, and is often conceived as a tool to achieve something intangible, fictitious, and unreal (Lévy, 1998). As defined by Lévy, the media scholar, virtuality is by no means an opposite of the real; rather, it offers potentialities other than the ones in real space. Referring to Benjamin's famous essay "The Work of Art in the Age of Mechanical Reproduction", the digital heritage has become a separate entity, detached from its original context, bringing the new opportunities to the digital heritage data. The digital domain offers new possibilities to transform the physical objects into digital formats, to store and preserve in digital repositories, to analyze and disseminate, and to securely exhibit through digital systems. This phenomenon of digital revolution is studied in a variety of disciplines concerned with theories of new media and cyberspace (Manovich, 2001). Manovich, a prominent theorist of new media, defined the general principles underlying the new media with connotations of numerical representation, modularity, automation, variability, and transcoding. Similarly, Gibson (1984) writing on cyberpunk, defined the concept of cyberspace as the site of computer-mediated communication providing an environment for new conceptions of space and spatial theories, while new media emphasizes the communicative aspect of virtuality. This dissertation treats the collection, visualization and communication of data within the framework of the above mentioned conceptions of space and visual communication.

Virtual museum is a product of the revolutionary changes in digital reproduction, which led to the emergence of new definitions in the field of museology. Since its conception in 1995 as recommended by the policy statement of ICOM, the concept of "virtual museum" is still being developed and continually adapted to new technologies. There are several definitions for virtual museum introduced by different institutions, thinkers, and researchers. Schweibenz categorizes virtual museums as brochure, content, learning, and virtual museum. The first three categories refer to the informative web sites of "brick and mortar" museums that are institutions with more conservative attitudes towards information technology (Schweibenz, 2004: 3). The very last, namely the virtual museum is where digital collection and information are linked parallel to Malraux's vision of the "museum without walls" (Malraux, 1947). Not bound by physical constraints, the digital objects are housed and displayed in this repository. The need to store large volumes of data by using digital technologies formed the basis for the idea of creating an analogy of the concept of museum, as museums no longer function simply as repositories of objects. Instead, they are increasingly serving as archives or storehouses of knowledge (Parry, 2007). Consequently, practices at virtual museums have experienced a shift in the way this knowledge is acquired, preserved, researched, exhibited, and communicated.

Documenting or recording is capturing the information which describes the physical characteristics, condition, and use of the cultural heritage. Cultural heritage documentation makes use of computerized techniques to acquire and preserve the information produced. Particularly in archaeology, the computerization of data helps solving specific problems in saving, presenting and understanding archaeological features. Through advanced technologies of digital documentation and analysis such as visual, dimensional, locational, aerial, environmental, and underwater tools, the information system serves the needs of archaeologists. These practices of knowledge formation can be considered as the initial steps towards a museum.

The visualization of digital heritage is one of the most attractive ways in which computer technology can be employed in the field of archaeology. The use of this technique allows visual reproduction of data through representation, modeling, and display. These methods of display allow the creation of virtual exhibitions in the web environment. The virtual domain, unlike the "brick and mortar" museum, is a flexible medium for sharing information in various formats, such as digital images, video recording, hyperlinked texts, etc. Moreover, the digital domain recodes the way the information is displayed in such a way to move it from a passive to a more interactive style.

New combinations of objects may be created automatically. In fact, users may create their own combinations of objects using the search and browse functionalities applied to object-level metadata. This emphasis on interactivity allows multiple user experiences, thus contributes to the development of interdisciplinary aspect of display. In the web 2.0 environment, new datasets can be created through user participation. The conventional definitions of cultural institutions such as libraries, repositories, and museums are redefined by digital technologies.

In the field of heritage preservation, five digital repositories stand out in their applications of the practice of virtual museology. Historic American Building Survey (HABS) , dealing with acquisition of building documentation data; the Turkish Archaeological Settlements (TAY) project, focusing on the conservation of archaeological data by archiving publications; Nautical Archaeology Digital Library (NAPL), a research tool on multilingual manuscripts; Institute for the Visualization of History (VIZIN) projects for the visualization of excavated sites; and Virtual Museum of Canada (VCM), a user-centered virtual museum project. The digital repositories focusing on three main types of underwater remains, namely anchors, *amphorae*, and sites are respectively Big Anchor, Roman Amphorae and Virtual Explorations of Underwater Sites (VENUS) projects. These digital projects illustrate the diverse applications of cultural heritage management. Their assessment is a useful exercise to conceptualize the information system for a virtual museum of underwater cultural heritage.

Following this theoretical background, the underwater environment, like the conception of virtuality, is considered as infinite and unexplored. The unidentified remains hidden in this environment are both the subject and object of the virtual museum. This cultural heritage comprises all underwater traces of human maritime activity along the Lycian region, the southwest Mediterranean coasts of Turkey, specifically in the environs of Kaş. Following the general preservation methodology proposed by the UNESCO "Convention on the Protection of the Underwater Cultural Heritage" in 2001, which is not yet signed by the Turkish authorities, a data collection methodology of underwater cultural heritage was developed by the author and her team, who conducted underwater archaeological surveys in Kaş region as part of the Underwater Cultural Heritage Project (UCH)[1]. Driven by this methodology, an information system was designed and developed to create a web-based and open-content platform for knowledge-building through the collaboration of multiple participants with different backgrounds and academic interests. This dissertation also discusses the analysis, visualization, and communication tools that are not integrated into this information system. Although the automation tools are not yet linked to the information system, the necessary technical steps required to establish this link are presented in order to suggest the methods of converting this information system into a virtual museum. Future features on the automation of analysis and documentation, exhibition and visualization, and the system of communication and interaction are briefly discussed. The methodology of data

[1] Data collection and processing for an online site called Underwater Cultural Heritage Project (UCH) currently carried out since 2007 with the permission of the the MoCT, since 2009 on behalf of Güzden Varinlioğlu. Among the fundamental goals of this project is the intention to contribute to the management of the underwater cultural heritage of Turkey.

collection and the web-based information system contributed to the model of a virtual museum (VM). Although this museum is not in place yet, the dissertation provides several suggestions towards its design and implementation. These suggestions are the products of the integration of computer science, museology and archaeology.

1.1. Objectives and Methods

Most studies on virtual museums are related to the integration and interpretation of information but there is still lack of systematic methodology for the collection, preservation, and dissemination of this digital data through web-based systems equipped with adequate visualization and communication tools. This dissertation formulates a framework for a virtual museum for the underwater cultural heritage of Turkey. The major component of this framework is a web-based information system, which was developed by three programmers for potential virtual museums that incorporate collected data, research, and storage of underwater cultural heritage. The design of the information system for this virtual museum is based on the archaeological surveys done in the pilot region of Kaş, on the Lycian coast. As a pilot study, the objective is to develop a data collection methodology derived from the principles of *in situ* preservation. This methodology is based on developing standard datasets that are collected by recreational divers who are not, by education, archaeologists. The system has been developed with the objective to build and test methods for data acquisition, conservation, and research. These methods are central to the process of transporting the data collected in the field to an online information system.

Initially, through a training session on nautical archaeology, these divers received a basic background that enabled them to participate effectively in the development of the design of the information system, as well as in future surveys for the collection of underwater data. To ensure the sustainability of the project, the methodology of data collection intends to rely on simple and standard tools, but detailed observations and measurements.

In this data collection methodology, datasheets, paper versions of the information system, are developed and tested on recreational divers. The overall design of the systematic information system is tested first by divers in the field, and later on by archaeologists and other users online. Using the remarks and comments of users on the collected data, datasheets, and database, the system is redesigned according to the needs of archaeologists. The objective is to systematize the ambiguous data of various media such as the measurements, sketches, photographs, drawings, images, notes, geographical coordinates, and any other archaeological element.

This online information system for systemic data collection, description, and interpretation, currently contains information on 22 geographically distributed archaeological sites. Combined with the GPS locations of sites and findspots, the result of integration of the database with Google Maps illustrates the distribution of sites along the Kaş shoreline. Particular attention is paid to collecting the information digitally and to refraining from disturbing the material culture. For this reason, artifacts are recorded with special care to maintain them untouched and *in situ*. This non-destructive recording method abides by the principles of the conservation and the protection of the sites accepted in the UNESCO 2001 Convention (UNESCO, 2001).

It is within this framework that the multiplicity of information and knowledge contributes to the unique nature of a virtual museum, where the sources of data and means of data collection are as diverse as the process is interactive. One of the objectives of this dissertation is to investigate the contribution of digital technologies to the preservation and presentation of cultural heritage. Another objective is to determine in what other ways digital technologies can contribute to data storage and sharing, and thus, to the development and further articulation of the concept of the virtual museum.

Using the capabilities of the information system separately produced visual media and archaeological interpretations are uploaded to the system through the collaboration of archaeologists and other interested parties. Based on the comments of the participants of this collaborative process, advanced tools should be integrated to the system. These tools consist of open source software programs for data analysis, visualization, and communication. Archaeologists use the information system to derive archaeological information based on the descriptions, distribution maps, and statistical studies of the recorded measurements of finds. Once the archaeological information is driven, the visualization of data can be considered as the next step towards a virtual museum, as well as a data analysis method for the archaeologists. Through the drawings of sites and finds, enhancements of the photographs i.e. the digital darkroom applications, processing of the photographs for photogrammetric information, and 3D reconstruction of objects, the system can be ready to be presented in the form of an online exhibition. As a communication tool, the exhibition of the finds can be thus achieved through locational, chronological and visual maps. Along with these navigation options, the system should have tools for query. Still, even with the inclusion of these tools, the information system does not actually result in a virtual museum. The virtual museum should have automated tools for digital documentation and analysis, a more powerful visualization for exhibition and an interactive user interface for the communication of the produced information. Moreover, beyond the limits of currently available technologies, further features, such as automatic archaeologist, visual virtuality and immersive interaction are presented for the virtual underwater museum of the future.

Among the features that will be developed in future is the conceptual discussion of the artificial intelligence of an archaeologist. This concept precedes the development of advanced visual features for designing an immersive user interface. The automatic archaeologist is a computer agent who thinks and acts rationally like an archaeologist. This feature equipped with artificial intelligence can perceive the environment, do research on publications and answer archaeological questions by image processing and other advanced technologies. The visual features of the system, such as computer reconstructions and photogrammetric tools are explored as well as the tangible properties using haptic devices such as gloves. Thus, the virtual system becomes immersive by conveying the senses in the digital domain. In this tangible and virtual environment, the knowledge can be created through the collaborative environment of web. This makes possible the coexistence of various navigation tools that do not depend on dictated curatorship.

Having conducted the thesis study in the Lycian coast of Turkey, and having specific research questions on this region, the objectives were to form a methodology for data collection and recording through underwater survey for the research, preservation, investigation, and display of Turkish underwater cultural heritage by means of a virtual museum, to bring a new approach to redefine the conception of the museum in virtual space through the collaboration of such disciplines as nautical archaeology, museology, and information technologies. In this system, non-governmental organizations and academic institutions will be able to collaborate and by sharing the approaches specific to their disciplines thus contribute to the development and improvement of the virtual museum and share different approaches.

1.2. Dissertation Outline

This thesis investigates a framework for the design of a virtual museum by data collection, collaboration and dissemination of underwater cultural heritage through field surveys and an online information system. The theoretical and practical basis of the dissertation is discussed in two parts. Part I, composed of chapters 2, 3, and 4, includes respectively the definition of the proposed preservation methodology on underwater cultural heritage, discussions on the concepts and practices of the virtual museum, and the literature review on virtual museum and information system examples. Part II, composed of chapters 6, 7, and 8, includes the implementation of the data collection in the field, storage and sharing using the information system, and a model of virtual museum along with tools for analysis, visualization and communication. Finally, some future features are conceptually explained to lead future studies on the virtual museum of underwater museum.

Part I starts by explaining theoretical issues with a clear definition of underwater cultural heritage in chapter 2. Having defined underwater cultural heritage in relation to archaeology, nautical archaeology and historical preservation, a critical review of the selected legal frameworks is presented in order to underline the relevance of *in situ* preservation methodology. Also, the gaps in national legislations that do not cover the research and promotion of archaeological potential of the region are summarized in order to emphasize the preservation methodology chosen throughout this dissertation. In chapter 3, theoretical approaches that are taken as the basis for the development of virtual museum are explained, including the definitions, theoretical criticism and practices on the concepts of museum and virtuality. This chapter underlines three practices of virtual museum and archaeology in conjunction of the developments of information technology: digital documentation and analysis, visualization and exhibition, communication and interaction. In the chapter 4, the existing information systems, repositories, and virtual museums used for the preservation, collection, dissemination and exhibition of cultural heritage are summarized, with a focus on information systems used in nautical archaeology (See Appendix F).

Part II presents the implementations of the proposed model, starting with a summary of the research setup of the study in chapter 5, including the problem definition, research questions, participants, and the methodology. This chapter establishes a common ground of other projects conducted under the heading of Kaş Archaeopark Projects[2]. The design process of the information system, which is implemented with divers of different academic backgrounds, is also introduced. The full list of the participants and their contribution are presented in Appendix E. Chapter 6 presents the methodology used for the data collection, including the evaluation of datasheets, visual materials, and maps. Three stages of the design of the data collection methodology are summarized

[2] The foundations of "Kaş Archaeopark Projects" were laid in 2006 so as to have multi-disciplinary academic and popular projects in order to gain attention of local people, archaeologists, and everyone interested in historical and archaeological potential of Kaş and its environment.

with the diagrams of the general organization schema. The detailed explanations of each component of underwater cultural heritage and the datasheets are Appendix A and B. The analysis of the datasheets and the clues found on the research diaries about the divers' data collection process form the basis of the design of information system in chapter 7. Based on the users' needs and comments, this chapter includes the design phase of the three prototypes based on the users' comments. The architecture and components of the final design are briefly presented in addition to the general features, such as mapping, data validation, and record relations. The explanation of the technical details is given in Appendix C and D.

Chapter 8 discusses the conceptual design of the virtual museum system as theoretically explained in chapter 3. Providing data storage, sharing, and collaboration, the information system is used for data analysis and visualization. Separately produced in open source software programs, textual and visual analysis of the data is uploaded to the system through the collaboration of archaeologists and other interested parties. Although this museum is not in place yet, several suggestions towards its design and implementation, such as digital documentation tools for data collection, artificial intelligence technologies for analysis, a more powerful visualization for exhibition and an interactive user interface for the communication of the produced information are presented towards the end of the chapter. Finally, the results of the discussion related to virtual museum, the archaeological surveys and information system are summarized and discussed in the conclusion to lead to further studies.

CHAPTER 2

2. Underwater Cultural Heritage

The study of underwater cultural heritage, as related to the field of nautical archaeology is a major scientific discipline about research on archaeological, historical and architectural sites and objects (Gifford, 1985: 373). These sites comprise archaeological periods from the Late Bronze Age to the present, to ships and harbors of the historic past, which are traces of nautical activity (Bass, 2005). Nautical archaeology, covering the disciplines of maritime, marine, wetland and underwater archaeology, is a recently established branch of archaeology. Its beginnings are identified with the excavation and publication of the Cape Gelidonya Shipwreck dating from the Bronze Age off Turkey in the early 1960s (Bass, 1961). As a new discipline, nautical archaeology, sometimes called "archaeology underwater" followed the tracks of land archaeology (Bass, 1966). The term "archaeology underwater" implies the implementation of the theories and practices of land archaeology to the remains found underwater. Thus, nautical archaeology had a limited exchange of ideas with other disciplines, among which is historic preservation.

The preservation of cultural heritage including underwater heritage is a relatively novel topic in archaeology. To avoid any confusion and conflict between these three disciplines, namely archaeology, nautical archaeology, and historical preservation, and to understand the theoretical background of preservation principles on cultural heritage, it is necessary to define the key terms presented by the prominent institutions. The perspectives of preservation of United Nations Educational, Scientific, and Cultural Organization (UNESCO) at the international level, National Park Service (NPS) in US and Ministry of Culture and Tourism (MoCT) in Turkey define the creation, usage, conceptualization and transformation of these three disciplines.

Archaeological surveys and excavations have traditionally used destructive methods of data acquisition. However since 1931, when the Athens Charter was drafted by the International Museums Office, international conventions on the protection of cultural heritage made possible the development of both national and international legal frameworks. These frameworks are presented in order to support and promote the *in situ* preservation. The latest legal framework currently signed by international authorities follow the principles of *in situ* preservation, which prohibits the dislocation of material culture. In contrast to the international consensus, in Turkey, this preservation method is still not considered as an established scientific method for either on land or nautical archaeology. The emphasis is largely given to excavations, the destructive methods of data collection. However, when the non-organic underwater remains with their excellent preservation condition in the clear waters of Turkey are examined, the principles of *in situ* preservation are preferred to be followed during the surveys on the Kaş shoreline.

2.1. Definition of Terms

As one of the aims of this dissertation is to introduce new concepts to the field of nautical archaeology, it is imperative to use a carefully chosen terminology (Fig. 2.1). Archaeology and its subsequent discipline, nautical archaeology studies the material remains to reconstruct the secrets of history. Paradoxically, archaeological data collection methods lead to the partial destruction of the historic evidence, although historic preservation favors the long term preservation of cultural heritage. The methods and terminology used in archaeology reveal the differences and contrasts between principles of archaeological research and historic preservation.

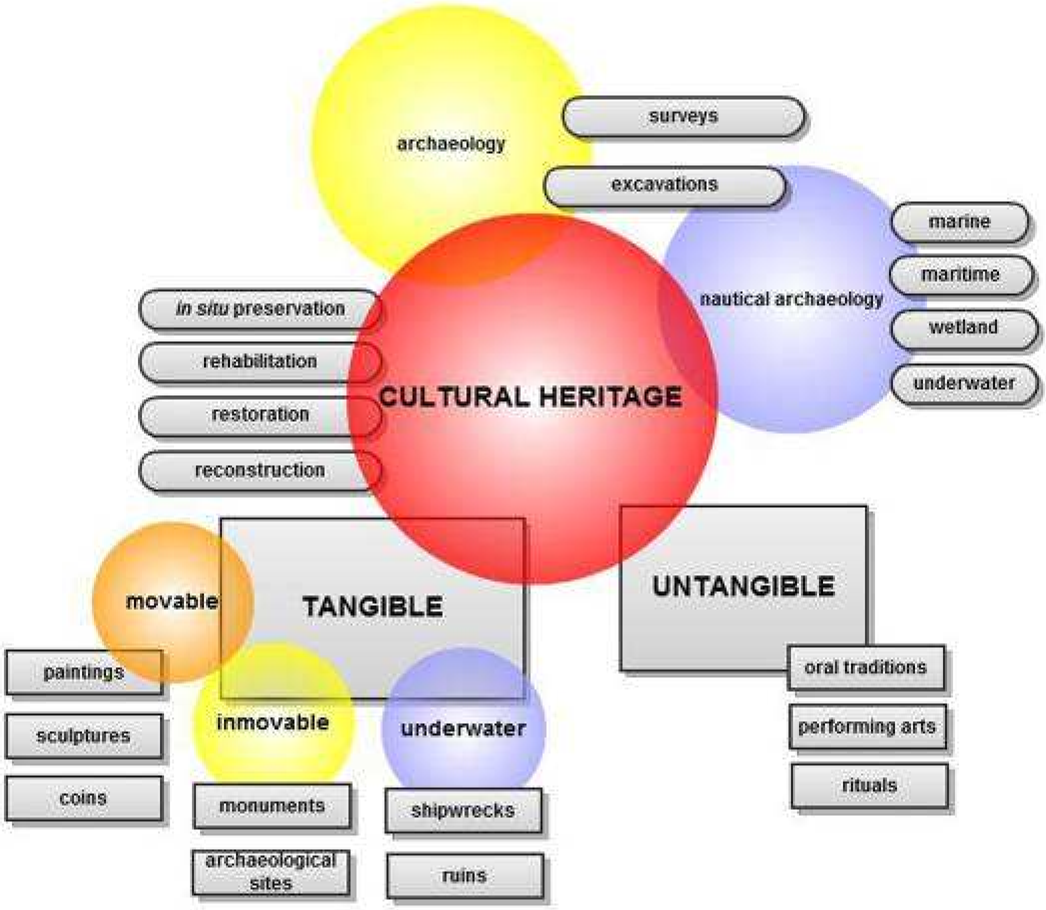

Figure 2.1. Definition and scope of the terms on cultural heritage.

2.1.1. Archaeology

Renfrew and Bahn define archaeology as partly the discovery of the treasures of the past, partly the careful work of the scientific analysis, partly the exercise of the creative imagination (Renfrew and Bahn, 1991: 9). Considered both a science and humanities, one of the main concerns of archaeology is the "study of past societies primarily through their material remains –the buildings, tools, and other artifacts that constitute what is known as the *material culture* left over from former societies" (Renfrew and Bahn, 1991: 9). This discipline involves the methods of survey, excavation and eventually the analysis of data collected in order to learn about the past. However, as stated by Sprinkle Jr., these methods result in the "destruction of the past through excavation, analysis, and interpretation" converting the artifacts into field notes of the archaeologists by isolating the material from its original context (Sprinkle Jr., 2003: 253).

Unlike many other scientific disciplines, the practice of archaeology is not a repeated experiment or procedure. Forte stated that "excavation and fieldwork are sometimes rather embarrassing for the archaeologist, because (paradoxically) they involve partially destroying the site that is the object of research without ever being able to recapture the whole of the information it contains" (Forte, 1997: 9). The excavation that is the main source of data collection for the interpretation and observation of archaeologists is in its nature a destructive process, which proves the profession's concern for recording (Sprinkle Jr., 2003: 253). As a result, archaeologists are devoted to archaeological records. As Sprinkle Jr. criticizes archaeologists, (they) "live and breath data because the archaeological record is an elusive, sexy, democratic past, not one generated by clerks, accountants, or politicians, but by the folks" (Sprinkle Jr., 2003: 270-271). As in the case of widely known movie trail, "Indiana Jones", archaeologists feel the romance and mystery of archaeology. For most archaeologists, the excitement is in discovery through excavation and fieldwork, not in revisiting previously excavated materials or places. They want to touch the artifact, and discover the hidden past on the earth.

Since its early days in the late 19th century, the practice of archaeology has evolved to a less destructive method. Later in the 20th century, with the advances in technology and its usage in archaeology, the excavations and surveys started to use advanced technologies borrowed from other disciplines. Still, even with adequate tools and techniques, the tradition of archaeology favors excavations rather than non-destructive research and preservation methods. As the same site on land is mostly occupied by various civilizations during different periods of history, archaeology on land relies on mainly excavations and surveys to acquire data. On the other hand, the archaeological remains found underwater mostly include more than clues, in fact sufficient information on the history of nautical activities.

2.1.2. Nautical Archaeology

Considered as a branch of archaeology, nautical archaeology is the systematic study of past human life, behaviors, activities and cultures using material remains as well as other evidence found in the underwater environment (Delgado and Staniforth, 2002). The term "underwater archaeology" mostly refers to the environment in which the practice of archaeology is undertaken (Bass, 1966). Contemporary definitions of nautical archaeology overlap with the definitions of maritime, marine, underwater and wetland archaeology. Maritime archaeology deals with humans and their interactions with the sea. It can include sites that are related to maritime activities such as lighthouses, port constructions as well as other sites found underwater. Marine archaeology is the archaeological study of material remains created by humans that are submerged in the marine environment (e.g. submerged aircraft). Wetland archaeology is the study of humans and their interactions with the water, not definitely in marine environment.

Nautical archaeology studies ships and shipbuilding with the techniques of underwater exploration, excavation and retrieval. This dissertation uses the term nautical archaeology, also preferred by Nautical Archaeology Society (NAS) in the UK, Institute of Nautical Archaeology (INA) in the USA, prominent institutions in this field, as it covers the study of all the remains of nautical activity.

"How can you call this planet earth, when it is quite clearly water?" is the general slogan of nautical archaeologists. Different from the archaeology on land, while the sea surface shows no traces of these ships and buildings, their remains lie on the seabed, safely protected by water (Delgado and Staniforth, 2002). Unlike the remains found on land mostly covered by earth, once discovered in the depths of water, the shipwrecks give important clues about the past. Shipwrecks are often described as "time capsules", as the term describes the essence and excitement of one instance in time, a slice through history when belongings and commodities on these ships are well preserved (Gibbins, 1990: 35). Unless looted or destroyed by human and natural factors, inorganic archaeological remains found underwater are protected and preserved by the water. Partially submerged under the seabed, the visible remains found underwater include important clues for the archaeologists without any archaeological excavation. Usually visited by recreational divers, rather than nautical archaeologists, who are not found in Turkey in large numbers, these archaeological remains are mostly encountered in most of the diving activities.

In Turkey, underwater archaeology is mostly associated with cargo remains of the nautical activity. The visible and long-lasting remains are *amphorae*, anchors and other materials carried by the ships as well as architectural elements of the harbors, submerged settlements etc. Once exposed to sea water, organic remains i.e. wooden parts of shipwrecks disintegrate by living organisms. When hidden under the seabed, the organic parts of the shipwreck hidden under their cargo materials are protected thus can be found intact after years. Sealed by a layer of encrustation, remains of the cargo offer substantial clues about archaeological information, such as shape, texture, and dimensions of the earthen artifacts, even without disturbing the material culture.

2.1.3. Cultural Heritage

Heritage is defined as something that is or should be passed from generation to generation because of its value (Webb, 2003: 28). Similarly, UNESCO interprets cultural heritage as "the entire quantity of artistic or symbolic signs handed on by the past to each culture and, therefore, to the whole of humankind" (UNESCO, 2008). Given this, any heritage vessel that is movable such as paintings, sculptures, coins; immovable, such as monuments, archaeological sites; and those found in an underwater setting such as shipwrecks, ruins are defined as tangible cultural heritage. According to the Convention for the Safeguarding of the Intangible Cultural Heritage, intangible cultural heritage consists of the practices, representations, expressions, knowledge, and skills that individuals, groups, and communities recognize as part of their identity (UNESCO, 2003). In this context, human expressions such as oral traditions, performing arts, and rituals are examples of intangible heritage (UNESCO, 2008). In this dissertation, cultural heritage is considered "archaeological heritage" is that part of the material heritage in respect of which archaeological methods provide primary information (UNESCO, 1990). Thus, the broad definition of cultural heritage covers the usage, conceptualization, and transformation of al the above mentioned descriptions.

The term cultural heritage is defined by the National Park Service (NPS), the federal agency that manages all parks, many monuments, and other conservation and historical properties in the United States. According to the NPS, cultural heritage reflects the significance of collective memory and defines the identity of the community. To encourage consistent preservation practices, NPS has developed guidelines and standards that guide the preservation methodology. Named as the Secretary of Interior's Standards, Guidelines of Archaeology and Historic Preservation are intended to promote responsible preservation practices that help to protect cultural resources (Weeks, 1995). These guidelines offer four treatment approaches such as preservation, rehabilitation, restoration and reconstruction. The preferred treatment is preservation rather then the other three consecutive treatment methods. These guidelines promote the preservation of the original as a preferred option.

Both UNESCO and NPS define cultural heritage as the place-oriented and physical manifestations of heritage assets; as well as the non-place and non-physical aspects. In Turkey, the Ministry of Culture and Tourism states in the Law Protecting the Cultural and Natural Heritage[3] the definition of cultural property as "[A]ll movable and immovable property above or underground or underwater that belongs to the prehistoric and historic periods and relates to science, culture, religion and the fine arts" (MoCT, 1983). This legislation establishes the national inventory of the cultural natural heritage as a form of protection.

Similar to cultural heritage, underwater cultural heritage means "all traces of human existence having a cultural, historical or archaeological character which has been partially

[3] The Turkish translation for the Law Protecting the Cultural and Natural Heritage is *Kültür ve Tabiat Varlıklarını Koruma Kanunu.*

or totally under water, periodically of continuously, for at least 100 years" (UNESCO, 2001). Within these interwoven disciplines on the study of underwater cultural heritage, UNESCO estimates that there are over 3 million undiscovered shipwrecks. Many of the famous shipwrecks are looted, including the Armada of Philip II of Spain, the Titanic, the fleet of Kublai Khan, and many other along the Turkish coasts when compared to the very limited number of shipwrecks that have been excavated using scientific and archaeological methods (Delgado and Staniforth, 2002). Similarly, the remains of numerous ruins and submerged settlements are looted more often, since they mostly lie in relatively shallower water. The excavations of Port Royal in Jamaica by Institute of Nautical Archaeology (INA), the ruins of Alexandria Lighthouse known as Pharos by Centre d'Études Alexandrines are the significant examples of systematic excavations of the underwater settlements. However, as explained above, illegal looting of the artifacts, sites and submerged sites is not the only destruction. No matter how careful archaeological research is, archaeological excavation includes irreversible modifications in cultural heritage sites. As a result of archaeological research, these objects of material culture are decontextualized and isolated from the milieu they represent. To prevent this decontextualization, several conventions, laws and guidelines were created in order to establish a legal framework at national and international level.

2.2. Legal Frameworks for the Preservation of Cultural Heritage

The legal issues relating to the discovery, survey and excavation of underwater cultural heritage were once described as a "legal labyrinth" (NAS, 2009: 45; Altes, 1976). Borrowing many rules from different professional fields like historic preservation, archaeology, and nautical archaeology, research on underwater cultural heritage follows a path through this network of national and international laws and regulations. As the underwater cultural heritage is generally found in the seas and oceans, the United Nations Convention on the Law of the Sea (UNCLOS) is the particular international law to be referred (NAS, 2009: 45). Adopted in 1982, this convention outlines systematically the divisions of the coastal waters into five different zones such as deep seabed and the high seas, continental shelf, exclusive economic zone, contiguous zone, and territorial seas. Defined mainly by distance to shoreline, called as coastal baseline, these zones named above have different regulations in terms of natural resources, navigational rules and the ownership of cultural heritage. When this convention was negotiated, the underwater cultural heritage was not the main concern; however it is important to know where land ends and sea begins (NAS, 2009: 45). As the main focus of the surveys conducted for this dissertation is the territorial sea, which extends up to 12 nautical miles from the coastal baseline, Turkey has the exclusive right to regulate all activities relating to underwater archaeology.

The two most important policies concerning the preservation of wreck sites were created by the UK and USA authorities. Current English policy heavily relies on a voluntary approach to heritage management. It relies on local organizations for a comprehensive, national vision for the management of underwater cultural heritage (Oxley, 2001: 12). In the case of the Unites States, the current legislative environment frames the management of underwater cultural heritage. Depending on where the resource is located and subject to specific and individual requirements, this heritage falls under one of the three regimes: General Maritime Law (1789), the Abandoned Shipwreck Act (1987) and the Marine Sanctuaries Act (1972) (Street, 2006: 468). The first outlines the laws of salvage and finds. The latter two acts of more recent period are about the ownership of the shipwrecks. However countries such as Turkey consider all cultural heritages to be owned by the government and no private trade in these items is allowed (NAS, 2009: 49). Some countries, such as Greece and Turkey, restrict search and diving activities, in the case of Turkey, a permission from Ministry of Culture and Tourism (MoCT) is required to conduct underwater surveys (NAS, 2009: 49).

2.2.1. National Perspective

Although the legislations in the UK and USA help us to draw a general outline of theory and practice of preservation, an overview of Turkish legislations is needed to evaluate whether these methods are applicable to Turkey. Turkish lands and waters have a vast amount of cultural heritage when compared to other European and especially American lands and waters. The complexity of remains from ancient civilizations is so vast that not only adaptation but also redesign of the legal framework is needed.

Turkey is geographically situated on the land that housed numerous civilizations throughout the history. As a result, Turkey is a prominent research area for many national and international scholars from diverse disciplines such as archaeology, architecture, history and historic preservation (Blake, 1994). The MoCT compiles the reports of these diverse archaeological activities in the annual International Symposium of Excavation, Survey and Archaeometry.[4] The published conference proceedings are accepted as the primary resource of documentation of the field studies conducted in Turkey.

[4] The Turkish translation for the International Symposium of Excavation, Survey and Archaeometry is *Uluslararası Kazı, Araştırma ve Arkeometri Sempozyumu.*

In Turkey, MoCT is responsible for cultural heritage management activities. Department of Antiquities[5] is the department within the Ministry that regulates the permits for any archaeological and historic preservation study and research. Following the earlier Turkish legislation, the Antiquities Law[6] (1973), the Ministry passed the Law Protecting the Cultural and Natural Heritage in 1983. This legislation was designed to be more comprehensive in order to protect and conserve the expanding meaning of cultural heritage (Blake, 1994: 276). According to this law, archaeological sites are classified into three groups with respect to the characteristics and values they carry. According to the significance and archaeological values, these sites are graded as first, second and third degree. This grading defines the level of intervention, for research, conservation and restoration.

Similar to archaeological sites on land, there is a vast amount of sites along the Turkish coastline where ancient shipwrecks or sunken archaeological ruins of ancient settlements are located. Most of the wrecks at shallow depths within the recreational limits have already been looted by sponge divers and recreational divers in the 1960s and 1970s. The current law passed in 1983 extended the scope of the antiquities legislation to cover for the first time underwater archaeological sites and other remains, while retaining most of the perspectives of the 1973 law (Blake, 1999: 173). With prohibitive perspectives, some designated areas are declared to be underwater protection zones. In these protection zones, recreational diving activity was prohibited to protect this underwater cultural heritage. Although the law expected to designate "no diving zones" as a solution for looting and destruction of the archaeological heritage, these zones became more attractive for public. Even though it is not clearly defined how they are designated, it is

[5] The Turkish translation for the Department of Antiquities is *Kültür Varlıkları ve Müzeler Genel Müdürlüğü.*
[6] The Turkish translation for the Antiquities Law is *1710 sayılı Eski Eserler Kanunu.*

believed that these zones are derived from researches done by the Institute of Nautical Archaeology (INA) in Turkey during 1980-90 surveys. As there is no publicly available database for this archaeological heritage, these "no diving zones" are excepted *de facto* shipwreck areas.

In Turkey, various state and non-governmental institutions such as the MoCT, the General Directorate of Foundations[7], the Turkish Historical Society[8], the Turkey Science Academy[9], universities, municipalities, and other non-profit organizations are working on establishing cultural heritage repositories[10]. However, to date, except from some non governmental attempts, such as TAY Project, there is no compilation of this vast heritage. Moreover, Turkish archaeology is often criticized to have insufficient publication on the excavated and surveyed sites (Yamaç and Tanındı, 2009) when compared to the vast archaeological heritage.

2.2.2. International Perspectives

There is a sequence of charters and conventions that leads the establishment of guidelines on the preservation of archaeological and historical remains. Athens Charter, created during the Athens Conference of 1931, organized by International Museums Office, established basic principles for an international practice for preservation. The Venice Charter, in 1964, underlined the importance of setting, respect to the original fabric, precise documentation of any intervention, and the significance of contributions

[7] The Turkish translation for the General Directorate of Foundations is *Vakıflar Genel Müdürlüğü*.
[8] The Turkish translation for the Turkish Historical Society is *Türk Tarih Kurumu*.
[9] The Turkish translation for the Turkish Academy of Sciences is *Türkiye Bilimler Akademisi*.
[10] A protocol was signed in 2005 between these institutions in order initiate a collaborative work towards creating standards and guidelines for digital libraries and databases. However, to date, no subsequent information of this protocol is available.

from all periods to the cultural heritage. The Venice Charter, which was adopted by the newly formed International Council on Monuments and Sites (ICOMOS) in 1956 and published in 1966, is an important modern milestone for the preservation movement. The Venice Charter was followed by a series of other standards, charters, formal recommendations and conventions relating to preservation.

Similar to these charters in the built environment, preservation of the archeological heritage is listed by International Council on Monuments and Sites (ICOMOS). The Charter for the Protection and Management of Archaeological Heritage is relatively new, when compared to charters on architectural preservation. Dating back to 1990, this charter defines the "archaeological heritage" as part of the material heritage. Following archaeological methods to provide primary information, archaeological heritage comprises "all vestiges of human existence and consists of places relating to all manifestations of human activity, abandoned structures, and remains of all kinds (…) together with all portable cultural associated with them" (ICAHM, 1990: article 1). Favoring *in situ* preservation, this charter forbids the destruction, degradation or alteration through changes of any archaeological site or monument or to their surroundings without "the consent of the relevant authority" (ICAHM, 1990: article 3). Accordingly, excavations are supposed to be carried out on sites and monuments threatened by development, land-use change, looting, or natural deterioration (ICAHM, 1990: article 5). In exceptional cases, unthreatened sites may be excavated to answer research problems and to interpret them more effectively for the purpose of presenting to the public. In that case, excavations are supposed to be partial, leaving a portion undisturbed for future research. Moreover, excavations should be conducted in accordance with the principles embodied in the 1956; UNESCO Recommendations on

International Principles Applicable to the Archaeological Excavations and that propose to have an adequate conservation, research, and exhibition of these excavated sites for dissemination of the information to the public.

For the protection of underwater cultural heritage, the 1996 charter and the 2001 convention explain the general principles and guidelines of the protection in the field of nautical archaeology. According to the Charter for the Protection and Management of Underwater Cultural Heritage in 1996, underwater cultural heritage is defined as the archaeological heritage which is in, or has been removed from, an underwater environment. It includes submerged sites and structures, wrecks sites, wreckage and their archaeological and natural context. Accordingly, the UNESCO Convention on the Protection of the Underwater Cultural Heritage in 2001 that adopted the UNESCO General Conference in 2001 intends to enable States to better protect their underwater heritage. As promoted in the information kit of the 2001 convention, the fundamental principles which favor the *in situ* preservation of underwater cultural heritage should be considered as a first option. If further research is needed, non-destructive techniques, non-intrusive survey and sampling should be encouraged in preference to excavation. During these investigations, unnecessary disturbance of underwater cultural heritage should be avoided. If any disturbance is necessary, an adequate documentation should be accompanied by the research. In overall design of the research, public access should be encouraged as well as the education of the related parties (UNESCO, 2001: article 1).

Consequently the question is how we can protect these underwater sites by retrieving the necessary information out of the artifacts that are defined as "underwater cultural heritage". So as a general review, all the charters and conventions listed above encourages the *in situ* preservation and non-destructive surveys as a general philosophy. This preservation methodology seems to be conflicting with the archaeological fieldwork as the latter favors methodological destructive excavations.

2.3. Scope of the Archaeological Surveys

Turkey, including the Anatolian Peninsula, occupies one of the most ancient settlement areas of the world at the trade roads of ancient civilizations (Özhan, 2005: 12). Similar to archaeological sites on land, there are many sites along the Turkish coastline where ancient shipwrecks or sunken archaeological ruins of ancient settlements are located. As a proof of the ancient maritime trade routes, these shipwrecks include many cargo materials produced in nearby settlements. On the way to designated ports, these shipwrecks sank leaving unanswered questions to the archaeologists: Why did these ships sink? What were they carrying? Who were they? Where were they trying to go? Archaeologists, as scientists, try to discover these shipwrecks and its cargo materials to explain the relationship of ancient settlements: What were the maritime routes in that specific time? What was the relationship between these civilizations?

The Teke peninsula is located in Lycia in the southwest Anatolia. This is a long and dangerous rocky coast housing several protected ports such as Telmessos, Patara, Antiphellos, Andriake, Phoinikousa, Phaselis (Akurgal, 1978). Lycia lay on strategic Eastern Mediterranean maritime trade routes between the Levant, Egypt, Cyprus, Greek islands, the Greek mainland and the other Anatolian coast (Keen, 1998). The region of Kaş, named as Antiphellos in ancient Greek and Habesos in Lycian, has a long history before the Bronze Age (Bass, 1966). Uluburun Shipwreck as well as other shipwrecks such as Gelidonya Shipwreck, dating to Late Bronze Age and Serçe Limanı Shipwrecks, dating to Byzantine period (Bass, 1996), located respectively on the east and west coast of Kaş show that this Lycian region is on the ancient trade routes. Uluburun, dating from the Late Bronze Age is the oldest known shipwreck, and it demonstrates the ancient trade routes by its cargo composed of various *amphorae*, ingots, *pithoi*, and stone anchors (Pulak, 1998).

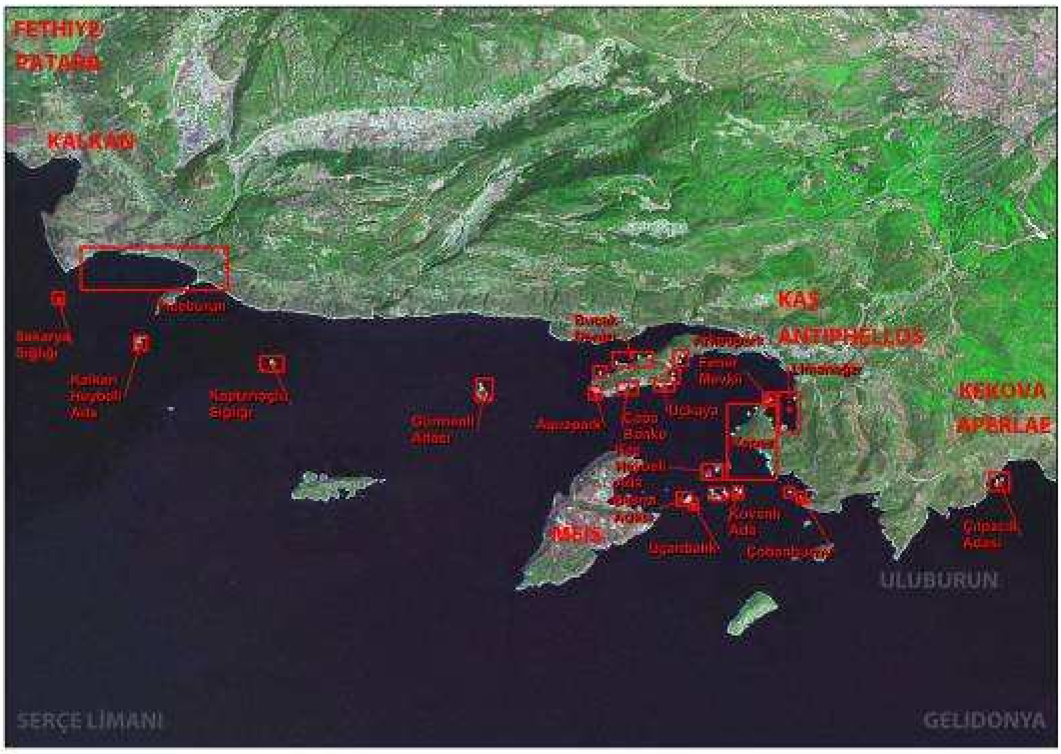

Figure 2.2. Scope of the surveyed sites.

Among all the coastal regions of Turkey, Kaş stands out as an area rich with geological (Bayari, in press) and historical resources, including the remains of ancient Phellos and its harbor, Antiphellos, partially integrated into modern Kaş (Zimmermann, 2005). Excavations carried out at the Uluburun Wreck have fundamentally influenced the course of the development of underwater archaeology and the understanding of Late Bronze Age interconnections of the Mediterranean world (Yalçın, 2006). Surveys carried out on coastal Turkey have included also the region of Kaş (Fig. 2.2) (Yıldız, 1984; Özdaş, 2007; Frey, 1984) but these efforts illustrate, more than anything, how much more information is still left unrecognized and uninvestigated, how much more detailed work is still needed, and how much more the underwater cultural heritage of Turkey is in need of trained divers in archaeological research.

2.4. Discussion

Today, underwater cultural heritage, shipwrecks and underwater ruins are becoming increasingly accessible, with the advent of SCUBA, self contained underwater breathing apparatus that allows humans to reach the depths of 42 meters as sports diver regulation permits, and far beyond the hundreds of meters as technical divers, and thousands of meters by the help submarines and submersibles. Once reached, the human tends to collect, either as treasure hunters to sell and make profit of the objects, or innate collection instinct. Either way, destruction, looting and commercial exploitations endanger the artifacts, as special care and conservations methods need to be applied to these waterlogged materials that have stayed underwater for a period of time. However, looting, selling and exploitation of underwater artifacts continue, as there are gaps in the legislations.

The review of current legislations on cultural heritage shows that legislative measures for the control of major archaeological research are lacking in Turkey. Although there are a few regulations, which are partially related to the topic and include some requirements for researching and reporting, many aspects such as the cultural heritage management and information to the public are not covered by this legal framework.

Although several studies have been performed in the past, covering wide topics such as cultural resource management, and the preparation and implementation of coastal zone management plans, the outcomes of the studies have not been put into practice. Moreover, archaeological sites are delegated to archaeologists who hardly have any systematic excavation, conservation and display programs of the cultural heritage sites. Not only visitors as recreational divers, but also archaeologists contribute to this destruction. In places where resources are available for maintenance, importance is largely given to excavations, moving artifacts into museums, thereby separating from the context in which they were first found.

As favored by UNESCO, in situ preservation of underwater cultural heritage should be considered as the first and preferred option before allowing or engaging in any archaeological activity directed at this heritage (UNESCO, 2001). Although not signed by Turkish authorities, following the UNESCO guidelines, the data collection methodology used in this dissertation follows the principles of the *in situ* preservation, the importance of and respect for archaeological context where the cultural object is found. As the participants to data collection surveys are not by education archaeologists, this methodology seeks to prevent the repetition of errors made in previous centuries when cultural objects were removed from their original locations. Furthermore, it seeks to discover new methodologies of data collection within these constraints. As underwater cultural heritage are well preserved owing to the low deterioration rate and lack of oxygen, it encourages the divers to visit these heritage sites without disturbing the material culture. Finally this project encourages the environmental awareness programs for local people, interested archaeologist and the on line users to promote the preservation of underwater cultural heritage.

CHAPTER 3

3. Virtual Museum

If not looted or destroyed by local people, cultural heritage is moved to museum by educated parties, such as archaeologists, museum curators, or the authority in charge. When placed in a museum, these "salvaged" cultural objects are considered to be preserved at highest level. Museum, as defined by International Council of Museums (ICOM), is a public place that acquires, conserves cultural heritage. After scientific and academic research, collections are communicated to the public through exhibitions. Museology, the theory and practice of museums, studies the experience of the visitors through the eyes of the institution. Eliminating the arbitrary private collections and opening collected works into a public sphere, museology has gone through numerous theoretical discourses.

The museum, regarded as the treasure house of authentic objects that are detached from its original context, has moved to a place of heterotopias in which "all the other real sites that can be found within the culture, are simultaneously represented, contested, and inverted" (Foucault, 1986: 24). Foucault argues that both the museum and library "heterotopias of accumulating time" are the products of Enlightenment (Bennett, 1995: 1). Positioning in opposition to these institutions, Foucault criticizes the idea of accumulating everything to establish "a sort of general archive, the will to enclose in one place all times, all epochs, all forms, all tastes […]" in museums (Foucault, 1986: 26). Defined as a space of difference and space of representation, museum has the potential to transform in the digital domain.

Digital domain brought new meanings, concepts and practices to the definition of museum. Virtual museum is not only a storehouse of objects but of knowledge. The term "digital reproduction" can be used for this transformation, referring to Benjamin's famous essay "The Work of Art in the Age of Mechanical Reproduction" (Benjamin, 1969). Benjamin's critic on the lack of "aura" of the original is replaced by the democratization of reproduction in the digital domain. Through the WWW, this digitized heritage can reach a larger public without being detached from its original context responding to Foucault's critique of museums.

Finally, the practices of museology and their counterparts in the virtual domain are explored both as a tool for the archaeologists and curators to convert the objects of cultural heritage into digital representations. These representations provide visualization of the cultural objects and the advanced technologies for their display along with the communication and interaction in a virtual museum environment. Within the scope of the dissertation, the usage of technology in "museum without walls" is only concerned with an online system that integrates digitally collected data. Using the potentialities of virtuality, the perspective of this dissertation on virtual museum is based on transforming museum objects into digital reproduction to explore the flexibility and potentiality in the virtual domain, on using visualization tools both as analysis and exhibition tools, and on creating an interactive environment to communicate this digital heritage through an online system called virtual museum.

3.1. Museum

Museums certainly are the institutions most representative of cultural heritage (Vinson, 2001: 61). Today there are several museums in every developed country. Depending on the subject, museums are dedicated to collect, preserve, research these cultural objects. In the case of a museum of archaeology, archaeologists are among the first to develop cultural contents. Sometimes coupled with conservation labs, museums and similar institutions are the places where heritage objects receive an academic care. Museum objects, different from other similar objects, are replaced in a new context in the museum space (Alberti, 2005: 561; Vinson, 2001). Usually decided and designed by the curators, the display mechanism aims to exhibit the object allowing the communication between the object and the visitor. Along with the practical considerations, or activities such as collection, preservation, research, communication, and exhibition, museum is defined as an institution housing cultural contents.

3.1.1. Definition of Terms

As defined by International Council of Museums (ICOM), the cultural heritage of humanity and its environment are displayed in museum that is defined as "a non-profit, permanent institution in the service of society and its development, open to the public, which acquires, conserves, researches, communicates and exhibits for the purposes of education, study and enjoyment" (ICOM, 2007). As the definition implies, museum's concern is objects which form their collections. These collections are displayed to the public through a process of musealization and visualization.

Musealization is accepted as placing the objects in museum, and sometimes goes hand in hand with heritagization, that is the idea of preservation of an object or a place, but it does not cover the entire museal process (ICOM, 2010: 50). Musealization begins with a phase of separation (Malraux, 1947): objects are separated from their original context to be studied further. The museum object is no longer an object to be used or exchanged, but rather it delivers authentic evidence of reality, named as the "aura" (Benjamin, 1969). This detachment from the original context is done sometimes by illegal looting or salvage excavations or systematic archaeological research. It is for this reason that musealization, as a scientific process, includes the essential museum activities: preservation which includes the selection, acquisition, conservation and management of collections; research which includes the analysis and study of the knowledge and communication via exhibition, publications, etc. Visualization includes exhibition of objects in line with the communication to public.

The properties listed above are not only specific to museums; there are similar cultural institutions to museums such as libraries, archives and repositories. While libraries, and museums look similar repositories housing cultural resources, there are some fundamental differences in what is collected, in how these collections are organized, and in how the users interact with. The traditional library is based upon the individual objects which are generally not unique. Archives manage groups of works and focus on maintaining a particular context for the overall collection. Repositories are focused on the acquisitions of the items. Museums collect objects of cultural value and place them in a curatorial context. The cultural value of each object provides the distinctions of what is collected and affect each institution's acquisition policy, cataloging, preservation and presentation to the public.

Libraries and museums are both repositories, while museums are object-centered, libraries are user-driven. While libraries provide free access to a vast amount of material, i.e. books which users freely make their own connections between works; museums provide a curator-driven navigation, a limited access to artifacts, usually through a particular interpretative exhibition context provided by curators. Museums provide a framework in which users can navigate within that smaller context. However, archives and repositories tend to be research driven. They are accessible in non-public spaces. (Dietz et al., 2003: 21) Thus, there are differences in these above mentioned institutions in terms of access, usability and content.

3.1.2. Theoretical Approaches

During Renaissance, the revival of learning in Europe, wealthy individuals, families or institutions began to form "cabinets of curiosity" in which art, rare and curious natural objects and ancient artifacts were displayed somewhat haphazardly (Renfrew and Bahn, 1991: 18). Later named as *wunderkammen* or *kunstkammen*, started in 16^{th} century Europe where art objects, instruments, artifacts of various nature, natural items, books and documents were basically integrated and displayed (Staniszewski, 1995: 171). This hybrid ensemble of all the collected entities was displayed without any conceptual glue, except from the curiosity of the collectors. Thus, the meaning of the collections is altered to a different order than what it was in its original context (Staniszewski, 1995: 173). Referring to Michel Foucault's famous book "The Order of the Things" on the ways we see and know ourselves and the word, new order of things began at the end of the 18^{th} century and the beginning of 19^{th} in modernity (Foucault, 1970). In his central thesis, he argues that all periods of history have possessed specific underlying conditions of truth that constituted what is expressed as discourse. He further claims that these conditions of discourse have changed over time. Different from the collections of the 16th and 17th centuries, in modernity there are public museums reserved solely for the works of art, archaeology and other disciplines. The principle reason behind the modern museum concept is to eliminate unstructured private collections. Exhibiting to the general public, beyond the elite and the privileged, this experience is to be shared instead of being cloistered and confined (Vergo, 1989).

As described above, museum is an institution of the Age of Enlightenment that attempts to order the world according to universal rules and the concept of a total truth. This approach is analogous to Foucault's definition of heterotopia that is a "space of difference, a space that is absolutely central to a culture but in which the relations between elements of a culture are suspended, neutralized, or reversed" (Lord, 2006: 1). Thus, a heterotopia is a real constructed space, yet it is outside of human tangibility and perceptions. Foucault's main examples of heterotopia are the cemetery and the ship: the ship is a "piece of floating space, a placeless place"; it functions according to its own rules in the space between ports, between cultures, between stable points (Foucault, 1998: 185). Other heterotopian spaces are hospitals, prisons, schools and museums. According to Foucault, the museum is a seminal example of a heterotopia.

According to Foucault, like encyclopedias and libraries, museums are monuments of the 18th century that impose to categorize, classify, and order the world in such a way to make it universal in scope and universally understandable. Foucault suggests a spatial and a temporal aspect: the museum brings together disparate objects from different times in a single space that attempts to enclose the totality of time. It is a house of collected objects, decontextualized from their original place. In this decontextualization, objects are reinterpreted in order to fit their historical era. The museum seeks to dissolve notions of time and geography by creating a non-place where the experiences are in a real location, but not of that time, and often geographically misplaced.

Correlated to Foucault's definition of museum, and following his critics on it, even today, museum remains an institution of the upper classes. Donated by wealthy individuals, collected by archaeologists and classified by curators, objects exhibited in museum are untouchable "heritage" in a glass box, with a definitive tag on it. Dislocated from its original context, the heritage is enclosed in the heterotopian place of the museum. Usually the original context is partially or fully recreated using both physical and digital tools. However, it is in fact possible to retrieve the hidden information in a heritage object using adequate digital tools, without losing the original context, thus preserving it for future generations. In the digital domain, the digital representation, which is completely isolated from the original material, redefines the practices of museology.

As the title of this dissertation indicates, the museum in this dissertation does not follow the traditional concept of a museum. The virtual domain and its implications for museology brought the definition of virtual museum, where the heritage does not exist in actuality. The material culture, which has been the basis of museums in most cases, was intricately connected to the formation of knowledge. In the formation of knowledge, the digital representation of objects and the emphasis on meaning of objects represent a break with the past practices. With its fluid character, digital domain shifted these pre-established definitions of museum and other heterotopian institutions.

Instead, the virtual domain not only facilitates to restructure the museology but offers new tools for the archaeology.

3.2. Virtuality

Virtuality is mostly associated with computer technologies, artificial environments and is often considered as a means to capture and present something intangible, fictitious, and unreal that is unnatural and absent from the so-called "real" world (Telhan, 2002: 3). On the basis of the theoretical discussions of Baudrillard and Lévy, this dissertation relies on two concepts of virtuality (Ryan, 2001): virtuality as fake and virtuality as potentiality. In virtuality as fake theory, Baudrillard, the French cultural theorist claims that definitions of reality and simulations endangers the physical reality, by replacing or sometimes transforming into a *simulacrum,* a representation that has no relation to reality, (Baudrillard, 1995). Baudrillard says that signs that are used to represent things are drained of their meaning forming the hyper-reality. Possibilities opened up by new media technologies hold that the culture no longer copies the real but rather produces it. This real is an effect of television, computer screens, stereo headsets, virtual reality goggles, etc. As stated by Baudrillard, "the simulacrum is never what hides the truth – it is truth that hides the fact that there is none. The simulacrum is true." (Baudrillard, 1995: 1). The second approach is by Lévy, stating that the virtual is not directly related to false, illusory or imaginary. In that sense, the virtual is not the opposite of the real. On the contrary, virtuality is a promising potential mode of being that "expands the process of creation, opens up the future, and injects a core meaning beneath the platitude of immediate physical presence" (Lévy, 1998: 16).

As explained above, virtuality is not the reflection of the real, rather has become a reality out of many that has the potential to produce more realities. This conceptual approach is mostly supported by the architects of the new media. Named as the hypermedia, multi-media and finally new media, this dissertation sees the virtual world as a potentiality, with hidden future characteristics. Before discussing this inexplicable potential, a review on the media theorists helps to figure out how this media has emerged.

In "The Work of Art in the Age of Mechanical Reproduction", Benjamin focuses one particular form of the cultural heritage that is the artwork (Benjamin, 1969). He argues that mechanical techniques of reproduction and re-presentation such as film and photography, but also advances in printing, have had the effect of destroying the "aura". Benjamin defines the "aura" of the work of art, of a historical or of a natural object, the uniquely existing character in an object (Malpas, 2008: 14). At this point, drawing parallels, he further claims that this loss has positive drawbacks as it democratizes and politicizes art, which allows dissemination among larger communities. Although Benjamin wrote seventy years ago, long before the advent of digital media and with a focus on art work, the concepts he discussed about mechanical reproduction are applicable to digital domain. The connection he indicates between modern media technologies, whether new or old, analogue or digital, seems an enduring and essential one (Benjamin, 1969: 221).

Virtuality and its associated definitions have been used in different scholarly disciplines. Computer scientists define virtuality from a scientific perspective, as a tool for augmenting the human intellect. In the fiction literature, virtual domain is considered as a challenge for science fiction and cyberpunk. The new media theorists combine artistic and scientific approaches towards this new domain. Finally the legal framework, as often defined by UNESCO offers guidelines for better usage of the digital environment and its associated tools.

From a scientific perspective, the digital domain has a long history of more than 50 years. Influenced by the article of Vannevar Bush (1945) "As We May Think", Ted Nelson stated that emerging information technologies could extend the power of human memory to build creative tools transforming the way of reading and writing. Particularly concerned with the complex nature of creative impulse of the users, he saw the computer as a tool that would reveal the interdependence of ideas. In 1963, he coined the term "hypertext", i.e. the non-linear textual writing and reading (Nelson, 2002). Ivan Sutherland (1965) contributed numerous ideas to the study of computer graphics and computer interaction by "Sketchpad", a computer program considered to be the ancestor of Computer Aided Design (CAD). He predicted that advances in computer science would make possible to engineer virtual experiences that were convincing the senses. He introduced conceptual approaches to 3D modeling, visual simulations, CAD, and virtual reality. In 1985, Scott Fisher developed an interface that would include all the senses, conducting the viewer into a realm of full sensory immersion. He added headphones for 3D audio, a microphone for speech recognition, adapted the data glove, the wired glove worn by the user that makes it possible to recognize virtual objects in cyberspace. This multi-sensory interaction with the cyberspace created the powerful illusion of immersing into a digital environment.

From a literary perspective, there has been a tendency to draw parallels between virtuality and technology, or between the cyberspace and information space of the computer, ever since William Gibson published his cyberpunk novel Neuromancer. In this novel of 1984, he coined the term cyberspace, as a "consensual hallucination", a "physically inhabitable, electronically generated alternate reality" (Gibson, 1984: 51). The implications of a wired and digital culture influenced the scientists, researchers, theorists, and artists.

From an artistic perspective, Lev Manovich, the media theorist, places new media within the most suggestive and broad ranging media history since Marshall McLuhan. According to his prominent book, "Language of New Media", Manovich (2001) describes the general principles underlying new media. These five principles are numerical representation, modularity, automation, variability and transcoding. Represented by numbers, objects exist in the digital domain independently and in multiple versions, and they can be created and modified automatically. Finally, the logic of the computer influences how we understand and represent ourselves. Later used in different medium, computers offer enormous possibilities for the enhancement of heritage experience and interpretation.

From a legal perspective as offered by UNESCO, digital heritage is resources of human knowledge or expression. Whether cultural, educational, scientific, administrative, or embracing technical, legal, medical and other kinds of information, digital heritage is "created digitally, or converted into digital form from existing analogue resources" (Webb, 2003: 13). Whether it is "born digital" or "converted into digital", and the digital heritage comes in a wide variety of formats: text, database, audio, film, and image.

Collecting and preserving cultural heritage for future generation as well as selecting which one to preserve is largely discussed by communities. In the last decade, academic, commercial, and research worlds tackled with virtual heritage. As the digital domain has become more accessible to larger communities, especially to the field of archaeology, more and more academic discussions started to spread. Today, used interchangeably in different fields, "virtual heritage," "digital cultural heritage", or "new heritage" is a common theme in research grants, academic programs, and at numerous conferences and workshops (Addison, 2008: 29).

In the museology, virtuality is mostly associated with the virtualization of physical museums. Museums found themselves surrounded by the new media in the mid-1990s. As recommended by ICOM in the 1995 policy statement, museums started to actively contribute to internet information to play their role in society more thoroughly (Babic, 2009: 141). Within the scope of this dissertation, the visualization tools used in physical museums is not discussed into detail. Instead, the virtual museum is conceived as a museum that exists only online.

3.3. Virtual Museum

The idea of the virtual museum is currently under construction. Museum-related digitized information resources are synonymously used as electronic museum, digital museum, online museum, hypermedia museum, meta-museum, web museum, and cyberspace museum. All these terms have one thing in common: they are online (Schweibenz, 2004: 3). As the title of this dissertation implies, the term virtual museum is preferred rather than above mentioned attributes (Fig. 3.1). The reason is that no matter what technology or medium is used, this new emerging museum type has the potentiality of the virtuality as explained in the previous section.

In this section dedicated to an overview of the concept of the virtual museum, the definition of "museum without walls" as often used by Schweibenz (1998) explains best this concept:

> "a logically related collection of digital objects composed in a variety of media which, because of its capacity to provide connectedness and various points of access, lends itself to transcending traditional methods of communicating and interacting with visitors (…), it has no real place or space, its objects and the related information can be disseminated all over the world"

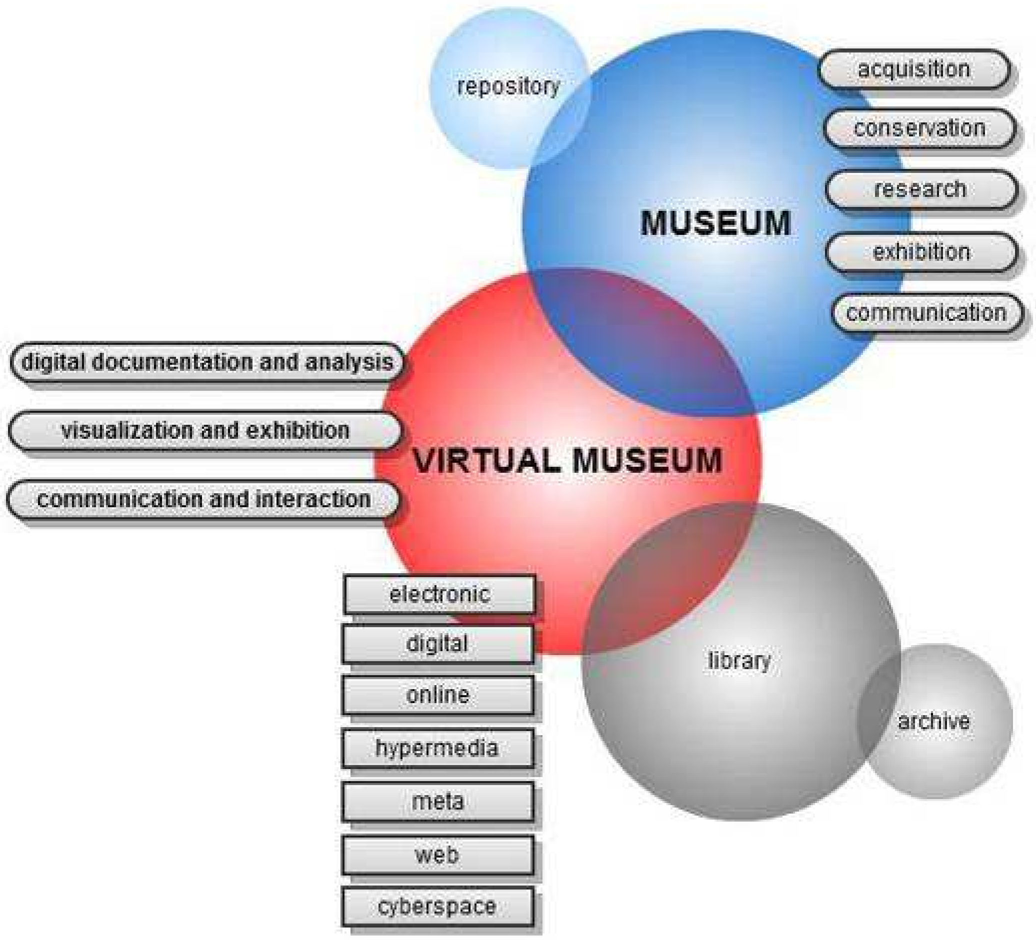

Figure 3.1. Definition and scope of the terms on museology.

According to Schweibenz's (2004), the term virtual museum covers a variety of categories. It is used as brochure museum, content museum, learning museum and virtual museum as this dissertation implies. The first type, the brochure museum is an advertisement web site of "brick and mortar" museum. It includes the contact information of the museum as well as a quick review of collections housed in that building. Secondly, the content museum type does not only invite the visitors to the museum building but also presents the museum collections online. That is an object-oriented museum. Third, the learning museum is a context oriented museum. Visitors' age, background, knowledge are considered and linked to additional information, it motivates the visitor to learn more about the subject and revisit the site. The final type is a virtual museum. Digital collections and information are linked as implemented by André Malraux's vision of the "museum without walls". It contains logically related collection of digital objects composed in a variety of media and has the capacity to provide connectedness from various points of access (Dietz et al., 2003: 24). Lewis described virtual museum as: "a collection of digitally recorded images, sound files, text documents, and other data of historical, scientific, or cultural interest that are accessed through electronic media" (Schweibenz, 1998: 190). This criticism that virtual museum lacks the permanence and unique qualities of a museum as it does not house actual objects refers back to Benjamin's lack of "aura" in the digital domain. However, reproduction in the virtual environment brings the democratization of the information. The WWW has the potential of disseminating the information to a wider public sphere.

As explained above, when compared to the long tradition of "brick and mortar" museums, virtual museums in technological sense, have been "under construction" for about a decade. Regardless of the name, the idea behind the phenomenon is to build a "museum without walls" as in Malraux's definition, which brings together digital collections all over the world. As a general agreement, virtual museum is understood differently in different disciplines.

When the field of archaeology is considered, the digital domain of WWW is mainly used as a medium for advertising as in the case of brochure museums, and recently as to a small extent, a data communication or scientific research tool. Although the internet is considered a popular medium, not a scholarly one, in recent years, an increasing number of excavations is published in WWW (Hermon and Niccolucci, 2000). Besides using the virtual world as an exhibition space, archaeologists began to use the digital technologies as an aid for analysis and documentation.

Similarly, in the digital domain, distinctions between libraries, museums, and archives begin to blur. The so-called digital repositories offer users the possibility of navigating through representations of objects and cataloging records on their own, making their own links between works. The essence of digital library is "the collection of digital surrogates for, or reproductions of, museum objects, with associated metadata or catalogue records that enable them to be retrieved and displayed individually" (Barton, 2005: 150). New combinations of objects may be created automatically; thus users may create their own combinations of objects using the search and browse functionalities enabled by metadata.

Virtual museum applications can be classified in line with usage of digital technologies. In the digital domain, three main practices of an actual museum are interwoven with the information technology that the virtual museum uses. Digital documentation and the related analysis tools is an aid for the archaeologist to create information out of the data collected. Once this information is created; exhibiting to the public in a virtual environment is achieved by some visualization tools. In that visualization process, the main aim is to inform the community, as well as propose some interaction tools to this knowledge forming process.

3.3.1. Digital Documentation and Analysis

For preservation, the heritage should be documented with highest level of accuracy and precision. Documenting or recording is capturing the information which describes the physical characteristics, condition and use of the cultural heritage. Traditional techniques, such as hand surveys, sketching, still and video images form the essence of digital methods in conveying the characteristics of a cultural heritage object into the representational domain. For instance, hand measurements register dimensions and features, photography records scenes of information including general outlines, lighting quality, and the appearance, and sketching record a view in a more subjective format (Akboy, 2007: 18). Compared to clumsy hand-held devices and techniques used in the documentation of cultural heritage, the digital domain brought several challenges. By the development in information technologies, three dimensional (3D) documentation tools, from electronic surveying instruments to laser scanners, photogrammetric cameras, and even Computer Aided Design (CAD) modelers, have brought more and more heritage data into the digital domain (Table 3.1) (Addison, 2008: 28).

Although considered as traditional surveying methods, the theodolite, Electronic Distance Measurement device (EDM) and total station are technological devices used in digital documentation domain. The theodolite, developed in the early 19th century, is a telescopic instrument for recording horizontal and vertical angles of target objects. Even though not applicable to nautical archaeology, it is occasionally used in recording harbor sites, semi-submerged city remains. Total station, a more advanced version of theodolite, is an optical instrument which includes an electronic theodolite, an EDM with integrated software and an external computer. In addition to angles, total station measures both angles and distances from the instrument to the points to be surveyed.

Table 3.1. Digital capture technologies.

Visual	Still & video cameras, color scanners
Dimensional	3D scanners, photogrammetric and surveying instruments such as Electronic Distance Measurement tools (EDM), Total Station, Ground Penetrating Radar (GPR) etc…)
Locational	Global Positioning Systems (GPS)
Aerial	Satellite Images, Geographic Information Systems (GIS)
Environmental	Thermal, acoustic, Carbon 14 (C14) MRi, X-Ray
Underwater	Remotely Operated Vehicle (ROV), Side Scan Sonar (SSS), magnetometers etc…

Considered to be one of the advanced surveying techniques, started in the 1970's, by the usage of photogrammetry, the three-dimensional coordinates of points on an object can be determined by measurements made in two or more photographic images taken from different positions. In other words, photogrammetry measures and draws by the help of photographs. Panoramic and photomosaic images are used sometimes as photogrammetric tools, as well as an aid to the visualization of sites and objects.

As the surveying technology advances, new tools have been added to traditional methods. Laser scanning, or 3D scanning, is a technology that captures the digital shape of physical objects. The collected data can then be used to construct digital 3D models useful for both documenting and visualizing. The captured data of 3D models is point cloud data for further processing. Although the accuracy is high, this gives only surface data to deduce the shape of an artifact. As often criticized with its enormous data size and complication of deducing dimensions, this technology has limited applications in underwater documentation.

Especially used in deep water environment, remote sensing technologies began to be widely used in archaeology (Singh et al., 2000: 319). Acoustic imaging, i.e. side scan sonar (SSS) illuminates the seafloor with sound energy and measures the reflections. Although SSS has been used for searching and mapping the seafloor, recent developments in its technology enabled acoustic images to achieve the quality of photographs (Singh et al., 2000: 320). Similarly, ROV, a multi-task underwater robot, linked to the operating vessel, often carries electrical power, video, and data signals back and forth to the vessel. It may include sonars, magnetometers, camera, and some other measurement devices, as well as a manipulator or cutting arm. Sometimes coupled with underwater acoustic positioning system, a system for tracking and navigation of underwater vehicles or divers, ROV's are mostly used for deep water research, meaning far deeper sea beyond the reach of a diver. The application of ground-penetrating radar (GPR) and other methods of geophysical survey have provided numerous examples of the need to visualize complex and noisy data. The particular problems of remote sensing underwater also have stimulated a number of visualizing projects.

In addition to all these named capturing technologies for dimensions for locational properties of the sites and objects, Global Positioning System (GPS) and Geographical Information Systems (GIS) coupled with satellite images are used in the field of digital documentation. GPS is a space-based global navigational satellite system that provides reliable location and time information. Through its widespread use today, the users can acquire 3D coordinates on earth. GIS is an information management tool which enables integrating, storing, editing, analyzing, and displaying geographically referenced information. Together with satellite images, GIS is used widely as an analysis tool in archaeology in the last decade. Another analysis tool is the application of image processing and 3D imaging technology in archaeology, such as artifact classification, conservation, geophysics, aerial photography, and satellite imaging. These digital technologies brought highly accurate heritage data in the field of heritage preservation. Data is more accurate, yet creates large files that are harder to handle.

These digital tools have been used in the field of both nautical and on land archaeology for more than two decades. Geographical information systems (GIS) are widely used in many archaeological surveys and excavations. However, an integrated system of online documentation and analysis does not exist yet in Turkey. Moreover, none of existing systems integrates further visualization and exhibition tools for the dissemination of information to a wider public. Beside archaeological analysis and documentation tools, visualization and exhibition is imperative for a virtual museum.

3.3.2. Visualization and Exhibition

Visualization is the technique of creating still, video or constructed images following the technologies (Table 3.2). Both in archaeology and museology, visualization is used as a tool for analysis and communication to convey a meaning. Accordingly, the visual information in the digital domain is examined by archaeologists and the users of a potential virtual system.

Table 3.2. Digital visualization technologies.

Capturing	Photogrammetry and video capturing
Modeling	3D modeling, rendering, animation
Virtual Reality	Headsets, goggles, data gloves
Web applications	VRML, Flash, QTVR

The visualization of archaeological information is one of the most attractive ways in which computer technology can be employed in archaeology as well as museology (Richards, 1998: 339). The term visualization includes almost any exploration and reproduction of data by graphical means. In his overview of computer applications in archaeology, Richards argues, that these exploration techniques allow "visual interpretation of data through representation, modeling, and display of solids, surfaces, properties, or animations" (Richards, 1998: 339). After 1990s visualization meant generally three dimensional (3D) modeling. Although the development of 3D technology was widely used in other fields, starting with the military and medicine and later in the film industries, its application in archaeology took a decade. Along with the developments in computer hardware and decrease in computers' processing time, the techniques of solid modeling started to be used for visualization in archaeology. Allowing archaeologists to visualize the above ground appearance of sites out of the information gathered from the foundations, the earliest models were aiming to replace the paper model equivalent of the illustrations made by a talented hand.

In his outdated but seminal article, Reilly (1992) presents two terms on archaeology in the information age: data visualization and solid modeling. Data visualization, with its connotations in advanced computing, refers to techniques which allow "visual interpretation of data through the representation, modeling and display of solids, surfaces, properties and animations, involving the use of graphics, image processing, computer vision and user interfaces" (Reilly, 1992: 147). Solid modeling is the production of representations of solids, different from the surface models that are sets of rendered polygonal panels (Reilly, 1992: 148). These virtual reconstructions using solid modeling are later replaced by surface models. As opposed to solid model equivalents, these surface models were not giving any information on the solid geometry of the target object, but rather it is a series of two dimensional flat surfaces that can be rendered, that is the process of generating an image from a model, in a variety of ways. By means of computer programs, this virtual scene contains geometry, viewpoint, texture, lighting, and shading information. The attempt to render brought the importance of achieving photorealism in three-dimensional models.

The principal drawbacks of the types of 3D models used in museum displays nowadays are the lack of archaeological complexity. In other words, these models are blank, that is, they only serve visualization needs but do not provide any other information. The current techniques of surveying such as photogrammetry and laser scanning allow the preservation of the complexity lost during the creation of the models. 3D models can now serve as research tools to interpret various kinds of data (Meyer et al., 2007: 400).

In the virtual museology domain, the computer visualization can be used to a great extent in raising awareness in museums. Beginning of 1980's, virtual reality (VR) based museum exhibits began to emerge. VR with its fully immersive form has a great potential as a medium for interpretation and communication. By the late 1990's, exhibits tended to become academically focused. At the same time, museums began to computerize their collections. This digital revolution was not different than the digitizing a picture book with additional hyperlinks. Now, VR applications still exist in museum exhibitions but they are not as popular as they first appeared. Richards argues that the use of VR in museum displays became a problematic subject given that so far "it is essentially an individual rather than a group activity" (Richards, 1998: 342).

After twenty years after the great boom in VR in museums, most of science and technology museums used intensively this technology of immersive reality. As the social role of the museum was modified, in a way to become more interactive and communication based, all types of museums began to install various kinds of VR based displays (Pujol, 2004: 4). However, not all applications were successful in terms of conveying the message hidden in the "aura" of the archaeological object. As Barceló states, future advancement of virtuality techniques should not be restricted to "presentation" techniques but to explanatory tools (Barceló, 2001: 242). Another critique on these virtual tools is the negative effect of the "Disneyfication of culture". The VR techniques should be used along with the photographic tools to enhance the conveyed meaning (Kenderdine, 2007: 303).

By 1997, online virtual museums were built mainly by the advent of VRML, the increasing speed of computer processors and graphics cards, better resolution headsets, and failing prices of the hardware (Sanders, 2002: 188). Web-based visualizations began to utilize the virtual reality modeling language (VRML) that is a standard file format for representing 3D interactive vector graphics, designed particularly for WWW. Interactive multimedia presentations featuring animated i.e. Flash, 3D models i.e. VRML or panoramic i.e. Quick Time Virtual Reality (QTVR) elements have become standard for web applications (Addison, 2008: 29).

WWW was widely used by museums since 1990s as an exhibition and communication tool. Solely existing in virtual space, virtual museums offer to their visitors the experience of virtual exhibitions. The term exhibition refers to the result of the action of displaying collections, objects, etc. In the physical domain of a museum, the exhibited object is chosen by curators. By recreating an exhibit in a virtual museum, the effort of creating a narrative is recoded. In other words, virtual creator duplicates the actual space of the museum. That is to say, virtual museum curators simply copy the building space and then place or rearrange objects in the newly created space (Jones and Cristal, 2002: 10). The digital domain of a virtual museum provides a more flexible medium for creating different narratives. As the museum objects are converted to digital reproductions, the non-linear navigation of virtual exhibition is made possible. Moreover, digital technologies allow the user to create its own narrative out of the displayed information. Consequently, the digital domain offers a multiplicity of narration by communication and interaction tools.

3.3.3. Communication and Interaction

Communication is the action of conveying information. In archaeology, information is communicated through publication, such as field report, books, articles, and all kind of data. Significant developments regarding communication have recently appeared with new forms of electronic publications (Meyer et al., 2007: 400). Electronic publication blurs the distinction between traditional archive and hard copy report. WWW provides a tremendous opportunity to link distributed resources and removes the traditional divide between publication and archive, particularly detailed fieldwork data.

In the museum context, communication emerges both as the presentation of the results of research on the collections and as the display of information about the objects in the collections. Communication as practiced by museums can be interpreted in two ways: firstly, it provides presentation of the exhibited objects exhibited, and second, it is most often unilateral, i.e. without the inclusion of the receiving public in the communication process (ICOM, 2010: 29). This passivity is currently been replaced by interactive environment of WWW.

Table 3.3. Web 2.0 technologies.

Digital repository	Youtube (www.youtube.com) for videos, Odeo (www.odeo.com) for podcasts, Flickr (www.flickr.com) for photographs, etc.
Encyclopedia	Wikipedia (www.wikipedia.org), etc.
Diary	Blogger (www.blogger.com)
Social Community	Facebook (www.facebook.com) for tagging, Twitter (www.twitter.com) for folksonomy, Delicious (www.delicious.com) for social bookmarking

In the digital domain, digital repositories such as encyclopedias, diaries, social communities that allow users to share and display their own choices redefine their analog versions (Table 3.3). In Web 2.0, the latest version of WWW, the websites are dynamic. Websites, i.e. wikis, that allow users to create, edit, and link web pages are replacing paper versions of encyclopedias with their open-content features. The content is added by collaborative contributions, thus they serve as not a scholarly but a reliable source for basic information on various subjects. Another feature of Web 2.0 development is blogs, i.e., personal websites where entries of different content types, are commonly displayed in reverse chronological order. Tagging, folksonomy and social bookmarking tools let users tag and annotate i.e. attach keywords to a digital object to describe it. Furthermore, multimedia sharing services allow storage and sharing of multimedia content.

Most museums, cultural sites, libraries, and other educational and cultural websites are predominantly static, not interactive (O'Reilly, 2005). They provide solely the contents, accepting users only as consumers. This passive display became more interactive as some cultural heritage organizations started to introduce web 2.0 services in their web pages. These web-based applications with "architecture of participation" are transforming the methods of both production of and access to cultural and educational contents. Heritage institutions evolve towards user generated content (Middleton and Lee, 2007). However, most of Web 2.0 applications in museum environment share the common approach of merely giving to the users the tools to record curator-driven collections. Only a few expert members still are the main content providers. This is different from a full 2.0 approach, in which the users are given the real opportunity of creating contents in a collaborative manner.

The recent shift of focus from physical characteristics of objects to narratives brought the formation of collaborative knowledge. In the web 2.0 environment, the users gained an active role in this process. Accordingly, in museology, virtual museum offers a unique environment from which to study the way in which knowledge is accumulated, analyzed, and distributed. Through the communication tools presented above, virtual museum became an interactive collaborative environment.

3.4. Discussion

Museums have undergone a process of different degrees of openness and accessibility to the public. After the advent of digital technologies, the meaning of museum has shifted using the potentialities of virtuality, giving birth to the new concept of virtual museum. In the current debates, virtual museum is mostly associated with the reflection of reality, particularly bringing the problematic discussion aura in the age of digital reproduction. In the digital domain, peculiarities of museum, library, and archive have merged into each other. As opposed to "brick and mortar" versions, these institutions are liberated in many aspects. The virtual museum, "museum without wall" became an interface to the information network.

Museums have always had an essential role in the formation and dissemination of knowledge. In the digital domain, the concept of museums is redefined as museum objects are isolated from material. Unlike the museum object, the digital heritage can be manipulated through analysis, visualization, and communication tools. Once captured by digital documentation technologies, the data can be interpreted by archaeologists. The analysis tools offered by information technologies augment the human intellect. Out of these analyses, the adequate visualization of the heritage objects can display the information for a better communication to the public. By using WWW as a means of communication, virtual museums redefine the museum experience. In particular, the associative capabilities of hypertext provide enhanced and extended experiences to include things which simply are not possible in the "brick and mortar" equivalent. This collaborative process of knowledge formation blurred the boundaries of author/ reader, curator/visitor, and even archaeologist/user.

It is not possible to create extensive archives on all the cultural heritage of Turkey within the restricted time frame and limited scope of this dissertation. It is, however, valuable to attempt to establish methods of data gathering, sharing, and preserving in order to explore the potentialities of virtuality. Data is real and, thus, can be seen as concrete. Yet, interpretative particularities affect the process of grouping data for attaining information. The procedure of reaching knowledge is further influenced by interpretive choices, thus, it makes multiplicity inevitable in managing information and knowledge. This study attempts to explore and determine ways in virtual space in which data and information can contribute to the preexisting notions of museum.

CHAPTER 4

4. Literature Survey

The broadening scale and scope of digital cultural heritage projects and the integration of different disciplines in archaeology necessitates the development of a digital repository. The representation and dissemination of data in a systematic, uniform and efficient way remains an essential discussion in the preservation of cultural heritage. Even though heritage professionals are exploring the means of developing digital repositories, the size and scale of these projects are often restricted to the extent of collections, geographical limitations and available resources (Crane, 1985; Castro, 2006; Varinlioglu, 2007). Furthermore, the rapidly advancing technologies and media challenge the implementation, maintenance and sustainability of the repository in digital repositories.

The digital repository is an information system digitally storing systematically collected and organized data. This system is the first step towards building differentiated digital systems such as virtual museums, digital libraries, etc. (Barton, 2005: 150). Significant heritage projects all over the world in the field of cultural heritage with an emphasis on nautical archaeology are examined (Fig. 4.1). These are Historic American Buildings Survey (HABS), Archaeological Settlements of Turkey (TAY, 1998), and Nautical Archaeology Digital Library (Castro, 2006), cultural heritage projects by the Institute for the Visualization of History, VIZIN (Sanders, 2003), a virtual museum project by

Virtual Museum of Canada (CHIN, 2009), digital repositories on nautical archaeology projects such as VENUS (VENUS, 2006), Roman Amphorae (Keay, 2005) and Big Anchor Project (NAS, 2008). Even though these projects belong to different parts of the world and are interwoven with diversified theory, practice and policy issues, the examination of these case studies from the preservation point of view provides us with the understanding of how to portray records of cultural heritage in a digital repository. Unlike the analog methods to store and make use of the heritage information, the virtual domain allows professionals to manage and disseminate the heritage data in the digital domain. These projects are significant to illustrate the diverse applications of cultural heritage management, and the assessment of these projects is a useful exercise to conceptualize the information system for virtual museum of underwater cultural heritage.

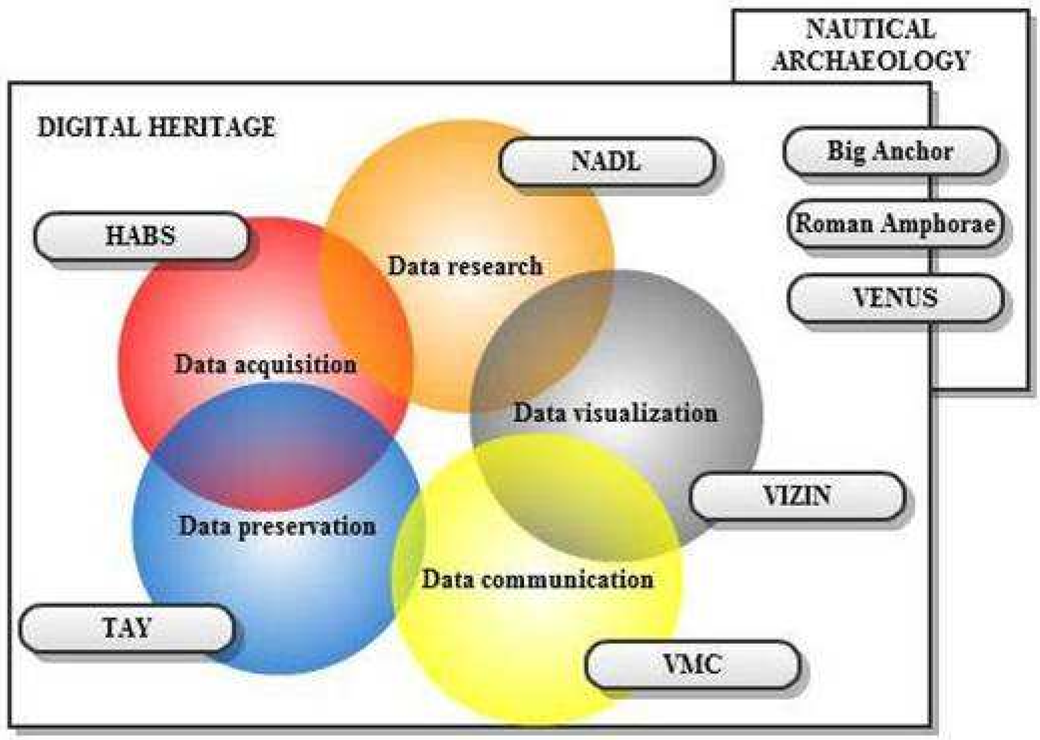

Figure 4.1. Scope of the literature review on digital repositories.

To date in Turkey, a web-based information infrastructure has not been completely integrated into the underwater cultural heritage. However this must become a standard component of the discipline. Although there are some attempts to create an inventory covering the entire cultural heritage domain in Turkey by the Turkish Academy of Sciences, and the non-governmental attempts by TAY project, the remains of nautical archaeology are not included in either of these established inventories. Thus, this chapter works towards the understanding of how to integrate a repository in the nautical archaeological practice in Turkey as well as in the international arena.

Information systems on cultural heritage are reviewed according to five practices they follow: acquisition, conservation, research, communication and exhibition (ICOM, 2007). The primary aims of this review are to determine the extents of these practices and to assess their quality and completeness. The selection is due to their widespread use in literature. Each example, besides its well-known handling of data, is an exceptionally fine archetype of museum practices as defined by ICOM. In order to achieve a better understanding of an ideal information system on cultural heritage, the following systems have been reviewed. First, HABS, HAER and HALS information systems are prominent examples for data acquisition and conservation on historical structures of the USA. The second example, TAY, is a non-governmental approach to conserve the "salvaged" data produced by archaeological excavations and surveys in Turkey. NAPL describes the initial steps for a database system on nautical archaeology that enables researchers to share their research. VIZIN displays an academic approach to visualize the archaeological sites, buildings. It has a special emphasis on the visualization of underwater remains, shipwrecks. VCM displays various virtual exhibits of museums in Canada from a single web page. Finally, Big Anchor, Roman Amphorae, and VENUS projects specialize in types of underwater archaeological remains, namely shipwrecks, *amphorae* and anchors in order to communicate the data.

4.1. HABS, HAER, HALS

The formal systematic and institutionalized process of architectural documentation for archival purposes began in the United States in 1933 with the establishment of Historical American Building Survey (HABS). HABS was one of the early recovery programs initiated by President Roosevelt, during the Great Depression. HABS sought out unemployed architects of that time, asked them to record the historic building collection of the USA with simple measuring tools. In 1934, this initial success in surveying was formalized by transferring the management of HABS to the NPS. Since then HABS, with the later additions of Historic American Engineering Record (HAER, 1969) and Historic American Landscape Survey (HALS, 2000), has been working extensively and is now the main documentation organization in the USA (Warden and Woodcock, 2005; Cliver et al., 1998).

Preservation through documentation has been the axiom of HABS since it was founded. The significance of the program is underlined in its memorandum as follows "the architectural heritage of buildings from the last four centuries diminishes daily at an alarming rate […] they should not pass into unrecorded oblivion" (Burns et al., 2004). Since its foundation, teams of architects and architectural students were organized in the USA in order to gather standardized uniform data about the built heritage. The objective of HABS was to gather a public record of built heritage of the USA for future generations. Once recorded in the Library of Congress (LoC), these buildings are supposed to be protected for future loss, being the only tangible evidence of their existence (Massey, 2003).

According to the agreement signed between the NPS, the Library of Congress (LoC), and the American Institute of Architects (AIA) in 1934, NPS sets the qualitative standards, directs the documentation process and the preparation of records; while LoC preserves the records, makes them available for study, and supplies reproductions upon request, and AIA provides professional guidance (Komas, 2005). HABS documentation projects are archived and digitized by the LoC, through the Division of Prints and Photographs. These copyright-free records, including the measured drawings, black-and-white photographs, color transparencies, photo captions, data pages including written histories, and supplemental materials are accessible by the public and available over the Internet (LoC, 2009). Together with the HAER and HALS documentation projects, LoC has approximately 600,000 measured drawings accompanied with photos and historic reports of 40,000 historic structures in the USA and new data is being added each year. HABS expands its collection by donations of student projects prepared according to predefined standards. Interested parties can also donate documentation drawings to HABS. As a principle, HABS does not accept any original historical drawings, photographs, manuscripts, or similar media donations to follow their standard guidelines.

The HABS and HAER documentation has to be prepared on materials that are readily reproducible for ease of access; durable for long storage; and in standard sizes for ease of handling. This documentation combines both visual and textual documents to explain and illustrate the significant characteristics of a historic structure. Visual records are mostly consisted of photographs, the contemporary and historic photographs and photographic copies of historic documents and illustrations; and of drawings, the historic, measured, or interpretive drawings. Written records are both historical and descriptive, displaying the research to determine the chronology and context of the structure being documented and the inspection of the physical fabric of the structure (Burns et al., 2004: 2).

The widespread use of digital documentation in the field of historic preservation launched new perspectives in capturing and communicating the significance of cultural heritage resources. Although cultural heritage professionals have started to use digital tools, digital technologies are used to generate two-dimensional measured drawings, digital elevation models, structure analysis reports and documentation reports. HABS recognizes the digital tools such as 3D laser scanner, digital photogrammetry and aerial imagery as heritage recording methods, but end products consist of standard two-dimensional drawings on Mylar. This dilemma is posed by the fact that digital media do not meet the 500-year archivability standard of the LoC; and the hardware and software necessary to recognize the digital files have a limited lifespan that makes them unacceptable for use in the Library. Thus, hard copies of the documentation records are submitted for the Library collection, and these traditional two-dimensional records are then scanned and stored separately in a digital repository.

4.2. TAY

The TAY project is a non-governmental organization (NGO) that was established in Turkey in 1993 for documenting and conserving information on archaeological settlements of Turkey (TAY, 1998). The principal aim of the project is to gather a chronological and regional inventory of all the cultural heritage of Turkey, particularly, the thorough documentation of archaeological settlements. Composed of archaeologists, architects, historians, scholars, and students, both professionals and volunteers, the project disseminates the collected, documented and organized knowledge of the 400.000 year-long history of Anatolia and Thrace to Turkish heritage professionals as well as to the international community through its website and publications (TAY, 1998). The concern was to underline that archaeological records on excavations and surveys in Turkey are neither well organized nor easily accessible. Thus, the team highlights the significance of a central inventory in order to document and preserve information about our cultural heritage for the future (TAY, 1998). Not accepted as scholarly at the earliest phase of the project, archaeologists extensively acclaim the endeavors of the TAY project. For instance Greaves and Helwing indicate that whereas few countries are experiencing the same levels of destruction as Turkey, however few are able to document and publicize as effectively as the TAY project (Greaves & Helwing, 2003, p. 71).

The primary objectives include collection by electronic salvage of cultural heritage, verification by comprehensive archival survey of Turkey, dissemination by publishing through websites and publications. Based on the published final reports of archaeological excavations in Turkey, the research through the Turkish Archaeological Journal[11], Turkish Historical Research Journal[12] and the International Symposium of Excavations and Archaeometry showed that only 86 out of 857 excavations had final reports (Yamaç and Tanındı, 2009). The development of a central inventory is not only

[11] Turkish translation for Turkish Archaeological Journal is *Türk Arkeoloji Dergisi.*
[12] Turkish translation for Turkish Historical Research Journal is a *Belleten.*

about dissemination of the already published data, but also aims to raise awareness of the lack of published archaeological records in Turkey.

The TAY database is based on chronological and regional information. The users can make inquiries about the collection using the TAY Search Engine (TAY, 1998). The catalog corresponds to the ancient names and locations of the archaeological settlements in Turkish provinces. The categorization of the data follows the historical and chronological periods of the ancient site. For the Byzantine era, the database is organized according to the building types. Black and white drawings and excavation maps accompany these records. In addition to the TAY Search Engine, the project also utilizes GIS as a technological medium, to spatially map, store and display archaeological data. GIS allows the project to create, edit, analyze, manage, display and share all geographical archival references (TAY, 1998). The users can query interactively and acquire information about the location, specifications, chronology, protection and destruction levels of each site. Furthermore, their web site allows also access to the TAY online dictionary (word base) that provides the archaeological terminology in Turkish, English, French and German. The project raises public awareness through its weekly online bulletin TAY News (TAY, 1998). A volunteer team browses all the newspaper articles on a weekly basis and shares the latest news through the online portal. Thus, the readers can access the latest news regarding the progress of excavations, heritage sites in danger, or the changes in the legal regulations. The team also frequently uses e-mail correspondence to communicate with the readers.

In this respect, their approach to the dissemination of data overlaps with the methodology of the LoC. The TAY project uses the traditional methods of archaeological library research, and electronically publishes the end product. Even though the significance of the utilization of technological tools and digital data is reflected through their efforts to utilize GIS as a data management tool; these endeavors lack the high technological standards of LoC. In this context, it should not be forgotten that the LoC is the oldest federal cultural institution in the USA and the largest library in the world. The library has substantial financial and human resources to maintain the digital collections. On the other hand, the TAY project is a small scale NGO that operates with volunteer work. However, with the addition of technological refurbishments, the project would definitely improve its infrastructure to deliver a more effective webpage and interface design to its users.

4.3. NADL

As opposed to many scientific disciplines, the practice of archaeology is not replicable. Consequently, the formal systematic archaeological documentation has been a must since the beginning of this discipline. Even though the recording process has been partially achieved, there has been very little effort to combine dissimilar information resources from different languages. However the formal systematic and institutionalized process of archaeological documentation for archival and research purposes began in the USA. Supported by the National Science Foundation, the Nautical Archaeology Digital Library (NADL) is a collaborative effort of researchers in TAMU Center for the Study of Digital Libraries (CSDL) and the Nautical Archaeology Program (NAP). TAMU-NAP was one of the early academic programs on nautical archaeology initiated by George Bass in 1976. As part of the Department of Anthropology, working in conjunction with the Institute of Nautical Archaeology (INA), TAMU-NAP (1976) focuses on the history of wooden ship construction, seafaring and seamanship through the ages, maritime trade routes as well as the cargoes, ports and ships. Leading many projects all over the world, this program is the temple of nautical archaeologists.

To satisfy the needs of nautical archaeologists, a digital library project was initiated to access, manipulate, study and consult a variety of sources from different media, geographical origins, ages and languages. This digital compilation of data aimed to connect various academic resources and researchers to "cross-link various data content in a dynamically-growing collection, flexible use of notes to enhance the community access, management of uncertain data, replication of digital library and visualization of 2D grids" (Monroy et al., 2006: 544). Given that, the content of the digital library had broad information resources such as excavation site, the archaeological process, the artifacts collection, shipbuilding treatises, and ship modeling and reconstruction (Monroy et al., 2006: 545). In the following stages of the project the project is concentrated to collect and share technical manuscripts of shipbuilding treatise by a multilingual approach (Monroy et al., 2007).

Geographically scattered archaeologists can use this digital library no matter where they are and what language the resources are, the system aimed to broaden the possibilities in the use and understanding of textual materials such as shipbuilding treatises (Monroy et al., 2009: 344). Moreover, their web-based interface of the glossary enabled scholars to work remotely in editing the glossary, expanding its contents and attracting other scholars (Monroy et al., 2009: 346). This cooperation aimed not only remotely editing materials, but also helped them to obtain new materials from other libraries. However, the attempt of creating a digital library remained limited in terms of its content. When the non-collaborative environment of archaeology is considered, the project remained restricted to the data provided by the project team. The project has never been widely used in nautical archaeology.

4.4. VIZIN

The Institute for the Visualization of History (VIZIN) is an educational organization combining advanced immersive computer graphics, virtual reality based education and detailed research of the past (VIZIN, 2003). Using data supplied by archaeologists, anthropologists, and historians, the Institute provides services for the visualization of the history of the places that no longer exist, that are otherwise inaccessible, or that are expensive or difficult to visit (Sanders, 2009: 16). Using computer vision technologies, it creates new tools for archaeologists who actually collect raw data in excavation sites. These tools consist of databases with linked images, and interactive 3D models such as animations, renderings, QTVR panoramas, virtual worlds and games. The emphasis is given to the usage of VR technologies both in the museum environment and online for the display of heritage collections. Various projects all over the world contributed to this visualization process by sharing their raw data with this Institute. Besides this academic background, VIZIN provides visualization services for customers such as school teachers, media centers and museums.

In collaboration with other heritage professionals, VIZIN used computer vision to change the way archaeologists conduct fieldwork by tools and techniques for excavation, reconstruction, and interpretation. Donald Sanders, the pioneer in the emerging field of Virtual Heritage, reconstructed the Kyrenia ship discovered in 1965

(Katzev, 2008). Once excavated with careful recording, out of the hull remains, two replicas, Kyrenia II and later Kyrenia Liberty are constructed and experimented to understand the voyage, loading and sailing capacity of the ship. However, expensive and time consuming experiments on these physical models were later replaced by digital models. In collaboration of VIZIN, Sanders began using the computer as a learning tool. After composing the digital reconstructions, the "virtual disintegration" on the seabed is reanimated. Thus the contribution of archaeological reconstruction project was not limited to only visualization of history, but also, to answer questions about the history of ships.

4.5. VMC

In its official web site, the Virtual Museum of Canada (VMC) is described as a virtual museum of artifacts in Canadian museum collections. It is a unique interactive space that brings together the collections through research conducted at the Canadian Heritage Information Network (CHIN) on the future of the virtual museums (Dietz et al., 2003). Besides the theoretical discourses on the next generation of museology in the virtual domain, it is an intuitive analysis of audience behavior. Five key areas studied by this review are the audience, interface, content, infrastructure, and sustainability. Accordingly, the key concepts related to a more user-centered design represent a platform based on functionality: Dietz claimed that "the next generation virtual museum should become exponentially more audience-centered, even if this appears to mean less focus on the goals and functions of individual institutions" (Dietz et al., 2003: 7)

As communication is the main issue VMC was created with a user-centered design. A visual metaphor of the museum is employed for home page navigation, described with museum arches leading to open spaces. Visitors are invited into the virtual museum to visit the artifacts and stories from different institutions across Canada. Once they entered through the virtual gate of the museum, their navigation can be directed either by the search engine or the hyperlinked navigation. The hyperlinked navigation is governed by the visitors' individual point of view (Deshpande et al., 2007: 269). Visitors always move in the direction of their choice. Thus the journey is entirely created by the interaction of the environment and its audience.

Besides the feature of user-centered design, VMC is a prominent example for a network of sustainable repository. Geographically distributed collections in Canadian museums are linked and displayed in this virtual environment. Moreover, with basic level imaging tools such as panoramic virtual tours of the museum environments and 3D modeling of selected objects, it explores the potentialities of virtuality. As Lévy is included at the conceptual design of this virtual museum, this project is a seminal example of the technological applications of theoretical discussions on the future of virtual museology.

4.6. Repositories on Nautical Archaeology

Although none of these three examples can be considered within the category of virtual museum, it is worth mentioning that these three are the most prominent information system on nautical archaeology. Based on shipwrecks, anchors of *amphorae*, specifically Roman *amphorae*, the way of categorizing the underwater cultural heritage was influential while designing the data collection methods presented in this dissertation.

4.6.1. Big Anchor Project

Big Anchor project is one of last projects of Nautical Archaeology Society (NAS), the prominent institution, organizing various training programs, publications and projects on nautical archaeology. NAS initiated Big Anchor Project in 2008, funded by various academic organizations especially from the UK. With special interest in stone and stock anchors, NAS has been working on this iconic symbol of the maritime past. Although anchors are considered symbols of the maritime world, there have been few studies in the field of archaeology specifically devoted to anchors except from books by Curryer (1999) and Upham (2001). Besides scholarly publications, surprisingly, little work has been conducted for collecting and organizing the information on anchors found on wreck sites, in museums and on public and private property (NAS, 2008).

By the website of the Big Anchor Project, NAS aims to develop a tool for the identification of anchors by helping individuals to gather information in a consistent format. The Big Anchor Project produced a freely-accessible, on-line database of anchors by gathering information through online datasheets and database. As this system is limited to volunteers all over the world, to date, limited number of anchors has been recorded. With future entries on the websites, the collection is expected to grow. In addition to submission mechanism, there is a search engine that defines the anchors according to type, context or location, date or origin, general information and the measurements. These initial steps of structuring the data gathered on anchors was influential at the design of the datasheets and information system designed and developed for this dissertation.

4.6.2. Roman Amphorae: A Digital Resource

Supported by the University of Southampton, Roman Amphorae project was funded by the Arts and Humanities Research Council between 2002 and 2005 in the UK (Keay, 2005). As a project of Archaeology Data Service (ADS), this project is an online introductory resource for the study of Roman *amphorae*. The format of the website is identical to other websites hosted by the ADS that supports research with high quality and trustworthy digital resources. By preserving digital data in the long term and disseminating a broad range of data in archaeology, ADS provides technical advice to the research community, and supports the deployment of digital technologies.

The website of the project is an online and introductory resource for the study of Roman *amphorae*, rather than a definitive study of all *amphorae*. Rather than the wide study area on ceramics, this site is concentrated on the principal types manufactured throughout the Roman Empire between the 3rd century BC and the 7th century AD. The preference of this historical era is to provide "basic information about the more common types of *amphorae* while trying to ensure as broad a geographical spread as possible" (Keay, 2005) Based on two key studies on amphora types from the 1980s by Peacock (1971), and Keay (1984), it illustrates basic typological information for 250 forms with full reference to characteristics, pictures, drawings, petrology, specimens and bibliography including detailed information on distinctive features, date range, origin, distribution, contents and classification of *amphorae*.

The website has been designed by ADS to have a standard ADS look and feel so as to be familiar to users of other ADS resources. The information is organized in such a way as to allow a user to browse in a non-linear fashion, with hyperlinks between related concepts. There are basically three main sections to the website: amphora types, fabric types, and bibliographic references. This website is both a product of thorough research and a repository for further studies on the amphora.

4.6.3. VENUS

Funded by European Commission, Information Society Technologies (IST) the 6th Framework Program, the Virtual Exploration of Underwater Sites (VENUS) project, aims to provide the scientific methodologies and technological tools for the documentation of deep underwater archaeological sites. This project helps the experts to study the sites beyond the limits of diving and makes the information accessible to the general public. The objectives were to acquire data through sonar (SSS) and photogrammetry, to create accurate 3D immersive reconstruction of the sites providing virtual access using virtual reality and augmented reality tools. Finally, the information is disseminated through web sites and archaeological publications. The emphasis is to use of advanced digital documentation technologies of sonars, ROV's and photogrammetry. The project is prominent in terms of giving insight on site exploration, not on single artifacts as in the case of previously mentioned repositories in the nautical archaeology. Besides scholarly purposes, the project intends to disseminate the information through 3D visualization tools of web such as VRML. Thus, covering the exploration, analysis, and dissemination of underwater sites, this project explores the usage of several technological media at various stages.

4.7. Discussion

The establishment of a digital cultural heritage repository in Turkey requires a collaborative work of both state and NGO's. The TAY project sets a good example in this context demonstrating the role of non-profit organizations in cultural heritage management. This organization has been one of many inspiration projects of this dissertation with its efforts to improve accessibility to archaeological records, raise public awareness, and preserve and promote the Turkish cultural heritage. However, the work is limited by its financial, technical and human resources. The project indicates the necessity of a common ground that allows the heritage institutions in Turkey to communicate their projects and complement each other's work. In this perspective, HABS is an illustrative case study indicating the significance of governmental organizations in cultural heritage management. The HABS collection is one of the largest cultural and historic resources archives of the world, hence ensuring that the past will continue an essential, inspirational dialogue with posterity. However, due to the Secretary's Standards, and the unsolved issues in digital data preservation, HABS still utilizes the archival technology from 1933. In order for HABS to embrace the technological media with all means, the advancements in archival technology should meet the Secretary Standards (Kapsch, 1990: 25).

The usage of digital technologies in the heritage management technologies is widely explored in various projects recently. Although NADL project was not the prominent example among digital libraries, it shows the needs and attempts to create a research platform for nautical archaeologists. Within the context of archaeology, VIZIN projects are well-known examples for the visualization of history, in terms of their widespread contexts and contents. However, the theoretical aspects of VIZIN projects remained superficial compared to VCM. This last project is a prominent example of a successful coordination and cooperation of various states museums with the idea of "museum without walls".

When the repositories in field of nautical archaeology are considered, the three examples discussed above, namely Big Anchor, Roman Amphorae, and VENUS emphasize the need to systematize the data collected at underwater sites. The attempt might be related to the fact that nautical archaeology has a higher level of interaction with other scientific disciplines, in particular information technology. As the underwater environment permits limited access to the visitors in terms of diving skills, time, and expertise, the projects are included and served interested parties other than the archaeologists.

A digital cultural heritage repository is a medium that allows the heritage professionals to preserve, manage, and make the data accessible to the public. Even though the digitization of the repositories challenges the heritage professionals in technical terms, these issues are being gradually solved with technological progress. The construction of knowledge in virtual space involves hyperlinks between different types and aspects of information, which is, in essence, groups of data. Within this general framework, a model in virtual space illustrates the concept of the museum as an interactive, recurrently re-interpretive, and experimental experience. The aim here is to form a platform of knowledge building through the collaboration of multiple authorities with different backgrounds and a variety of interests. In order to achieve this aim, the initial stage of operation is forming a web-based information system.

CHAPTER 5

5. Research Setup

Situated on the Lycian coast of Turkey, Kaş is one of the most significant sites in Turkey in terms of its natural, historical and cultural heritage. In addition to its rich archaeological potential on land such as the ancient city of Phellos and Antiphellos, Kaş is well known through Uluburun Shipwreck, one of the oldest shipwrecks in maritime trade history (Pulak, 1998). Since 2006, various projects have been conducted in this area, among which is the project presented in this dissertation. The foundations of "Kaş Archaeopark Projects" were laid in 2006 so as to have multi-disciplinary academic and popular projects in order to gain attention of local people, archaeologists, and everyone interested in historical and archaeological potential of Kaş and its environment. Within the "Kaş Archaeopark Experimental Archaeology Project" (2006) an underwater museum with the re-animation of the Uluburun ship and of its cargo was placed underwater in Hidayet Bay, Kaş. Called as Kaş Archaeopark, the Uluburun III wreck site and archaeological cargo site were subject to underwater archaeological trainings and experimental archaeology studies.

In 2007, during the fieldwork of the "Virtual Underwater Cultural Heritage Museum of Turkey: Kaş Archaeopark Project (2007)", the first steps of design for an online database system was created and various data collection methods were tested. Building up the workshops initiated in 2007, through a nation-wide training program, "Kaş

Archaeopark Erkut Arcak Science Camp (2008-2010)" a training program was developed for all the interested parties. The continuation of this foundation project, "Young Archaeopark Project (2010)" was to improve historical and environment awareness of the local youth by introducing cultural heritage concepts both above and underwater. Based on these above mentioned projects, an intensive survey along the Kalkan-Kekova coastal region has been conveyed in the project of Underwater Cultural Heritage (UCH) since 2007.

Using the common ground of the above-mentioned projects, this study is based on designing a system which incorporates the practices of collection, preservation, research, visualization and exhibit for the preservation of underwater cultural heritage. Named as virtual museum, it recognizes that no single satisfactory answer exists for the question of what a virtual museum is. It further recognizes that the means of acquiring information at a virtual museum can vary according to the nature of display for a multiplicity of audience by a multiplicity of interpretation by archaeologists. This study further seeks to avoid the currently present debate of such definitions as virtual museum, online museum, electronic museum, hyper museum, digital museum, cyber museum, and web museum. Instead, its objectives are developing a methodology for collecting, storing and sharing data, which scholars and other interested individuals can subsequently retrieve on the internet in order to create various meaningful groups of information.

In order to meet the objectives of the study, a comprehensive information system has been developed since 2007, which provides an integrated framework for the trainings and surveys done in the fieldwork campaigns. However, the presence of the system as software and hardware is not sufficient to have an effectively functioning system, which meets the requirements of the users properly. In addition to the technological infrastructure, the availability of data empowers the usability of the system. Without adequate data, no information system can be functional. Although the developed system has user-friendly interfaces and facilitates sharing of information by providing open-content environment, it is certain that the build up of data was time-consuming at the beginning and having a useful content took quite a long time if collaborative data collection should start from scratch.

In order to create this system, except from the initial design process that was mainly worked out during the field study of 2007, the methodologies were primarily tested on divers. Since 2007, the data gathering process and the ever-changing development of the system have lasted four consecutive years by divers and archaeologists. Although the complications of logistics and bureaucracy of an archaeological project took most of the research time, spending four years doing surveys was preferred rather than using existing archaeological datasets collected in previous studies because of four reasons: the lack of publicly available data on nautical archaeology, archaeological prosperity of Turkish coasts, the lack of systematic methodology based on *in situ* preservation and challenges of redefine the museology and nautical archaeology in the digital domain.

The lack of publicly available data on nautical archaeology was the first challenge. Accordingly there is no public information system for nautical archaeology used in Turkey. Limited research on underwater cultural heritage is published in the proceedings of some archaeological symposiums, journals and newsletters by the MoCT. These papers do not have a general common methodology to be formulated as a database. Another attempt was Shipwrecks of Anatolia Project (SOA) Project that relied on several years of research of INA. As is stated on its website, the mission was to provide regular on-line updates for research, including images, videos, and live web-cam transmissions. Aiming to extend the shipwreck database to include information about ancient harbors, underwater structures, and isolated finds, this web site tried to raise social and political awareness about the conservation of underwater sites (INA, 2001). After two short campaigns, this project dissolved without leaving behind any publication due to political and bureaucratic reasons. This last attempt documented several shipwrecks along the Aegean Coastline but it has never either become online, neither shared in academic fields.

The second challenge was the archaeological prosperity of Turkish Coasts. A vast amount of data still lies along the Turkish coasts. By gaining attention of the archaeologists, conducting an archaeological survey on undiscovered remains empowered the dissemination of data. As the non-collaborative academic environment of archaeology is taken into account, collection of new data along the coast was preferred to facilitate further research on the content of data and to prevent any potential copyright problem that would probably occur in an open-content online system.

The lack of a systematic documentation methodology based on *in situ* preservation was the third reason to do surveys. Accordingly, the researches done in Turkey are limited with excavations and surveys that both include some kind of destructions on the archaeological sites. As the second chapter clarifies, *in situ* preservation of cultural heritage was preferred to collect data rather than the objects. As this methodology was taken into account, the existing methodology used in long-lasting systematic destruction methodology of excavations, and short term systematic sampling methodology of surveys was not appropriate for this virtual museum project.

Last but not least, the challenges to redefine museology in the digital domain by collaboration of interested parties were the prominent reason. The field of museology has remained within the constraints and conventions of "brick and mortar" museums. In the digital domain, the definition of museum has shifted from a passive style to a more interactive domain. The virtual system created for this dissertation follows the wiki principles, as an open-source information repository.

During the field studies, several data collection tasks have been performed in order to supply an initial dataset, which shorten time required to have a functional system, demonstrate usefulness of the system, draw attention of visitors and first time users of the system to make them regular users, encourage users of the system to participate in data collection, and support archaeological studies.

5.1. Research Problem

Most of the studies on cultural heritage are related to the integration and interpretation of data but there is still lack of systematic methodology for collection, preservation and dissemination of data through online systems. Accordingly, a virtual museum of underwater cultural heritage requires the availability and access to data produced by nautical archaeology alongside tools for analysis, visualization and communication. The objectives of this case study are to formulate a framework for a collaborative data collection through field surveys, *in situ* preservation and presentation of the underwater cultural heritage and dissemination, analysis and sharing of digital heritage through an information system. Using the information system, separately produced analysis, visualization and communication methods are followed, in order to define the conceptual framework of a virtual museum. Moreover, conceptual design of a virtual museum system is given based on automation, immersion and interaction.

5.2. Research Questions

Based on the concepts stated above, the study examines the musealization issues of acquisition, conservation, research, communication and exhibition of nautical data:

1. How to formulate a framework for the collection of data on underwater cultural heritage using *in situ* preservation?
2. How this collected data is transferred into, stored and shared in the digital domain?
3. What are the methods of analysis, visualization, and communication conducted through the information system?
4. How can this system be transformed to a virtual museum?

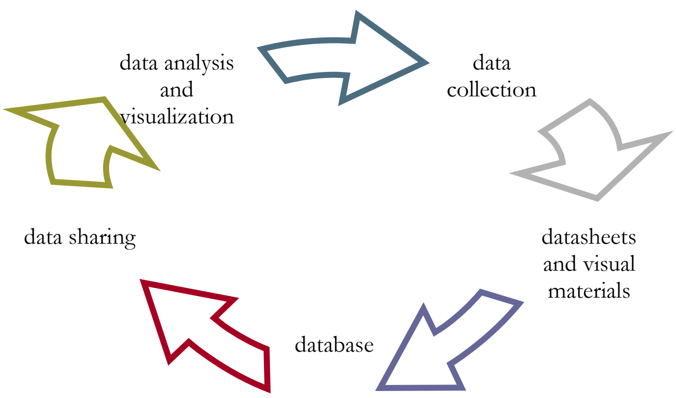

Figure 5.1. Design process of the information system.

Related to the first questions, the existing digital repository examples all around the world were studied and their concepts, theories, methodologies and practices were examined in chapter 4. In collaboration with the survey team consisting of divers from different backgrounds, a data collection model was developed using datasheets, visual media and maps. The analysis of datasheets including measurements, photographs, sketches and maps resulting from over 1000 dives led to the improvement of both the datasheets and data collection methodology, which followed closely by the principles of *in situ* preservation. Related to the second question, parallel to the development of data collection methods, several information system prototypes have been designed and tested by divers and archaeologists. The final version is a web-based, information system which stores sketches, photographs, measurements, dive logs as well as the preliminary field reports, drawings and images. Related to third questions, a team has worked on composing meaningful wholes out of this data. Besides the technological medium used in the overall design of the information system, further software programs were used for analysis, visualization, and communication based on the data housed in the information system. This research has led to the fourth question that is the concept of virtual museum. For this purpose, the methods of archaeological analysis, data visualization and communication were explored, as a continuation of the components of the information system. Overall, these four research questions cover the five main aspects of the musealization.

5.3. Participants

Three groups of users were involved in the project: divers as collectors of information and archaeologists as interpreters whose main role was the post-processing of the data in order to create meaningful information of the data gathered both in the field and online and online users who were visitors of the system (Fig. 5.2). The subject profile is listed along with their contribution to the project in Appendix E.

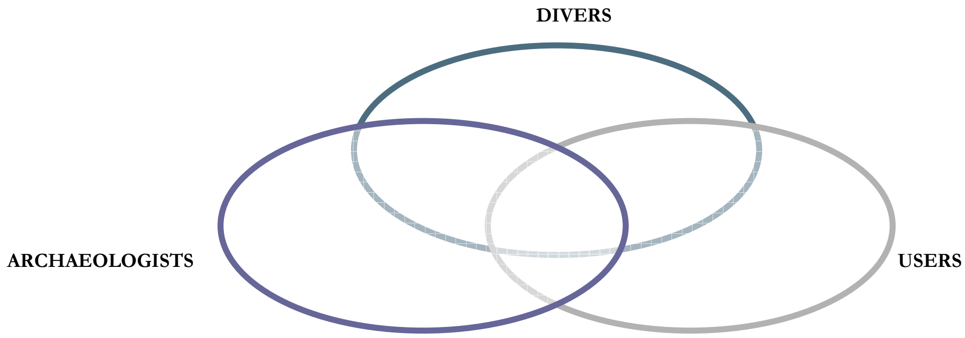

Figure 5.2. Diagram of the participants' groups.

The project was designed to include the local individuals as individuals are considered to have first responsibility to preserve cultural and historic heritage. These individuals are the divers, working in the region of Kaş as diving guides and instructors and other divers all over the world who are interested in nautical archaeological works, the recreational divers. The second group is the archaeologists, as advisors, and other professionals from the related disciplines as the users of the system. The third group was the interested parties who did not participate in the field surveys, but joined the data analysis process by using the online system. As seen in the diagram, these three groups are not totally separated from each other. As an example, there are archaeologists who actually participated all the phases of the design process.

The field studies were conducted with more than hundred volunteer divers. There were two reasons for including the recreational divers in the field surveys. The recreational divers other than archaeologists are aware of the importance of the underwater cultural heritage but do not have the constraints that the discipline of archaeology has, in other words thinking of the needs and requirements of work conducted underwater, which was also an emphasis in the public awareness of the study. The second reason is that although substantial archaeological surveys and excavations have been carried out in the past decades, the shoreline of Turkey is so vast that a thorough coverage is beyond the reach of the nautical archaeologists, who are certainly not found in Turkey in large quantities.

5.4. Methodology

The field surveys were preceded by the introductory training of the divers on the survey and documentation methodology to be followed in Kaş Archaeopark area (Varinlioglu, 2008). After this brief introduction, divers from a variety of disciplines were assigned various tasks in order to fill datasheets, test the database, and collect visual data. This field survey was followed by primary data analysis. This was the first interaction between divers and archaeologists. As a result of this evaluation, datasheets and database were modified according to user needs. Following the data produced by field surveys, the information system was designed and developed. As a result of the comprehensive research on and study of available tools, financial and technological contingencies, the information system was selected to be used as a tool for the virtual museum implementation. The methodology of data collection and the web-based information system contributed to the model of a virtual museum. Although this museum is not in place yet, several suggestions are provided towards its design and implementation. These suggestions are the products of the integration of computer science, museology and archaeology.

CHAPTER 6

6. Data Collection for the Information System

One of many objectives of the field surveys was to develop a methodology of collecting data based on trained divers who were not only, by education, archaeologists. After following training program of SAD[13] and NAS[14], these divers could then receive a basic background that enables them to participate effectively in the UCH Project (Varinlioğlu, 2008; Varinlioğlu et al., 2010; 2011). Considering the sustainability of the project, the UCH Project intended to rely on simple, standard tools for underwater recording -buoys for marking findspots, numbers and letters for tagging finds, plastic tapes for taking measurements, a scale and a north sign for photographic recording, and plexiglass slates for underwater sketching and note-taking.

The methodology consisted of recording of all significant finds that identify a site as archaeological or historical and that mark on the underwater landscape different forms of nautical activity. Since all finds were left *in situ*, the process of recording was conducted as scientifically and as systematically as possible under water. Different from the conventional recording methodology of the excavations, the artefacts found on the seabed remained in their original context.

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[13] Underwater Research Workshops in 2007 as a part of the "Virtual Museum of Underwater Cultural Heritage: Kaş Archaeopark Project", Erkut Arcak Underwater Archaeology Training Camps in 2008-2010, Erkut Arcak Archaeology Conferences in 2010

[14] Nautical Archaeology Society (NAS) training program, Introduction, NAS-1 and NAS-2 courses as part of the Young Archaeopark project in 2010.

The aim of our surveys was not definitely highly-accurate recording of the artefacts as in the conventional excavations and surveys. Excavations need to have higher accuracy, since they involve partially destroying the site without ever being able to recapture the information it contains (Forte, 1997: 9). In this occurrence, the surveys did not include any kind of destruction as in the case of excavations or any decontextualization of the artefacts as in conventional surveys. As background information, in most conventional excavations and surveys, in order to record an object found at the bottom, artefacts are carried to the surface to eliminate time spent underwater. Before and after basic treatments, they are recorded carefully in a dry environment. The final recording of the artefacts that includes photography and drawing is usually realized after all conservation process is over. On our surveys, less accurate but precise methods were sufficient to cover as many artefacts and sites as possible (Holt, 2003: 246). The sacrifice of accuracy did not mean that information gathered was not reliable but rather it had some constraints. Each discovered piece such as anchor, amphora, *pithos*, etc. was measured and sketched *in situ*. At sites with a large number of finds, best examples of each type of find were chosen for recording, while each distinct object or fragmentary remain was separately recorded.

6.1. Search Methods

In order to record a cultural heritage, the first step was to find the object. This study used both methods: those deploying a diver and relying on the human eye or hand-held equipment, and remote-sensing surveys usually employing acoustic or magnetic equipment and remotely operated vehicles (ROV) deployed from a boat (NAS, 2009: 96). Initial steps towards locating the heritage of the region started during the 2007 survey by using acoustic remote sensing using side scan sonar (SSS), as well as deploying a diver and hand-held equipment such as drop-cameras.

When the rocky bottom of the Turkish coast is considered, differentiating a rock from an amphora is tricky depending on the quality of the remote sensing equipment and the expertise of the operator. This remote sensing technique was then substituted by diver search method. As stated in Nautical Archaeology Society (NAS) handbook, diver search methods, based on the observation of divers, are towed search, swim line or free line search, jackstay or corridor search, grid search, and circular search (NAS, 2009: 97-101). In the survey, divers used various methods according to the size of the object, sea bottom and weather conditions. They usually followed the bottom contours using free line search.

Figure 6.1. Distribution map of the dives.

Through more than thousand dives, the field study covered a coastal area of about c. 30 nautical miles between Kalkan and Kekova (Fig. 6.1). The depth of the surveyed area reached up to 40 meters, which was often covered by teams of two divers and at intervals of 5 to 10 meters, depending on the conditions permitted by the terrain of the seabed and the water currents. Along the search, the position of the area covered and identified targets, together with related observations were accurately recorded. Each remain, which was encountered along the course of the survey line, was individually marked with a buoy with the purpose of recording its location by GPS. Subsequently, each find was measured and sketched, while observations made on the site were noted. Divers recorded the measurements they took and observations they made on data sheets upon the completion of each dive. As stated in NAS handbook, all information should be recorded for the potential interest for subsequent analysis (NAS, 2009: 96). This information, alongside photographic recordings, was then entered into the on-line information system.

6.2. Recording through Datasheets

This data collection system has particular emphasis on collecting the information digitally without disturbing the archaeological remains. Consequently, the find types were recorded carefully *in situ* (Fig. 6.2 and Table 6.1). Other projects which have developed theoretical and methodological approaches to *in situ* analysis of underwater sites and finds include the Ancient Port of Caesarea (Alves, 2008: 83) and Florida's Underwater Archaeological Preserves (Scott-Ireton, 2006: 5). Such an approach also ensures the protection of sites in line with the UNESCO 2001 Convention, one of whose basic principles encourages *in situ* preservation of underwater cultural heritage (UNESCO, 2001).

Figure 6.2. Various find types, such as stone anchor, stock anchor, amphora, *pithos*, architecture, ballast stone, millstone, touristic and historic wreck (photos by O. Aytür, Ö. Yolaç, M. Draman, U. Aksu, T. Ceylan, C. Çimen, G.Varinlioğlu, B. Özkırlı, A. E. Keskin, and A. Kara).

Table 6.1. Different find types.

Find type	Description
Cargo Sites	Sites with various finds of similar types.
Anchorage Sites	Sites with wide range finds from different chronological periods
Historical Wrecks	Wrecks sank less than 100 years ago, mainly with different cargo specifications.
Tourist Wrecks	Wrecks put down for touristic purposes.
Clusters	Different or similar types of finds to compose a cluster.
Ceramics	*Amphorae*, *pithoi*, and other ceramic vessels.
Anchors	Stone anchors, stock anchors, and modern anchors.
Miscellaneous finds	Ballast stones, millstones, ingots, architectural cargo, architecture, tiles, etc.

Particular care to avoid physical intervention in the archaeological record has resulted in recording only what is above the sea-bed. This was a limiting factor in attempts to gather the maximum amount of information at any given site without an archaeological excavation. At the same time, the information gathered without decontextualization the artefact helped to gain general insight into the nature and the extent of sites and provided a foundation for further and more detailed research. The range of materials visible consisted mainly of *amphorae* and other sizeable artefacts such as large ceramic vessels or even *pithoi*, stone and stock anchors, ballast stones, millstones and architectural cargoes. Whether or not a site might produce preserved remains of ship-parts was difficult to determine without excavating. Subsequently, sites were categorized as anchorage site with wide range finds from different chronological periods and as cargo site with various finds of similar types. The term "cargo site" was preferred instead of "wreck site", which exclusively includes the hull remains of a shipwreck. In areas which contain large numbers of finds, the best-preserved examples and unique finds were selected for photography, drawing, and recording of detailed measurements. Additional measurements were collected to contribute to determining the wider extent of the site using offset and trilateration measurement methods (NAS, 2009: 120-122)

During the survey, the divers tested various recording techniques throughout different stages of the Kaş Project. Work carried out at Cape Kepez best illustrates the current stage in the development of the survey and recording methods. The site was investigated during a total of 221 dives covering an area of c. 50 x 75 m. Divers marked each pile of finds with a number and each individual find with a letter marked on a small plexiglass slate. These numbers enabled find-spots to be investigated during multiple dives and by different groups of divers. These tags also provided a link between types of recorded data within the structural design of the database when the finds were entered into the system, enabling connections to be made between multiple sketches and measurements made by different teams and multiple photographic and video recordings, each of which could be made on different dives (Fig. 6.3).

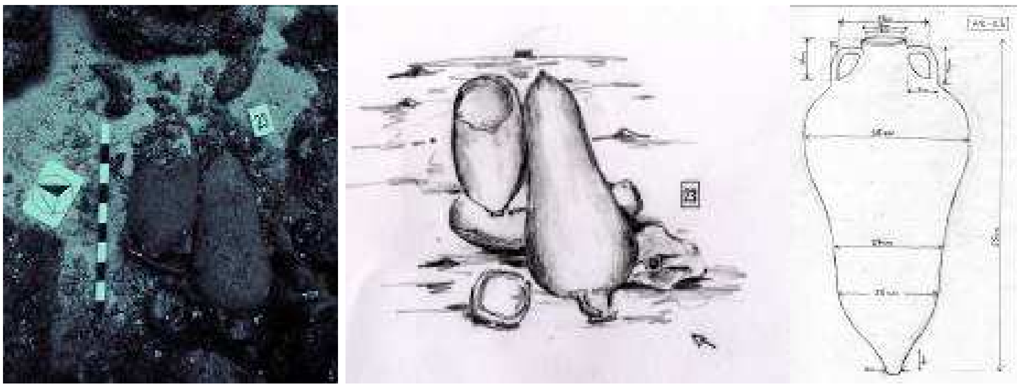

Figure 6.3. Collected data on KE-23 (photograph by G. Varinlioğlu, sketch by S. Pilge and measurements by D. Atalay).

At Kepez, divers counted 115 undisturbed *amphorae*, in addition to a T-shaped anchor in small sandy niches on the rocky sea-bed. All the measurements, sketch drawings of finds, observations, and photographic recordings were entered into the database after the completion of each dive in the following manner: in the case of ceramics, descriptions of rim, neck, handle, shoulder, base, and body types were separately documented in addition to height, width, rim, neck, base diameters, and shoulder and handle heights. In certain cases, details, such as handle sections or observations made on body decoration such as rips, were also included in the database. Similarly, amphora descriptions and measurements of various details were collected and noted. These eventually provide suggestions for the origins and dating of distinct types of discoveries.

6.2.1. Dive logs

In order to keep track of search methods presented in the previous section, each dive was recorded on a separate datasheet by a diving safety officer. These datasheets were not only for documenting the information on dives, such as time, date, location the dives and the air consumptions and observations of the divers, but also for the diving safety. All along the surveys, the dive log datasheets had minor changes as logging of the dives has definite standards since the advent of various diving disciplines (See Appendix A.1 and B.1).

6.2.2. Archaeological Finds

The team tested various survey and recording techniques throughout different stages of the project. Out of the observations, comments and experiences of divers, the datasheets were developed all along the survey. This analysis resulted in three consecutive stages for the development of datasheets and data collection methods, schematically presented in this section. The detailed explanations on data collection methodology and the full version of the datasheets are given in Appendix A and B.

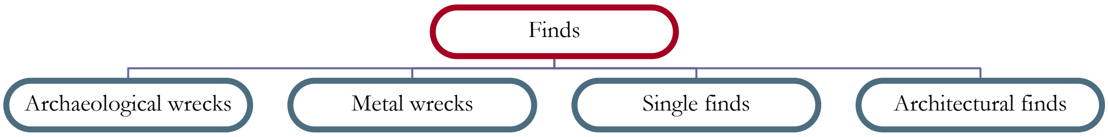

Figure 6.4. Organization schema of the first draft datasheets.

Except from minor changes all along these four campaigns, including the careful usage of terminology both in English and Turkish, the datasheets went through three major changes. The first design was based on the literature review on the repositories on nautical archaeology, especially inspired of the Shipwrecks of Anatolia (SOA) Project (INA, 2001). As UCH and SOA projects have similar aims, this framework could have been adequate as the first draft. However, when tested in the field, this version of datasheets was found insufficient for the intensive survey method used in the project and was excessively detailed as it included archaeological post-processing data such as the dating methods, amphora types etc. Moreover, the lack of relations between the collected data and insufficient technical support required a new design for the second draft (Fig. 6.4).

The second draft was based on the divers' needs as data collection agents. Rather than covering the archaeological analysis, it aimed to cover the systematic methodology of data collection of the encountered objects. In the Kaş region, the most common artifacts were single finds, scattered along the shoreline, sometimes coupled with other finds, the clusters that were studied differently from the archaeological cargo sites (Fig. 6.5). The decision to name scattered clusters as an archaeological site is not reliable unless careful archaeological studies are done. As a general comment, the second draft was a useful tool for systematic data collections, but lacked the archaeological details.

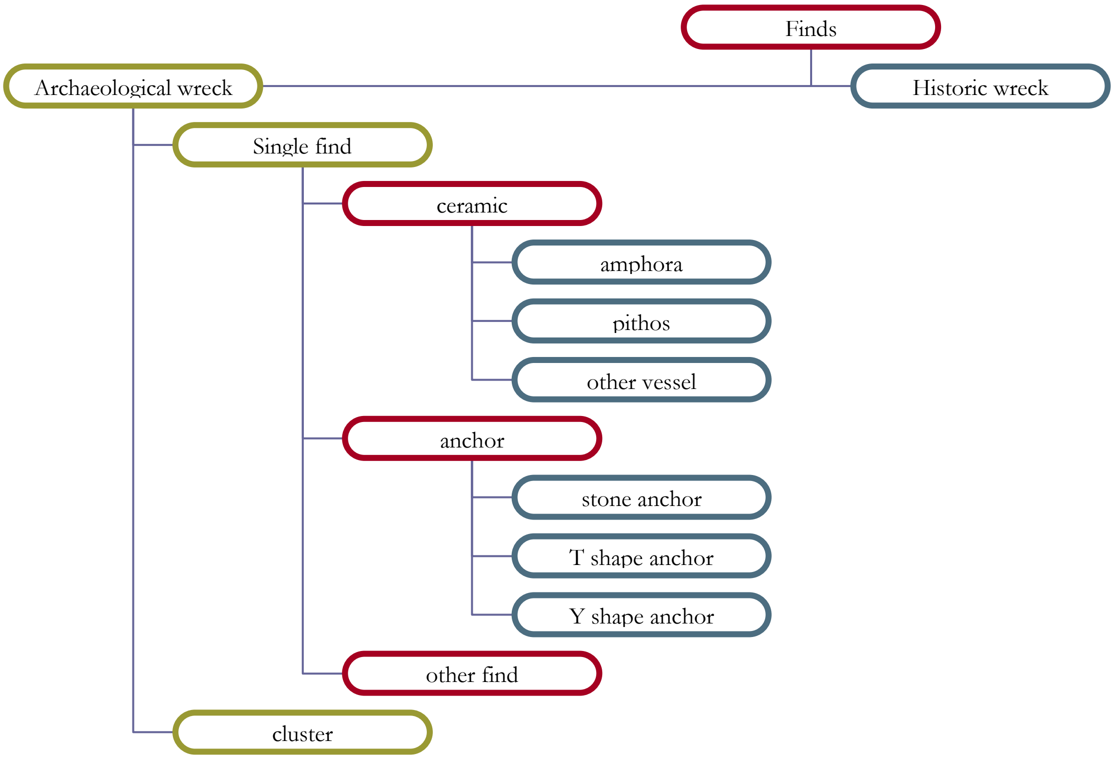

Figure 6.5. Organization schema of the second draft datasheets.

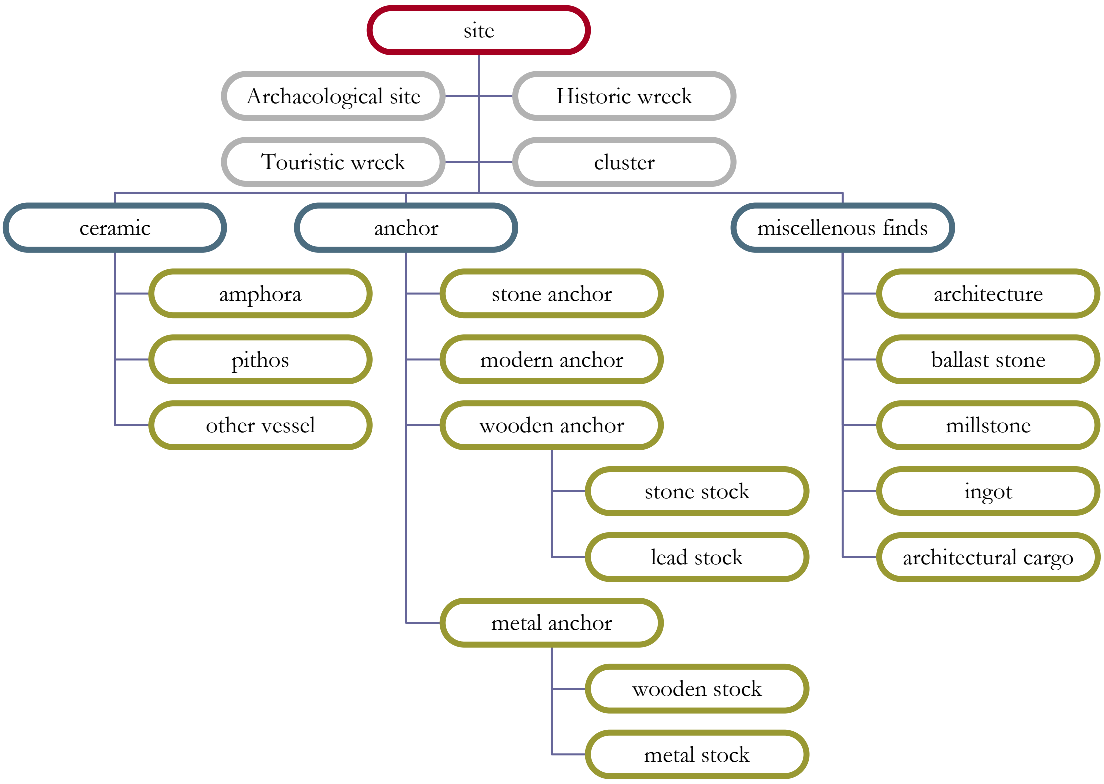

Figure 6.6. Organization schema of the final version datasheets.

The final draft was developed based on the archaeologist's needs. Inspired by the Roman Amphorae and Big Anchor Projects, the systematically organized data on each single find was re-designed. For the last version, various measurements were added and changed due to discovered material, needs of the archaeologists, ease of use for the divers who were data collectors, technical constraints such as the skills of the divers, and the availability of the equipment (Fig. 6.6).

6.2.3. Archaeological Sites

As the material culture dealt with is the shipwreck, its cargo materials and its maritime voyage, the general layout of a site has a tremendous importance. The layout of the artefacts found in cargo site together with the seascape holds the secret of ship's final voyage. The scattered artefacts with their position, depth and preservation condition were recorded and presented to facilitate archaeologists to work on the drawings. In order to draw the general distribution of the finds, separate datasheets were prepared and necessary measurements were noted by the divers (See Appendix A.5).

6.2.4. Historical and Tourist Wrecks

As the definition of UNESCO indicates, underwater cultural heritage means "all traces of human existence having a cultural, historical or archaeological character which have been partially or totally under water, periodically or continuously, for at least 100 years" (UNESCO, 2001). In this category, all remains other than archaeological ones were documented including historical wrecks that sank in the last 100 years and some of the tourist wrecks that were put underwater intentionally in order to create an artificial reef and tourist attraction in the vicinity of Kaş. As a general category, besides photographs and sketches, a general measuring systematic was applied to these wrecks. This recording methodology might be enhanced in future when special attention is to be paid to these wrecks.

6.3. Recording through Visual Media

In archaeology, more than in any other discipline, visual media is essential to the production of knowledge with the purpose of sharing with scholarly authority (Van Dyke, 2006: 370). Van Dyke defined some emerging forms of visual media in archaeology, including documentaries, maps and photographs, hypermedia, experimental films and peripatetic media. Although he did not mention anything about sketches, drawings and field notes, these media were considered the initial steps of surveys for an accurate picture of the site, usually a two-dimensional plan, and a representation of an artifact, usually through photograph and drawing (NAS, 2009: 114). As mentioned earlier, the project is different from a conventional archaeological survey or excavation when the level of destruction is considered. The information gathered during the project could be considered as an assessment and pre-disturbance survey that was not followed by excavation, monitoring and topographical survey as defined by Bowens in the Handbook of NAS. As finds were kept *in situ*, different methodologies were developed after analyzing the visual materials that were produced after several dives.

In the initial stages of the project, some methods of emerging forms of visual media were used in order to get a better understanding of what kind of data could be collected in such a survey. Composed of sketchers, photographers, and searching divers, a total of c.100 divers, prepared more than 1000 photographs and 100 sketches. In order to keep track of these visual elements, a cataloging system was developed and remained the same all along the project. In order to emphasize the importance of the raw field data, initial sketches, field notes and photographs were all stored in digital format.

6.3.1. Initial Sketches

The first step in surveys was to create a sketch of the site to form the basis for any future study. Especially in the early stages of the project before planning further studies, a good sketch of site provided a large amount of information on its size and shape (Fig 6.7). Thus, the sketch aimed to give an overview of the main features, both topographic and archaeological, and helped to decide where control points such as buoys and the baseline were to be fixed (NAS, 2009: 115-116).

Figure 6.7. Initial sketch of an amphora and of a site with field notes (S. Pilge and G. Varinlioğlu).

Before these sketches were done, each diver followed a training session of one day. During this training day, the basic drawing methodology was explained but the divers were free to express their observations on these sketches. After analyzing the sketches, two main categories were encountered such as general site plan including the GPS coordinates, depth, bottom condition and tags of the finds put as separate field notes, and single find sketches including different characteristics of finds such as the overall dimensions of artifact, distinct characteristics of artifacts including dimensions and notes. This information was carried to drawings at the interpretation stages of the project.

6.3.2. Field Notes

The field note was the primary record of observation of divers, and was kept even after they have been processed. As stated in NAS handbook, "keeping a notebook with day-to-day accounts, observations and ideas about the site is often useful, as the notes can be helpful later when the measurements are being processed" (NAS, 2009: 123). During the surveys, field notes were kept on separate datasheets and on drawing slates. The divers' comments helped to redesign the methodology of datasheets and measurements continuously till the final version of the data collection methodology was developed. Still, the record of this raw data together with comments of the divers is part of the final design of information system.

6.3.3. Photography

During the twentieth century archaeological illustration developed rapidly influenced by new ideas and techniques. By the widespread use of printing from photographic originals, drawings and paintings became no longer the only method of making archaeological illustrations (Adkins and Adkins, 1989: 5). Later, at the end of the twentieth century, apart from the mechanical reproduction technologies, digital technologies were widely used in the field of archaeology. Technological advances in cameras and digital image processing brought cheaper, user-friendly equipment and software.

Picture making i.e. photographic reality is often taken for granted in archaeology. It is accepted both as a technical aid to record and identify the features of objects and as a tool to provide illustrative ambience (Shanks, 1997: 97). Accordingly, photography, both still and video was used as recording techniques available to the archaeologist during the surveys. Still photography was used to generate the record of a site at one instance; video was used to record the occurrence of an event in a site. Video remained a primary image resource for the publicity of the project i.e. the documentary.

In the project, as all the finds were kept *in situ*, as the objects were not brought above water, photographic rules widely used on land were partly applied. Difficult conditions, such as poor visibility caused by particles suspended in the water, low light levels and loss off contrast and loss of color with depth were typically encountered in underwater archaeological sites. To overcome these problems, a wide-angle lens enabled the photographer to get close to the subject; an underwater flash was used to overcome the loss of light and color with depth and to improve contrast and resolution.

Photography was used in two essential phases; the artefact photography, as an aid to hand drawing; and general photographs of the site for photogrammetric studies. The wide spread use of photography was artefact photography with a specific setting of natural and artificial light (Dorrell, 1994). Tagged by a diver, each find, even before it was identified as single find or a cluster, was photographed framed with a north sign and a scale as a unit. Scales were placed carefully so as to avoid masking any detail, and try to keep them parallel to the frame of composition of the artefact. This scale helped including the metric data to be used in photogrammetric studies during the following studies. If carefully placed, scale and north sign were cropped out for preparing scholarly publications. A variety of chosen artefacts were also photographed at a higher image size, quality and resolution. While taking underwater photographs, the essential thing was perfect buoyancy and fin control of the diver in order not to disturb the visibility caused by the silt and sand particles on the seabed. Shots from different angles were frequently taken in order to obtain the best angles to depict the artefacts (NAS, 2009: 76).

In most excavations, significant finds are plotted and photographed *in situ*, and then registered, drawn and re-photographed after conservation is over. The final photograph of the find after cleaning and restoration is the used for study and publication. However, this methodology using *in situ* photography required further processing to enhance the final versions using photo editing programs, called as digital darkroom (See section 8.1.2).

6.4. Recording through Maps

The speed, accuracy and photorealism of aerial photography as an archaeological tool led to find new ways of illustrating the archaeological sites. Borrowed from the geomatics, the study of geographic information or spatially referenced information, the applications of analytical techniques for producing charts, diagrams and distribution maps started to be used in archaeology (Adkins and Adkins, 1989: 5). Along with mapping tools, geographical location information became an important and integral part of archaeological surveys and excavations.

In Turkey, the major institution for mapping is the General Command of Mapping[15]. Covering the maps of the whole country, 1:25.000 and smaller scale unit maps are produced and updated periodically by this institution. 1:25.000 and larger scales are basically produced by the General Directorate of Land Registry[16] and local municipalities upon request. As an alternative to these map sources, detailed satellite images are available by means of remote sensing technology. Through large scale servers and internet technologies, these satellite images are accessible on our desktop computers, as well as the end products of some scientific studies on national and international data sets. Some examples are the datasets Shuttle Radar Terrain Mapping (SRTM) raster height dataset prepared by the U.S. National Aeronautics and Space Administration (NASA), and Digital Chart of the World (DCW) vector thematic data set prepared by Economic and Social Research Institute (ESRI) for the USA.

Nautical charts of Turkish waters, namely the Mediterranean, the Aegean, the Sea of Marmara and the Black Sea are prepared by Turkish Naval Forces, Office of Navigation, Hydrography and Oceanography[17] for navigation and marine use. These 1:750.000 to 1:10.000 scaled maps are grouped by region and numbered by 2 to 4 digits. These maps focus on the marine details, having basic information on terrestrial details near the coastline such as important settlements, mountains, rivers, and main roads, etc. For the Kaş region, four navigational maps demonstrate the scope and coverage of the maps (Fig. 6.8 and Table 6.2).

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15 Turkish translation for General Command of Mapping is *Harita Genel Komutanlığı*.
16 Turkish translation for General Directorate of Land Registry is *Tapu ve Kadasro Genel Müdürlüğü*.
17 Turkish Translation for Turkish Naval Forces, Office of Navigation, Hydrography and Oceanography is *Deniz Kuvvetleri Komutanlığı Seyir, Hidrografi ve Oşinografi Dairesi Başkanlığı*.

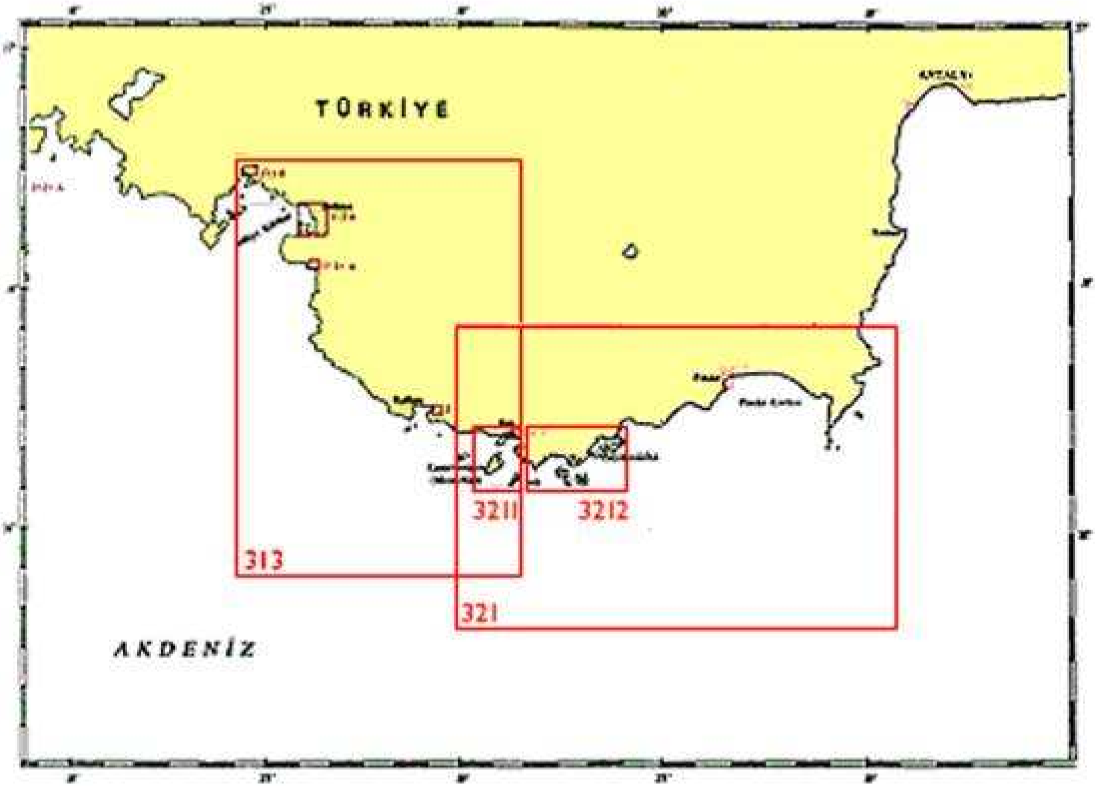


Figure 6.8. Scope of nautical charts of Kaş region.

No	Title	Scale	Limits	Publishing Date
313	Fethiye - Kaş	1:100.000	35°53'.0N - 36°46'.0N 28°54'.0E - 29°37'.5E	December 2001
321	Kaş - Çavuş Burnu	1:100.000	35°49'.0N - 36°25.0'N 29°30'.0E - 30°34'.0E	December 1993
3211	Kaş Limanı	1:15.000	36°06'.0N - 36°13'.8N 29°32'.8E - 29°39'.4E	September 1993
3212	Kaş Doğusu Uluburun - Geyikova Burnu	1:25.000	36°05'.5N - 36°14'.2N 29°40'.9E - 29°56'.75E	November 2000

Table 6.2. List of nautical charts on Kaş region.

During the survey, it was necessary to display the geographic distributions of finds and area covered by dives. For this purpose, national and international map sources were investigated in terms of data quality and detail level. For the bathymetric information, nautical charts prepared by Turkish Naval Forces, Office of Navigation, Hydrography and Oceanography were used. The paper versions of the navigation maps were scanned, digitized, and rectified for appropriate coordinates. The maps had different datum systems, ED-50, the European datum system and WGS84, the world wide datum system were converted to WGS84. Landsat GeoCover 2000/ETM+ satellite images were acquired from Global Land Cover Facility (GLCF) data archive and cropped to the project region (University of Maryland, 1997). All the information gathered during the field studies were transferred to Geographical Information System (GIS).

As mentioned above, some map sources and data sets for GIS studies were available on the market. However, the common properties of all topographical maps and satellite images were that they were all focused on the land, and they have little information on the sea except from coastal areas. The possible map resources used in the survey were the nautical charts by Turkish Naval Forces, Office of Navigation, Hydrography and Oceanography; Landsat GeoCover 2000/ETM+ raster satellite images by Global Land Cover Facility, University of Maryland and Google Maps, by Google internet based map and satellite image system. These separately used maps were later replaced by Google Maps system with its integration of the information system as explained in section 7.1.3.

6.5. Discussion

As the full list is given in Appendix E, the participation of c. 100 divers from a variety of backgrounds, these data collection agents lead to the development of new surveying methods for nautical archaeology. Systematizing the collected data helped formulating a framework for the data collection using *in situ* preservation. In this systematic analysis, more than 100 divers participated in the design and development of the data collection methodologies. For this purpose, c. 200 measurements were taken, c. 100 sketches were drawn and c. 3000 photographs were taken solely during the 2007 field survey. Dedicated mainly to the design, rather than data collection, the methods and techniques of training in Kaş Archaeopark area, surveying, photographing, sketching and measuring the finds and sites were developed during this initial stage of the project. In the following years, the focus was on data collection. Overall, these methods were tested by c. 100 divers, including 30 archaeologists. The participants helped produce c. 500 sketches and c.10000 photographs and filled more than c.1000 datasheets to form the information on the finds and sites presented in Appendix D.

After the process of updating the data collected during the field surveys, the project continued with studies of amphora, and anchor types in order to investigate implications of interconnections of the maritime trade routes and chronological frameworks of the finds. As the project started because of an evident need to inform interested parties on underwater cultural heritage of Kaş, particular care was placed on raising awareness about cultural heritage. This contributed to the sustainability of the project for the preservation of the underwater cultural heritage as the methodology could be transferred from the experienced project participants to other interested participants. Due to the costly nature of underwater research, the methods were based on very clumsy hand held devices. However, in the future, these devices could be replaced by more technological ways of documenting underwater cultural heritage. On the other hand, conventional the tools and methods were, the inclusion of divers in the data collection ensured the sustainability of the project. The divers as data collectors participated to the later phases of the project for data analysis and data sharing process through the open-content, web-based information system.

CHAPTER 7

7. Information System for the Virtual Museum

Cultural heritage documentation started to use computerized systems to handle and preserve the information produced. Especially in archaeology, the quantity of data produced during surveys and excavations can become enormous. Moreover, in addition to the archaeological datasets made of primarily research in the field, necessary links to secondary research including interpretations and image collections are needed (Meyer et al., 2007: 397). It is then necessary to develop systems that allow the creation of relationships between these numerous and heterogeneous data for the retrieval of information.

The deficiencies and drawbacks of information systems currently used in the field of cultural heritage are related to the establishment of databases for archaeological sites using collection methods other than *in situ* preservation. Currently, there is no information system satisfying the needs of this data collection methodology. Furthermore, the analysis and visualization of the collected data through a collaborative method necessitated an online system of data storage and sharing. The idea was then to propose an information system for underwater cultural heritage, which aimed notably to avoid the difficulties mentioned before. By the help of three computer programmers[18], a tool was developed for the management of the data collected during the surveys conducted since 2007. Essentially an online database for systemic data collection, description, and interpretation, the system currently contains information on c. 600 finds through sketches, measurements, drawings, and photographic entries of individual finds, in addition to regional descriptions and observations made by divers. Combined with the GPS locations of sites and findspots, the result of the integration of the database with Google Maps illustrates the distribution of sites along the Kaş shoreline. The process of gathering and recording data for the Virtual Museum has been interactive and continually increasing.

The information system is an integrated, collaborative, open-content application with web-based client-server architecture. It was specifically designed and developed to serve multiple aspects of data collection in field surveys done in the pilot region of Kaş. While the server side includes a database component for data storage and retrieval, the client side has data entry forms with advanced user interface components, listing tools and a mapping component for spatial data display.

The following objectives were considered during the design and implementation of the information system, such as preservation, accessibility, user-friendliness, and integration. The extensive amount of data gathered during the field surveys were stored and preserved in this system. Allowing relations between the entities, the database preserved

[18] The scope of the information system used in the dissertation builds upon what was initially developed during the project "The Virtual Museum of Turkish Underwater Cultural Heritage: Kaş Arkeopark Project" (TÜBİTAK SOBAG-107K133). Dr. Serkan Girgin of the Middle East Technical University (METU) has constructed the technical framework of the database based on the codes written for his doctoral research project, while Altay Özaygen has worked on its online application. In 2010, further changes were made by Yusuf Şafak Bayram, also of the METU.

the complex data relations that could be restored only in the digital domain. It was aimed that the system to be accessible by a wide range of interested parties, including archaeologists and divers, as well as the public. For this purpose, a web-based design has been developed. Following open-access and open-content neologism coined by David Wiley (1998), describing the creative work that explicitly allows copying and modifying of its information by anyone, the content of the information system is available to the public. Moreover, the means of data entry and update were provided for the users to share information in a collaborative manner. During the design and development of the interface, the user-friendliness was emphasized by visual elements for comprehensive data entry and update interfaces. For an integrated system, the number of data fields was minimized to avoid duplicate or redundant data input. The system has provided an integrated framework, which gathers several aspects of archaeological research on a single platform. The spatial data, textual entries, photographs, sketches and drawings, typological observations as well as numerical measurements were included in the database.

Using the AMP software bundle, the information system is a platform free, web-based information system, which works on the Apache server, stores its data on MySQL database system and is programmed using PHP scripting language. The proposed information system is compliant to underwater sites and finds discovered during the 2007-2010 surveys, and allows the management of very diverse types of data, such as visual and textual materials. Furthermore, as the technological infrastructure allows, the system is open to development for new find types other those than explained in chapter 6.

7.1. Information system

The use of computer science in the archaeological domain is often driven by software rather than by archaeological questions (Meyer at al., 2007: 398). In the information system developed for the UCH project, the needs of users were taken into account in various degrees of the design. The collected data was recorded in three different formats: datasheets designed for specific data on the dive logs, finds, site and wrecks, visual media in the form of sketches, field notes and photographs, and the geographical data as maps, charts, and coordinates. In order to store and share these media, an information system was designed and developed. It is composed of a database system that houses the datasheets and the visual media with an external connection to Google Maps as a mapping tool.

7.1.1. Database

A common and powerful method for organizing the datasheets and other types of collected data for the computerization of the raw data is to use a database system. By the widespread use of database management systems, the use of a database for archaeological purposes was no longer considered as particularly new (Richards, 1998: 333). In archaeology, especially in the nautical archaeology excavations by INA, FileMaker Pro (1994) is the mostly preferred cross-platform relational database application that allows users to modify the database. However, this database system is neither totally platform free nor suitable for Linux operation system that is popularly used for server applications (NetCraft, 2010). Instead of the above mentioned database system, the AMP software bundle was preferred. This system aimed to use open standards to enable data sharing between different systems easily. Seamless data sharing became an important issue with the ever growing number of data as well as different platforms used by different research groups. This inter-operable software bundle was preferred in order to prevent the incompetence of the Linux-based internet server as the main server and Windows-based desktop computers used in the field.

The database system designed for this dissertation stores and shares the collected data for further queries and analysis. It is a relational database system of related tables and fields containing the complex entities that are closely related to each other. For this purpose, this generic database had an evolutionary design process that followed the traditional modeling theory which involved three steps: analysis, design, and implementation.

> "**Analysis** is the process of creating a conceptual data model independent of the target database technology.
> **Design** is the process of creating a logical data model. This step is already dependent on the target technology, but not specific implementation.
> **Implementation** is the process of creating a physical model or schema for a specific database system; the result is an optimized physical design" (Kadar, 2002: 74-75).

These three phases of the database design methodology, conceptual, logical and physical database design were subject to change following the developments made in datasheets. During the overall design of the system, the system had undergone three major changes according to the comments of the users. These changes were named as versions in accordance with the three drafts of the datasheets. The final version of the database system is presented in detail in Appendix C.2. The full list of the project participants and their subjects of contribution are given in Appendix E. Overall, 35 users tested the database system all along four-year-long project.

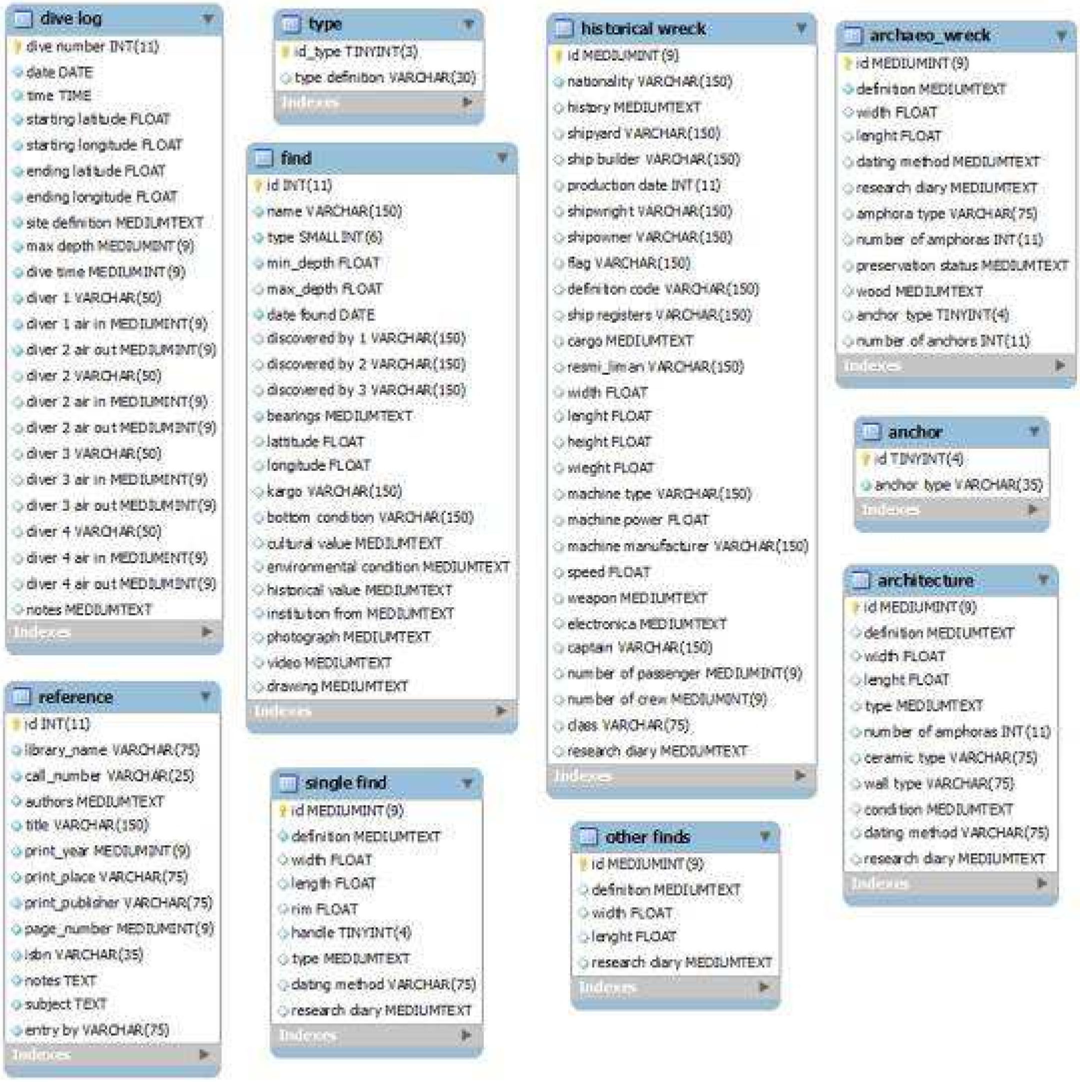


Figure 7.1. EER diagram representing the data that can be managed by the first prototype database and the connections between them.

For the first version of the database, based on the literature review on digital repositories, a throwaway prototype was created and converted into paper versions to be tested by the divers in the field. After the preliminary design of the database having the paper prototypes as the datasheets, the initial experiments were conducted in the Archaeopark Area, composed of the replica material of Uluburun III and its cargo site (Varinlioglu, 2008). Later, datasheets were tested and improved upon the archaeological sites discovered during the underwater surveys. In this user evaluation analysis, the datasheets recording various find and site types were considered as an assessment tool.

The main idea was to test both the design of a database system and of the ever-developing datasheets by the users in the field.

The first prototype was criticized for having duplicate entries and redundant data (Fig. 7.1). The major criticism was done by the divers, who were unable to collect highly detailed archaeological information using the data collection methods of *in situ* preservation. Including post-processing data of an archaeological research such as chronological information on the discovered items and bibliographical information on the related publications, this first version was found inappropriate for storing the data collected during field surveys. As this methodology implied, links between the dive logs, researchers, finds and findspots as well as the visual materials formed important part for the consistency of the stored data. As opposed to conventional excavations, the surveys were conducted at various sites without any permanent tags or grids for marking the sites both above and underwater. Thus the geographical coordinates above the sea and general layout of the finds under the water gained importance for identifying and differentiating sites and finds. The first version of the database was often criticized to the lack of mapping tools. In conclusion, the first version was found inappropriate for this survey methodology and replaced by the second prototype.

After the analysis of this first database design and the contributions of the users, a new paper model was used, followed by the second conceptual model. This conceptual model was based on the relations between entities (Fig. 7.2). Eliminating redundant data of the previous prototype and housing various kinds of data, such as the visual, textual and numerical data, the second prototype was based on the data validation and record relations.

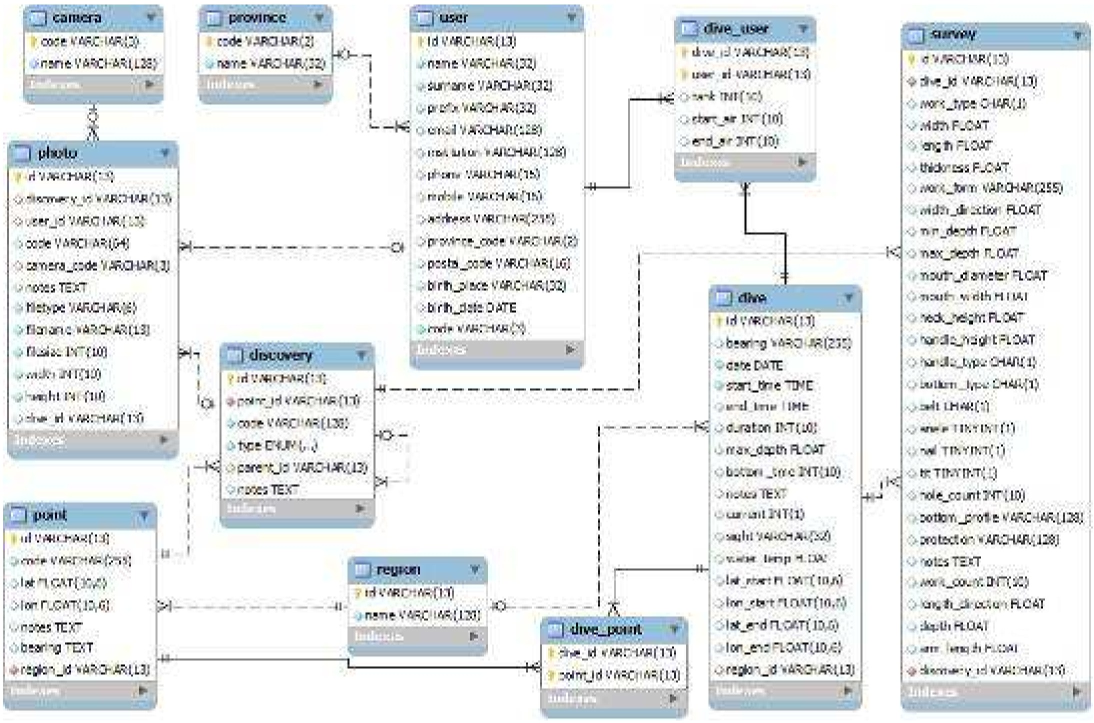


Figure 7.2. EER diagram representing the data that can be managed by the second prototype database and the connections between them.

Following the creation of the first prototype, the second stage involved the interpretation of information through the feedback of specialized nautical archaeologists, as well as through the input of online contributors. According to these contributions, with the changes in the datasheets towards a more detailed archaeological data collection, the number of fields in the tables was augmented and visual icons were added along with textual explanations. According to users, the database had still duplicate entries for the visual material which overloaded the system. The record relations of the finds and visuals were changed to eliminate multiple entries of the same visuals. Both for archaeologists and other users, as a visualization and analysis tool, mapping feature was added to the system. By the integration of Google Maps, the system allowed the users to locate the geographical coordinates on a map of explored areas.

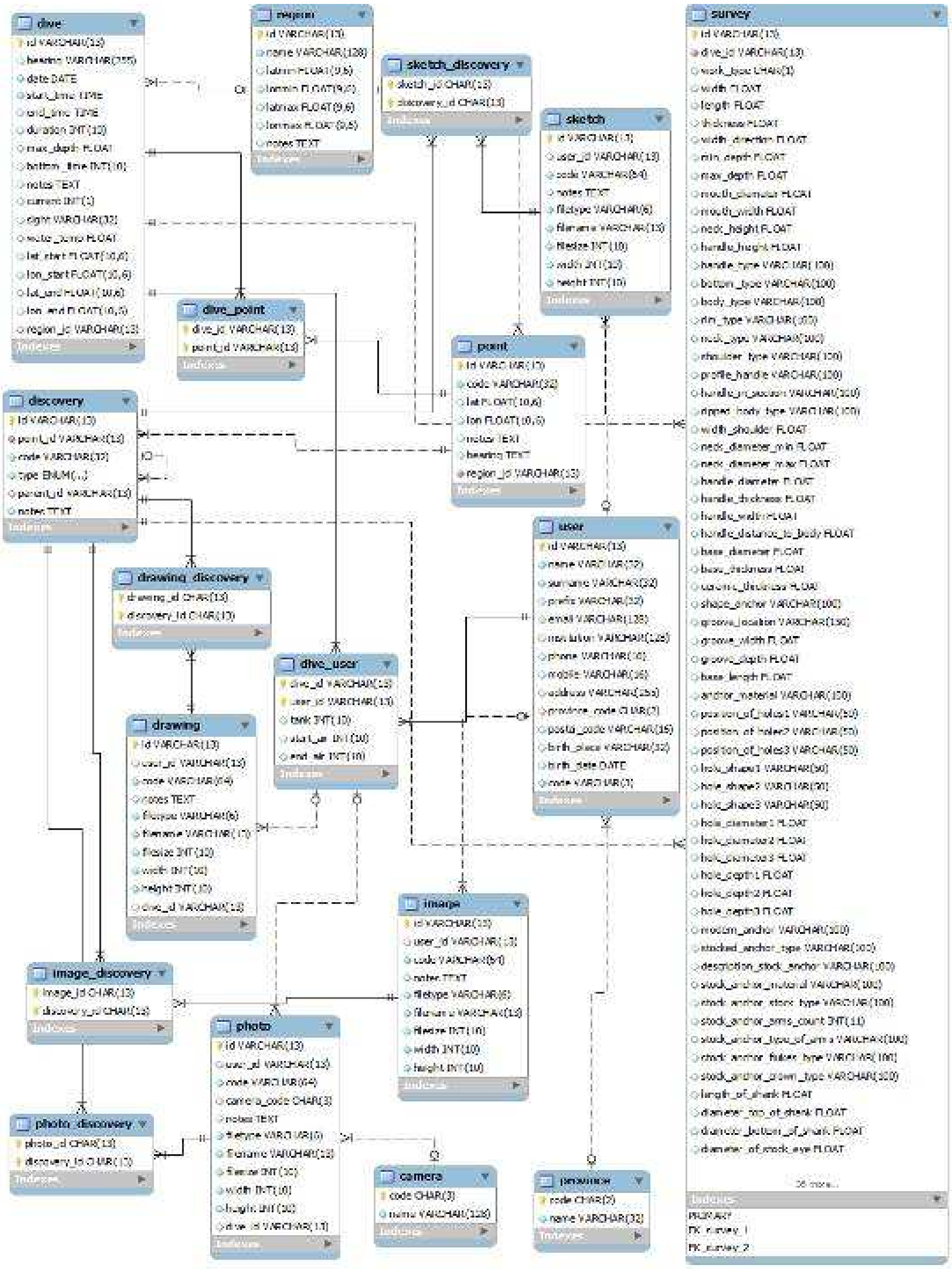


Figure 7.3. EER diagram representing the data that can be managed by the final prototype database and the connections between them.

The framework of the collected data was redefined and then reflected to the final information system design (Fig. 7.3). The final version of the information system offered a web-based and open-content platform for raw data of nautical archaeology in Turkey. Moreover, with advanced user interface and record relations, the database system offered an integrated and user-friendly digital repository. Based on the analysis of the datasheets and later the database, this information system met the majority of the needs of archaeologists. Although the components of the information system were designed according to the material remains found in that specific coastal area of Kaş, with little modifications, it could be adapted to other remains of material culture in Turkey.

7.1.2. Visual Media

The storage of data necessitated the combination of textual data with visual media. However, at early stages of the database design, visual materials were stored separately from the information system. The photographs, scanned sketches and the field notes were stored first in hard drives and later integrated to the database system. In order to keep track of these digital media, a cataloging system was developed and used in the project. With some minor changes throughout the surveys, this coding system made it possible to keep track of the visual data, when and where it is taken, who has taken it and to which find it is related.

In the database, a visual record had low resolution and consequently a small image size stored preferably in JPEG (Joint Photographic Experts Group) format with a compression factor of 10 to 20 with very visible loss in image quality. The resolution was usually kept to 96 dpi. On the other hand, the original photographs were kept in RAW or TIFF format with the highest resolution possible for that camera or scanner. RAW, as the name implies, refers to the raw unprocessed data of an image taken by a digital camera. TIFF refers to the preferred scanned image format suitable for better preservation without degradation. Their advantage is the high image quality allowing maximum manipulation of the image without degradation and their disadvantage is the large file size (NAS, 2009: 73).

7.1.3. Mapping

Geographical location information is an important and integral part of archaeological field studies. Such information was used to display geographic distributions of finds and the area covered by the survey. As the finds discovered were part of the maritime voyage, the geographic and environmental properties had great importance in figuring out these non-space objects and vessels. Hence, availability of mapping tools was a requirement for information systems on archaeological surveys.

Owing to the development in internet technologies, web-based mapping services supported the online server load of the high-value maps and high-resolution satellite. Google Maps, for a time named Google Local, is one of these web mapping service applications and technology provided by Google. Its application programming interface (API) allows website developers to integrate Google Maps into their websites with their own data points for free. During the development period of the information system, the web services has become widely used and major information technology companies such as Google, Yahoo and Microsoft initiated free web mapping services providing world-wide data including high-resolution satellite images and maps on the majority of the areas of the world. These mapping services provide not only maps on their own websites, but also programming libraries and interfaces for the integration of mapping services into external web sites. Although GIS technology together with nautical charts were adequate for basic mapping purposes, evaluation of web services provided by aforementioned companies revealed that those services can be easily integrated to the information system, feature more advanced and user-friendly interfaces for map navigation, and provide more detailed and updated maps.

In order to illustrate the improvement in the image quality, comparison of nautical charts, satellite images of Landsat GeoCover 2000/ETM+ and Google Maps are given for the same region of primary interest, Kaş Islands (Fig. 7.4). Although it does not include any bathymetric data, i.e. distribution of depth data on the sea, high-resolution data on and around the shoreline and islands is available on Google Maps.

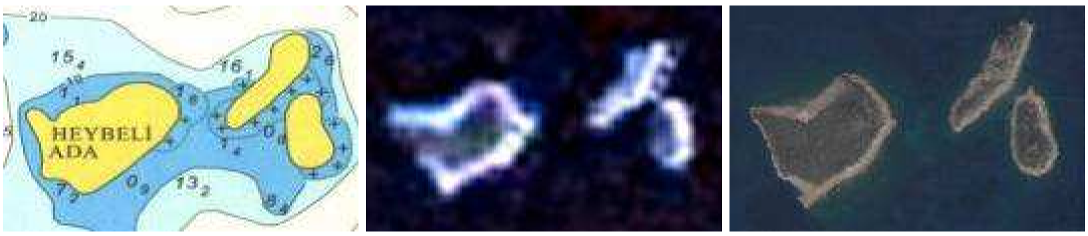


Figure 7.4. Comparison of nautical chart and Landsat GeoCover 2000/ETM+, Google Maps satellite images.

The satellite imagery provided by Google Maps has higher resolution, smaller scale and more details when compared to Landsat satellite images and the scanned and rectified versions of nautical charts (Fig. 7.4). To date, there is no national map source available with this much detail. Even if there were such a source, the cost of data would definitely have been very high since none of the national map sources are freely available.

7.2. System Architecture

Following the conceptual and logical designs, the physical design of the database system was planned out of a consensus of three programmers. The architecture presented in this chapter is based on the last version of the database system. The information system has been developed with a web-based, client-server architecture. It is publicly accessible on the Internet, at http://www.sanalmuze.org.tr/skm[19]. All data storage is done on the server side, while data input and display are done on the client side. The server application works on a web server and is supported by a relational database management system (RDBMS) and the native file system for data storage and retrieval. The client application works on web browsers and communicates with the server application synchronously and asynchronously through the Internet. For mapping an external Internet Map Server is used.

The information system used the software package called LAMP. A term originally coined by Michael Kunze (1998), LAMP (Linux, Apache, MySQL, PHP) is an acronym for a set of software subsystems and components, named after the first letters of the Linux operating system, the Apache HTTP server, the MySQL database software and the PHP programming language. Depending on the operating system installed, WAMP is another alternative, working on Microsoft Windows operating system. The information system has four structural elements: the web server, the web browser, information system programming and the database. The simplified architecture of the information system is given in Appendix C.1.

7.3. System Components

The information system was composed of major components that are self-competent information systems on specific topics, which are closely linked to each other. Each

[19] To date, the system is protected by a password that can be given upon request from the following address (sanalmuze@sad.org.tr).

component covers several record types and includes all data entry interfaces and database queries. The simplified structure of the information system is given in Fig 7.5. These components were categorized as dive-logs including researchers/divers, sites, dive logs, findspots, find logs including measurements, photographs, sketches, and analysis/visual media such as drawings, images, notes.

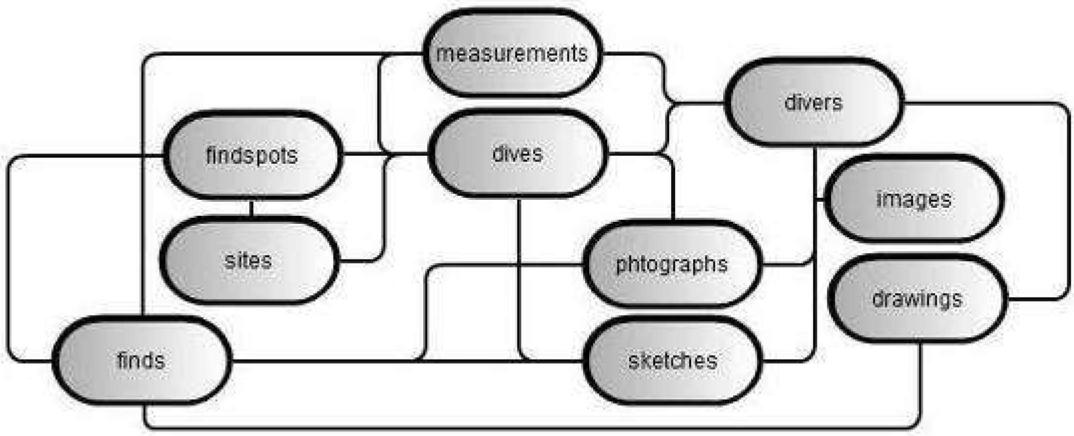


Figure 7.5. Simplified diagram of the system components.

In order to explain this highly complex database system, three major paths were defined. The first path was based on the dive logs, in which divers, findspots, measurements, photographs and sketches were linked. The second path followed the find and related information. Finds and the related findspots, photographs, sketches were linked to this system component. The third one, towards recording of the post-processed data, the images and drawings produced by the team members were linked to find system components (See Appendix C.2).

7.4. General Features

To date, the information system has general features for data validation, record relations and mapping. In order to avoid redundant information, enhance the ease of use, and check the geographical coordinates, these features are currently available in this system. However, even in its current stage, users asked for other features to be added to the system. These features are presented in the next chapter under the heading of further features.

7.4.1. Data Validation

The data entry to the information system was done through the data forms working on web browsers. For ease of use, the data forms comprised standard user interface elements, such as textual inputs for descriptions, numerical inputs for measurements, coordinates, selection lists for pre-defined types of entries, and calendars for date. Some of the form elements such as coordinates have limitations to avoid redundant data, and some of are dynamic in nature since their contents change according to selections of the user. To avoid redundant and incomplete data, some input fields were indicated with an asterisk. Before submitting all the entered data to the server, the data was validated on the client side. In case of missing or invalid entries, the user was warned to correct those problems by exclamation marks next to related input elements. Thus the optimum amount of control was achieved by the feature of data validation.

7.4.2. Record Relations

The ability to define relations between different record types allowed reducing the work-load of the information system. Owing to this feature, measurements, photographs, sketches under dive logs, additional links and relations were made between the photographs and the finds. Thus, it is possible to access one record from the other and vice versa through bi-directional record relations. As listed on the information page of each find, the relations can be added and deleted by the user. According to the selected record type, the information system listed all available records, that the user selects the related record.

7.4.3. Mapping

The mapping component was primarily used for findspot, site and dive log components for the designation of geographical locations of finds, the extents of sites and dives. The sites were marked as rectangular areas, whereas the locations of findspots were marked as single points, and the dives were marked as two points defining a straight line. The selected point locations for the findspots could easily be moved by dragging the marker. For rectangular areas of the sites, a custom extension was developed for Google Maps that allowed rectangular areas to be drawn on the map. These areas could be resized by dragging upper left and lower right boundary markers or by dragging the central marker. Accordingly, the lines defining the start and ending coordinates of the dives could be modified by dragging the central marker, or by entering the latitude and longitude values manually.

Mapping tools were available for expanding, contracting, zooming and removing rectangular areas. As maps are updated automatically by Google, the coordinates of the manually entered locations were displayed on the updated map automatically. To facilitate manual entry of coordinate information, the mapping component allowed coordinates to be entered as various formats. The format of the coordinates was automatically determined by the system and converted into decimal degrees during data storage. Latitude and longitude of the marked location were indicated on the corresponding data form elements.

The component was linked to findspots for displaying the distribution maps of finds and to dive logs to keep track of the area covered during the surveys. The information system has built-in lists of sites with data on their geographic boundaries. Once a site is selected, boundary information is retrieved from the server and the extents of the map are updated to display the selected site. .In order to increase ease of use, a custom windowing interface was developed, which allowed map display having a fixed dimension and position on the page to be undocked from its location and resized freely. Ability to enlarge map display size without affecting other data entry elements greatly enhanced the friendliness of the mapping component and facilitated marking on the map.

7.5. Discussion

The information system has been developed with the objectives of preservation of the data gathered during field surveys, accessibility by the interested parties, the integration of multi-aspects of archaeological research under a single roof, and user-friendliness for the users. Composed of a database, visual media and mapping tools, the information system allows recording, storage and sharing data of c. 600 finds from 22 different sites. In comparison to conventional database systems used in archaeology, the information system developed makes it possible to manage all types of data related to underwater sites. As the system was not limited to any site, the user can do different kinds of spatiotemporal searches on the data, especially on Google Maps.

This information system is the first web-based collaborative and open-content platform for raw data of nautical archaeology in Turkey. In this respect, it is a pioneering and unique project for the preservation of cultural heritage in Turkey. Based on the analysis of the datasheets and later the database, this information system met the majority of the needs of archaeologists; hence the possibility of its use should be considered by the MoCT, which aims to put a regulation similar to the currently available information systems into practice. Thus, the archaeological data collected during the surveys can be used to prepare an official underwater archaeological repository of Turkey. Although the components of the information system were designed according to the material remains found in Turkey, with little modifications, it can be adapted to other remains of material culture in different countries.

Following the creation of the information system, the next stage involves the interpretation of information through the feedback of specialized nautical archaeologists, as well as through the input of online contributors. Although this information system seems to be limited within the boundaries of collecting, storing and sharing data, it aims in future to integrate other disciplines at the interpretive stage, which is open to the general public. The system is an electronically distributed, online workspace, which provides the opportunity for the interaction of geographically distributed archaeologists and other professionals from related disciplines through the WWW. This model of information system enabled access to data for the shared input of educated and interested parties. Thus, this system in essence acted as an information retrieval system and provided a collaborative flow of information.

CHAPTER 8

8. The Virtual Museum Model

Musealization, as a scientific process, necessarily includes the essential museum activities: research, visualization, and communication via exhibition. In the developed system, a data collection methodology and information system was developed to record the data collected during systematic and intensive archaeological surveys. Thus, the surveys allowed the acquisition of data, and this information system fulfilled the needs for preserving, storing and sharing the collected data.

Through data stored in the system, the methods of producing archaeological interpretations and of visualizing interpretative information are adopted. Using the open-content system, separately produced visuals and interpretations are uploaded to the system through the collaboration of archaeologists and other interested parties. Separately used software programs helped to accomplish further analysis and visualization activities by collaboration of the users. In the choice of software programs, to prevent any copyright problems, open source alternatives were preferred when expertise of the users is available. As the system allowed uploading any kind of textual data and images in JPEG format, all master copies of the produced visual media were kept in separate folders as TIFF and RAW, file formats. This collaborative nature of data processing helped to analyze the user evaluate studies.

Table 8.1. Software programs used by the contributors

Analysis	OpenOffice (http://www.openoffice.org), Microsoft Excel (http://office.microsoft.com).
Drawings	QCAD (http://www.qcad.org), AutoCAD (http://usa.autodesk.com/).
Images	Gimp (http://www.gimp.org), Google Picasa (http://picasa.google.com), Adobe Photoshop CS3 (http://www.adobe.com).
Photogrammetry	AutoPano Giga (http://www.autopano.net), Hugin (http://hugin.sourceforge.net), Adobe Photoshop CS3 (http://www.adobe.com).
3D modeling	Google SketchUp (http://sketchup.google.com).
Geo-referencing	Google Maps (http://maps.google.com), Google Earth (http://www.google.com/earth/index.html).
Communication	e-mail groups (http://groups.yahoo.com/group/sanalarkeopark/), online documents (www.docs.google.com), private e-mails, project web sites (http://www.sad.org.tr, http://www.sanalarkeopark.org.tr, http://www.sanalbatik.org.tr).

The virtual museum is not in place yet. However, basic methods that are necessary for the creation of the virtual museum were investigated as well as the methods that were followed and the examples that were created by online users working collaboratively. Thus, the users of this information system participated in the musealization of information through independently used open source analysis, visualization and communication tools such as Gimp, QCAD, Picasa, Hugin, etc. The first step in the data analysis was the definition of the sites and finds, the analysis of the collected data, the distribution maps of the finds and the statistical study of these maps. Once meaningful information was driven from these analyses using different software programs, the data was visualized. The drawings and 3D models were driven from the measurements and typological data. The images were created using digital darkroom that is processing and enhancing photographs through digital photo editing programs. In addition, photogrammetric, panoramic and photomosaic images were generated from the photographs. The last step was the communication of data through geo-referenced maps. Still, even with the implementation of these tools, the information system does not actually compose a virtual museum as the theoretical background presented in chapter 3. The model of virtual museum proposed in this dissertation includes automated digital documentation, visualization and analysis tools and interactive user interface for providing dissemination of information. However, it was not possible to implement these features within the budget and time constraints of this dissertation.

8.1. Data Analysis

Through the information system, collected data was stored and shared to facilitate interpretation of data by archaeologists. In this process, except for interpretations, visual analysis of data composed the most powerful part. The archaeological analysis emphasized the importance of the information system with its open-content features. Whether composed by archaeologists or other interested parties in a collaborative manner; the products were uploaded to the system as JPEG or textual entries.

Each discovered artifact is a trace of past societies. Except from the distribution of artifacts, their specific characteristics allow archaeologists to define and date the provenance, intended destination of artifacts. By comparing and contrasting published archetypes and the finds recorded in the database, six possible anchorage-sites and five potential cargo sites are illustrated in Fig. 8.1. In order to support the archeological value of the project and to attract the attention of archaeologists, the cargo sites were presented in this data system as separate entities. Not only are the general distributions of sites, but also studies of ceramic and anchor-types are imperative to investigate the implications of interconnections and chronological frameworks of the maritime trade.

Figure 8.1. Distribution map of anchorage and cargo sites (G. Varinlioglu based on Google Maps).

Scattered ceramic and anchor remains that are clustered at five areas in the vicinity of Kaş, at Bucak, Üçkaya, Kepez, Heybeli, and Besmi, have been interpreted as cargo sites (See Appendix D). Situated not far away from notorious reefs and rocks above water, the cargo sites are often open to harsh weather. Of the five, three seem to have been considerably damaged, most probably through deliberate looting. These sites at Bucak Bay, Cape Üçkaya, and Kaş-Heybeli Islands are all located in relatively shallow waters. The remains at Bucak Bay are near notorious rocks above water named as Köfte Island, exposed to westerly winds at Cape Çukurbağ, on the west of the sheltered inlet of Port Vathi. The completely disturbed site covers an area of over 50 m at a depth ranging from 6 to 10 m. Also very damaged, the second cargo-site is recognized at depths ranging from 10 to 24 m and near a hidden reef exposed to westerly winds at Cape Üçkaya on the south of Kaş. Presumably including more than one wreck, this partially disturbed site covers an area of over 100 m. The third of these disturbed sites is located further south, at a depth of between 12 and 24 m, on the west of a group of five small rocky outcrops, commonly called the Kaş-Heybeli Islands. Remains at this site include various *amphorae* of similar types, ballast stones and a T shape anchor.

The anchorage sites at Kovanlı, İnceburun, Çılpacık, Kalkan – Heybeli, Gürmenli and Çapabanko are described as likely rest stops on the course of ancient maritime voyages. These sites have produced remains of a variety of anchors and a wide range of *amphorae* and other types of pottery scattered on the surface of the seabed. Furthermore, these sites are located within bays and by small rock croppings or islands, often on the east of the landmasses. Such observations support the argument that ships often followed the shoreline and attempted to take shelter by protective landmasses at nights, at rising conditions of danger or at times of harsh weather conditions (Wachsmann and Bass, 1998: 297; Parker, 1992: 4-7). In addition, the wide range of *amphorae* and anchor types that are recognized at these six sites potentially marks different chronological periods and illustrates the long-lasting use of these secluded areas by seafarers during their voyages across the Lycian coast of Turkey.

The old saying "a picture is worth a thousand words" is applicable to the field of visual analysis (NAS, 2009: 170). Hence, illustrations convey visual and technical information about objects for researchers to recognize parallels, similarities or differences with materials at different locations. The visual analysis of objects allows archaeologists to compare object types discovered during the surveys to other remains of material culture discovered in different contexts.

8.1.1. Drawings

Archaeological drawing is described as a mechanical process. Conveying measurements from sketches, examining photographs, and analyzing archaeological aspects are the main skills required to produce archaeologically accepted results. Imaginative elegance is an advantage, but it must be combined with archaeological information. For this purpose, various drawing standards are examined and discussed to design and develop the drawing methodology to convey a vast amount of information (Coockson, 2006: 170-180; NAS, 2009; Green, 2004: 289-324). Within the constraints of the survey methodology following *in situ* preservation, the objects were illustrated as outline drawings, without the information on body texture, thickness and fabric. The depiction of the information on surface details requires the removal of the object from its original context following the conservation process to prevent any disintegration and degradation of the waterlogged materials. However, as the material culture objects encountered have specific body shape and apparent body decoration, even without disturbing the objects, a wealth of information is illustrated in these drawings.

The initial step in generating the drawing of an artifact was to draw its outline by using general dimensions. Although the techniques differ from object to object, the technique useful for drawing the outline of a ceramic vessel, an amphora KE-23-A in Kepez (KE) site helps to introduce methods which are applicable in a wide range of situations (Fig. 8.2 and Table 8.2). Some of the techniques were borrowed from drawing of underwater ceramic objects that are raised above water, cleaned and conserved, but as is explained above, most of the information of a "clean" ceramic material was not applicable when drawn *in situ*. Decoration and surface details related to composition and manufacture were rarely visible to any of these drawings as details were hidden beneath encrustation.

Moreover, the section of the amphora is illustrated, as the thickness of the ceramic is a misleading data without adequate cleaning and conservation process. Nevertheless, the outline and dimensions of a complete or near-complete amphora with adequate rendering convey a great deal of information.

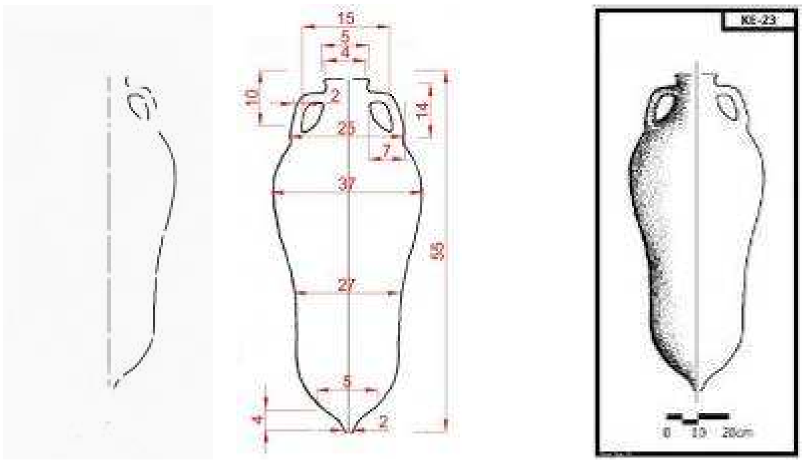
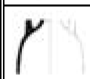


Figure 8.2. Steps for drawing of amphora KE-23-A (S. Pilge based on hand drawing).

Table 8.2. Typological data and measurements on amphora KE-23-A.

Typological Data		
Body type:		Ovoid
Rim type:		Beaded
Neck type:		Conical
Base type:		Knobbed
Shoulder type:		Rounded
Profile handle:		Short Vertical
Handle in section:		Grooved
Handle type:		Handle on neck – shoulder
Ripped body type:	-	None

Measurement Data	
General	
Depth (m):	33.1
Length (cm):	55
Width (cm):	37
Width shoulder (cm):	25
Ceramic thickness (cm):	2
Rim	
Rim diameter (cm):	5
Rim thickness (cm):	1
Neck	
Neck height (cm):	10
Neck diameter max. (cm):	15
Neck diameter min. (cm):	4
Handle	
Handle height (cm):	14
Handle distance to body (cm):	7
Handle diameter (cm):	2
Handle thickness & width (cm):	2 & 4
Base	
Base length (cm):	4
Base diameter, ring/ flat bottom cm):	5
Thickness base:	2

After the conservation process in conventional excavations, recording dimensions and drawing the profile of an amphora is achieved using simple methods involving a right angle block and caliper compass or any similar device (NAS, 2009: 173). Following the *in situ* preservation methodology, as the objects were measured and sketched under the water, few tools were available due to time constraints. The most useful tool was to take detailed measurements with a measurement tape and make observations on the typological data. Combined with photographs and sketches, these drawings were generated by hand. Initial steps for the automation of drawings through computer programs show that iterating the production of ceramics using potter's wheel by rotating along an axis and after adding the handles, it is possible to produce not only 2D drawings but also 3 D models.

The drawing of a site was generated first by positioning on the world coordinates and then using known features to place unknown survey points (NAS, 2009: 118). During the survey, the coordinates of sites were determined using floating buoys placed at the extremities of sites underwater. Once the GPS coordinates were recorded, the distribution of the finds were recorded following three survey methods, such as offset, trilateration and angle/distance methods. Depending on factors such as the requirements of surveys, time to be spent, available equipment, expertise of surveys, environment of the site and available funding, the appropriate survey methodology was decided. Varying according to the characteristics of the sites, such as the geography, physical condition and available resources, these methods were essential to place artifacts on a drawing plane.

Kepez (KE) an undisturbed cargo site was measured by the offset method, measurements that position features relative to a baseline fixed between two control points (NAS, 2009: 120). These underwater control points were transported to the surface by floating buoys for recording GPS coordinates, positioning the site on world coordinates. By measuring the distance between two known primary survey points with a baseline drawn between them, the unknown points, in this example, the position of amphora cluster Ke-23, were plotted relative to the two initial control points on the plan (Table 8.3). The network of unknown points illustrated the general distribution of finds on a site. By placing the refined sketches on this network, the archaeological site lying on the seabed was illustrated on the paper (Fig. 8.3).

Table 8.3. Offset measurement table on cluster KE-23.

Site	**Find No. (x-coordinate)**	L/R from baseline - looking from zero point	Distance on baseline	Depth of point on baseline	Depth of point on buoy zero	**RESULT**		**Find No. (y-coordinate)**	Distance of find to baseline	Depth of point on baseline	Depth of find	**RESULT**
KE	**23-x**	R	32	32,5	18,6	**28,82**		**23-y**	11,7	32,5	34,5	**11,53**

$$23x = (Db^2+(dpb-dpbz)^2)^{1/2}$$
$$23y = (Dfb^2+(dpb-df)^2)^{1/2}$$

Where

23x and y= Find number 23 and its Cartesian coordinates
Db= Distance on baseline
dpb= Depth of point on baseline
dpbz= Depth of point on buoy zero
Dfb= Distance of find to baseline
Df= Depth of find

Formula 8.1. Offset measurement formula.

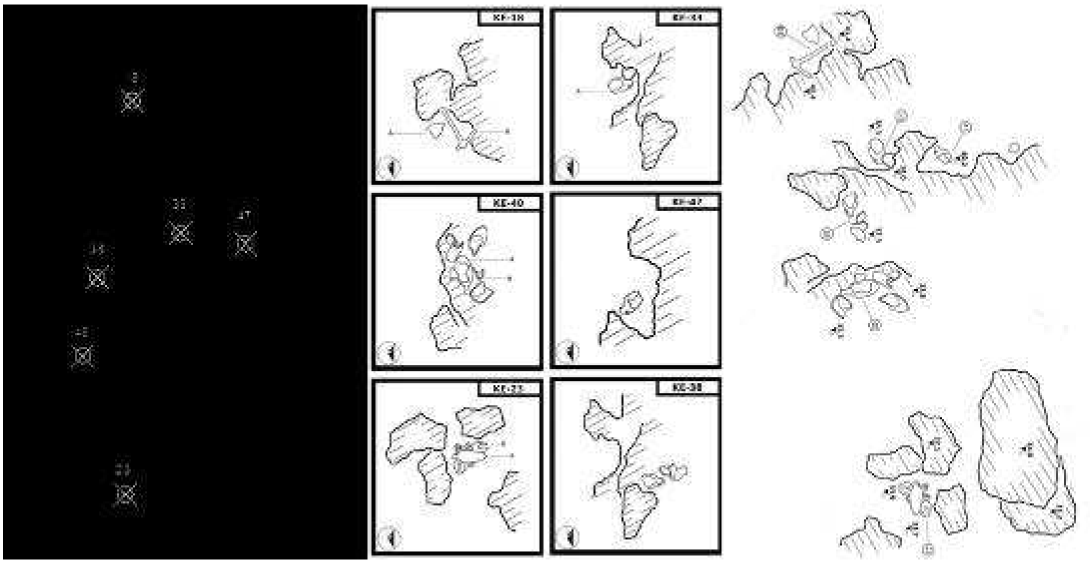


Figure 8.3. Steps for drawing of Kepez (KE) cargo site (E. Köşgeroğlu, B. Özkırlı, and S. Pilge based on QCAD, GIMP and hand drawings).

According to formula presented above, the distribution of the finds was calculated and drawn using software programs (Formula 8.1). Once the general outline of finds was determined, the sketches of finds were placed at these points. As in conventional archaeological drawings, the north sign, scale and control points were added besides significant underwater landscape surrounding the finds. The detailed drawings of the Kepez site, as well as other sites are presented in Appendix D. Depending on the conditions of underwater sites such as bottom profile, visibility and depth, and related factors such as time, equipment, expertise, and funding, details of the drawings were decided to be displayed (NAS, 2009: 117-118).

8.1.2. Images

The traditional analog photography has changed with the invention of digital camera. Although there are similarities between analog and digital cameras in terms of shooting methods, the digital factors, such as image quality, resolution and file size affect the end-product (NAS, 2009: 73). After the unprocessed photographs of the artefacts were gathered in the filed, with minor manipulation by some software, the presentation of the artefacts could be improved (Smith, 2006). Called as digital darkroom, processing the image by photo editing software program, images were enhanced by adjusting density, contrast and color, followed by a series of further refinements including reframing or cropping, resizing and making adjustments to isolated areas (NAS, 2009: 77). For the highest quality, shot and stored in RAW format, the images were then processed by adjusting exposure, white balance, hue, saturation and sharpness with little or no degradation of the original unprocessed data.

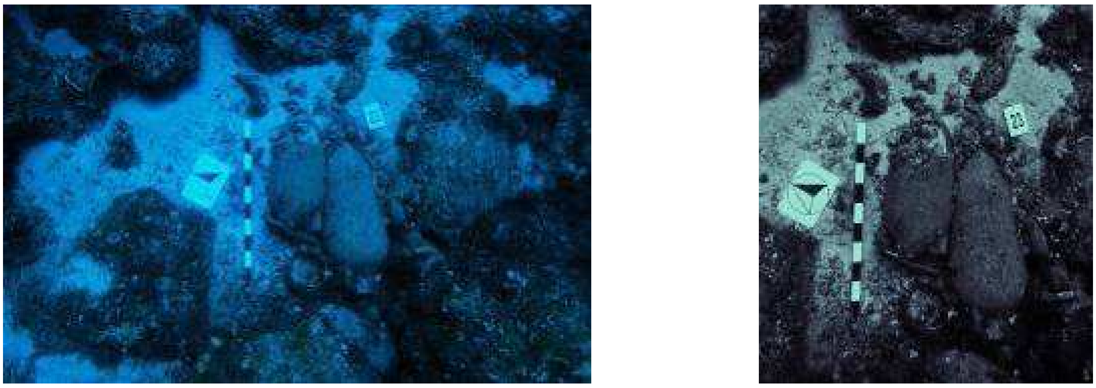


Figure 8.4. Steps for enhancing photograph of KE-23 (G. Varinlioğlu based on Gimp).

The methods for enhancing a photograph start by adjusting the overall exposure, brightness and contrast. By adjusting "levels", changing the histogram of the highlights, mid-tones and shadows, the overall exposure was controlled. The color was controlled by adjusting the hue and saturation, respectively the purity and vibrancy. Color balances refined the color, particularly to set the white balance and to eliminate the overall bluish effect of the underwater environment. After sharpening the image for emphasizing the contours of the objects, the final step was to crop and set the frame for archaeologically correct settings (Fig. 8.4).

As the quality of the underwater photograph depends on depth, available light condition and environmental condition, additional computer processing was needed. After the upload of unprocessed version of photographs into the database to allow others to launch their collaborative studies for the project, the photographs were turned into images in acceptable archaeological formats.

8.2. Data Visualization

In addition to open-content repository of the collection, preservation and research of the archaeological data, the virtual museum should also feature a model for visualization of the underwater cultural heritage. To date, automatic visualization tool are not integrated to the information system, neither exhibition feature is available for adequate display of these highly stylistic methods. In future, it is aimed that these automation tools are coupled with adequate computer algorithms.

Visualizing archaeological information is one of the most attractive ways in which computer technology is employed in museology (Meyer et al., 2007: 399). The use of these techniques allows visual interpretation of data through representation, modeling, display of solids, surfaces, properties or animations, which is rarely possible in traditional museum web pages. Outdated but prominent article by Reilly's historical overview on the basic utilization of 3D modeling in archaeology presents two visualization techniques on archaeology in the information age: solid modeling and data visualization. Solid modeling meant the three dimensional reconstruction of data. Constantly evolving visualization techniques bring more and more heritage data to the virtual domain of museology.

8.2.1. 3D Modeling

The perception and knowledge of 3D structures is essential to both archaeology and museology. For archaeologists, modeling of 3D data presents the opportunity to advance 3D knowledge into the realms of interdisciplinary research (Razdan et al., 2001). For the display of archaeology in the web environment, the first step is the 3D reconstruction (Bruno et al., 2010: 44). On land applications, the digital reconstruction of an object is usually achieved by scanning and texture-mapping. Using 3D scanners, called also laser scanners, the shape and texture of the object is transformed to a 3D digital model. The digital model of an artifact is the first step for creating VR applications in a virtual environment.

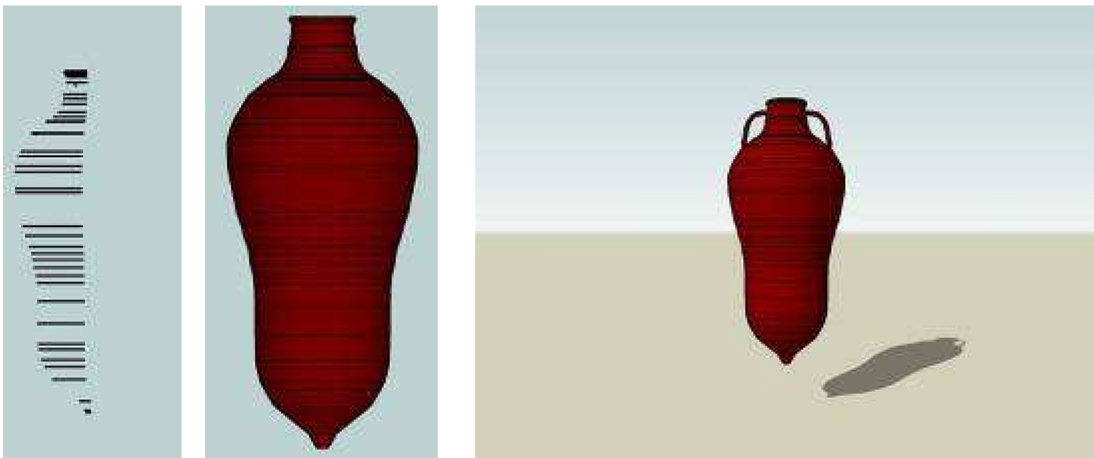


Figure 8.5. Steps for 3D surface model of amphora KE-23-A (B. Özkırlı based on Google SketchUp).

For the geometric modeling techniques used in the visualization of the amphora KE-23-A, the shape data comes from the measurements in Table 8.1 and the drawing presented in section 8.2.1. As the symmetrical profile of an amphora illustrates, the 3D model of the main body was achieved by sweeping around an axis. The handles were produced separately and added to the body to complete the form. This "blank" model of the amphora displays the 3D form of the amphora KE-23-A (Fig. 8.5). Rendering, the process of generating an image from a model was the last phase to achieve a photorealistic display of the selected object.

8.2.2. Photogrammetry

Photogrammetry is the practice of determining the geometric properties of objects using photographic images. The two methods of photogrammetry used in the project are the photomosaics and panoramic images of the sites. Beginning in the 1960's, photomosaics were produced by physically stitching images together to create new images from arrangements of individual picture frames (Ludvigsen et al., 2007: 141). Similarly, overlapping sets of photographs for assembly of photomosaics are used in underwater surveys (NAS, 2009: 78-79). In underwater applications, especially while the photographs are taken by a camera operated by a diver swimming above the site, rather than a camera attached to a ROV, several practical difficulties have been encountered. The must fundamental difficulty was to control photographic sets, the inconsistencies of the height that pictures were taken from, the flickering of the horizontal film plane, and the shortness of overlap between the sets of photographs (Martin and Martin, 2002: 137). There are some considerations in producing a good photomosaic, such as camera and light configuration, seascape, and the image quality. Carefully chosen altitude, in line spacing, and velocity of the photographer corresponds the efficiency of image overlap, sidelap, seabed resolution and acquisition. The term overlap is used for the common area in two images taken sequentially while the camera moves along a line, and sidelap denotes the common area of the images across track (Ludvigsen et al., 2007: 142-143). The area covered by each image directly depends on the distance of the diver from the seabed and the view angle of the camera. Following Ludvigsen's technique, for mosaics of aerial photography 50% overlap and 25% sidelap was used with a 45° field of view of the camera. According to Green (2004: 171), the camera height and the focal length of the lens are calculated by this formula:

$D/H = W/f$

Where

D= the distance of coverage required in meters,

H=tower height in meters,

W= width of the film in millimeter,

f=l focal length of the lens in mm multiplied by 1.33 for use underwater.

Formula 8.2. Photomosaic camera height formula.

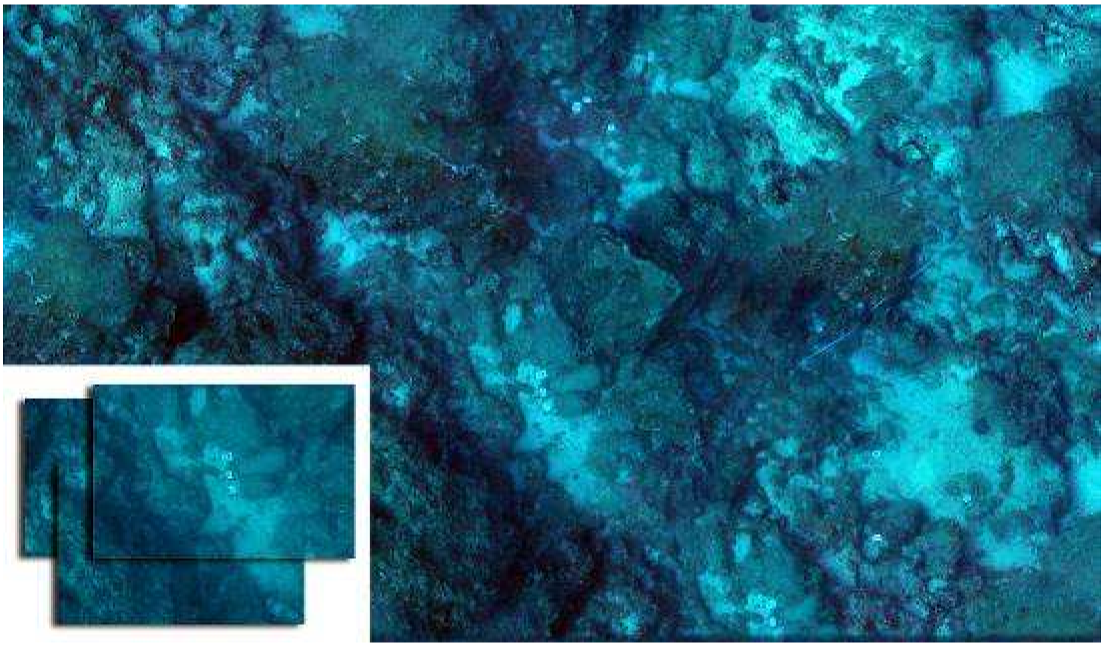


Figure 8.6. Steps for photomosaic image of the Kepez cargo site (KE), focused on KE-23 and its surrounding (U. Aksu based on Photoshop).

Some initial attempts were done by a series of free swimming sets across the site, estimating the camera height and level, and the frame intervals. Surprisingly good results are obtained in small extent sites by using the Hugin and Adobe Photoshop automated photo stitching software programs (Fig 8.6). The results became erroneous in bigger sites.

Panoramic images are efficiently used for documenting archaeological sites and objects applied especially for walls and slopes. On land, panoramic images are achieved through three techniques (Baştanlar et al., 2006: 222). The first two methods use special wide angle converter or a wide angle lens that takes distorted images of 360 degree at one shot. As the overall image of the site is taken with one shot, there is no exposure problem in between the scenes. The widely used third method is usually performed by taking panoramic image sequences (Fig. 8.7). Each sequence consists of concentric photographs to cover the object to be documented (Haggrén et al., 2004). For underwater applications, waterproofing equipment such as housing for camera and additional lenses is the main concern for choosing the third alternative. This alternative is composed of photo sticking of separately taken images and processing in software programs. However, concentric photographs heading to different angles cause differences in exposure in panoramic image sequences.

Figure 8.7. Steps for panoramic image of Kepez (KE) cargo site (C. Çimen based on AutoPano).

As an alternative to conventional manual triangulation-based documentation, photogrammetry is a well-established technology in archaeological surveys and excavations. Photomosaic as aerial and panoramic as vertical photography provide both exact and detailed recording for archaeological analysis. Photogrammetry is applied for documentation of excavations and reconstruction of finds (Haggrén et al., 2004: 1). PhotoModeler is essentially a photo-triangulation program that uses a calibrated camera to measure the light rays from the lens through the photographic image to various points on the object. Through the calibration of the camera, providing the geometry of the camera and the lens, it is possible to calculate the angles with multiple views of the same points. Therefore, from the various camera locations the complete geometry of the object can be determined. Some kind of control measurements are required to provide scale for the data created. PhotoModeler was used for maritime archaeological work, but little has been published until recently on its application to underwater archaeological sites (Franke and Montgomery 1999). The most recent study in the field of nautical archaeology is the documentation in Tektaş Burnu Shipwreck. Coupled with Rhinoceros and Virtual Mapper, PhotoModeler is used as an alternative to triangulation measurements taken by divers (Green et al., 2002). As explained above, there are some alternative photograph based digital documentation and modeling tools available in the market. To date, as there is no open source alternative to PhotoModeler software, the modeling through Photomodeler could not be realized during the surveys.

8.2.3. Video Images

Films and videos offer a lively way into the past. Usually combined with moving image and sound, video images are powerful tools for communicating with the public (Van Dyke, 2006) Sometimes coupled with animations and graphical reconstructions it provides novel ways to think about the past, and help the users to visualize beyond what is actually underwater.

In nautical archaeology, especially in deep water archaeology, video images are taken by deploying remotely operating vehicle (ROV) to the depths where divers can not reach (Ballard et al., 2001). A remotely operated camera captures various moving images of the depths for further analysis. When at a reachable depth, a diver captures video in good lighting conditions. During the survey, captured video images were edited for finds and sites. To date, captured data were stored separately from the information system.

8.3. Communication via Exhibition

When the overall features and potentialities of the information system are taken into account, communication and interaction of information is at its preliminary stage. Except for enabling the users to upload visuals, change the content and update information, visualization and communication tools are not yet integrated to the system. Users of the system communicated by separate e-mail and e-mailing groups, documents were shared in document sharing platforms.

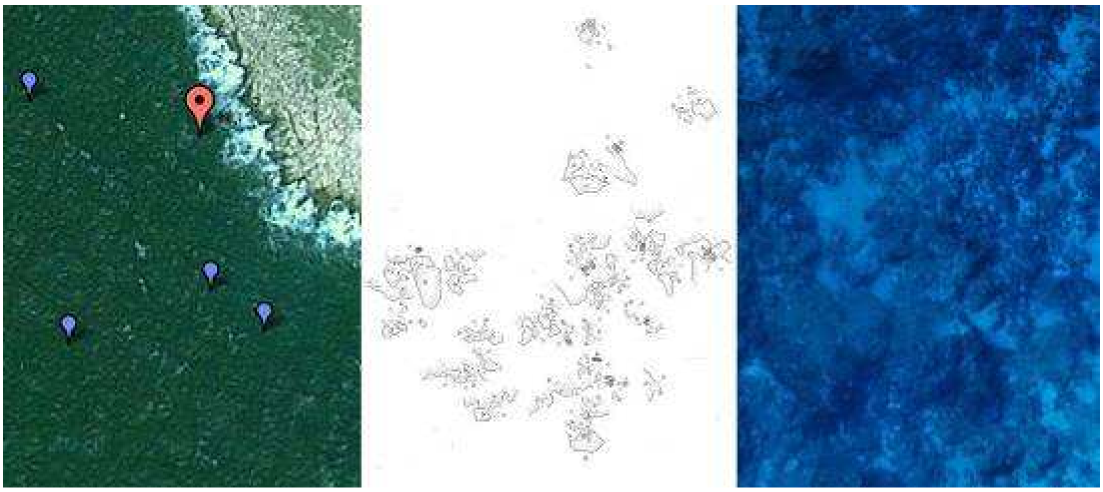


Figure 8.8. Steps for integration of satellite image, site drawing, and photomosaic of the site Kepez.

In archaeology, the outcome of studies should have locational and chronological information. For location information, Google Maps offered a navigation pattern for the interested parties. Coupled with Google Maps, the information system allows users to view the distribution of the findspots, sites and dives. Although Google Maps provides high resolution multi-temporal satellite images, higher resolution is needed for a better display (Cultraro et al., 2009). Together with bathymetric data, photomosaic images and drawings of the sites, the satellite images acquired from Google Earth and Maps can be overlapped to ensure the immersive aspects of the system (Fig. 8.8).

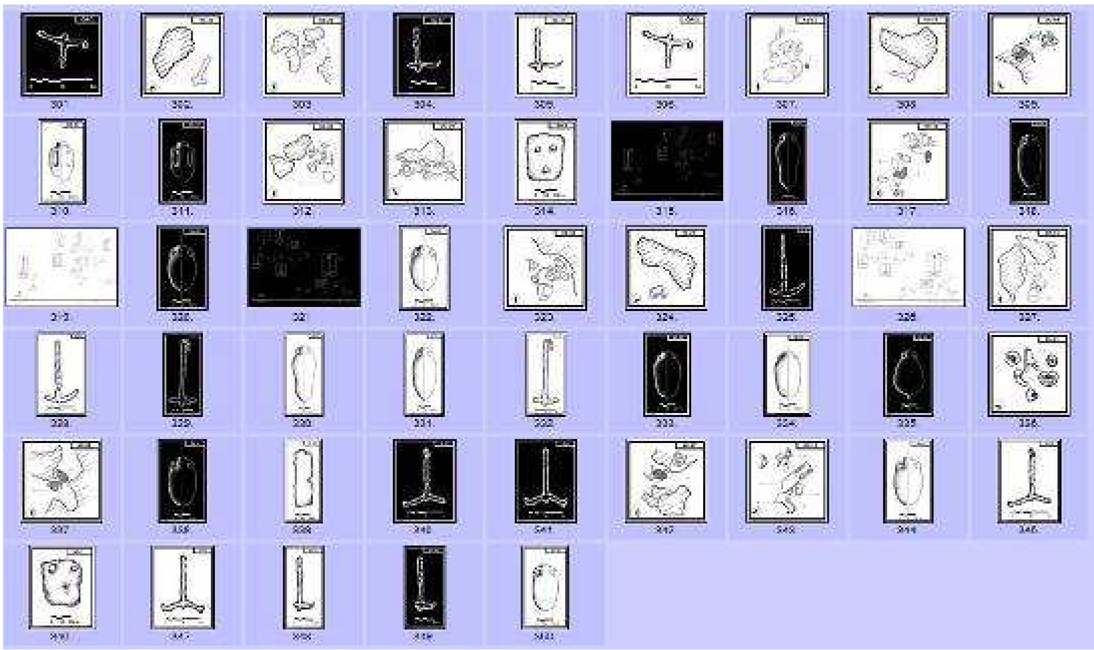


Figure 8.9. Screenshot from the information system displaying thumbnails of the drawings.

Besides the query mechanism of the system relying on textual search, the system should have image search options for drawings and images. To date, displayed as thumbnails, the images convey quick view of the artifacts (Fig. 8.9). Further studies on archaeological publications and comments of archaeologists showed that chronological charts and tables on the discovered artifacts display both visual and statistical information on the archaeological analysis. Thus basic models for the chronological distribution charts were produced separately for the finds and sites.

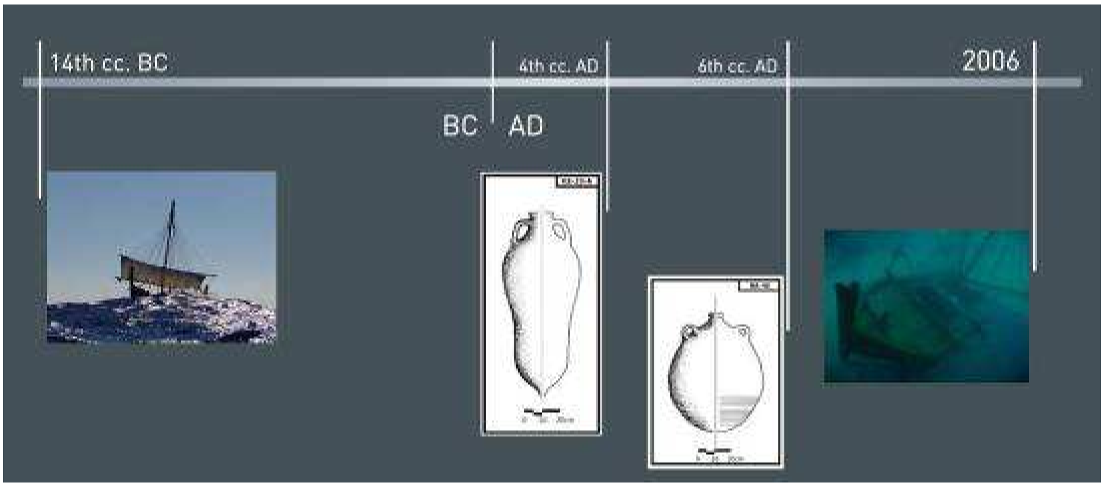


Figure 8.10. Chronological distribution of the finds.

In this chronological chart, two *amphorae* are dated based on visual similarities to *amphorae* discovered, studied, and published in previous studies (Fig. 8.10). The amphora, KE-23-A might possibly be dated to Roman period, the 4th century AD (Yıldız, 1984: 23; Varinlioğlu, 2011: 185), and the second amphora, BA-46 run parallels to an amphora from Bodrum Underwater Archaeology Museum, and is dated to 5th-6th centuries AD, possibly from Palestinian origin (Alpözen et al., 1995; Varinlioğlu, in press). As the archaeological analysis on the cargo sites is still in progress, the two wrecks chosen for dating are, Uluburun III that sank in 2006 as a part of Kaş Archaeopark Project, and Uluburun II (Varinlioglu, 2008), the reanimation project of the original Uluburun wreck dated to 14th century BC (Pulak, 1998). This chart can be extended when archaeological studies on dating of the artifacts and wrecks are completed.

8.4. Further Studies

The first step in the data analysis is the description of sites and finds, distribution maps of the finds and statistical study of these maps. Once meaningful information is driven from these analyses using software programs, the data was visualized. The drawings and 3D models were driven from the measurements and typological data. The images were created using digital darkroom that is processing and enhancing photographs through digital photo editing programs. In addition, photogrammetric, panoramic and photomosaic images were generated from of the photographs. The last step was the communication of data through geo-referenced maps (Fig. 8.11).

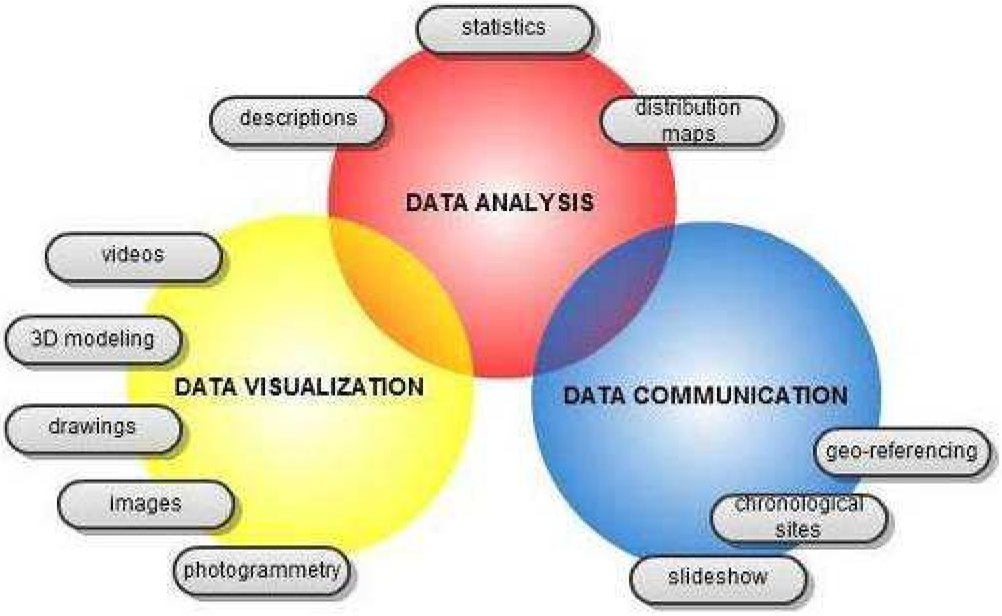


Figure 8.11. Future implementations to the information system.

Analysis of the systematically collected data is a necessity for further research in the field of archaeology. As analysis tools are not yet integrated to the system, the analysis is driven manually from the information system. The archaeological questions answering distribution map of the findspots and of the find types, some statistical approaches to distribution maps and to dating of the artifacts, description of the sites, environment, and finds should have adequate query mechanism.

The comments of users showed that collected data should be displayed on the same page. As the system stores and displays all the collected data, there are inconsistencies between the measurements and observations of different users. Archaeological measurements have discrepancies related to the skills of divers measured objects and measurement tools. As separately stored entities, these ambiguities and inconsistencies should not be eliminated, but rather, a statistical mechanism should be integrated to standardize the data. Similarly, the visualizing of the data should have some automated tools for producing drawings, for enhancing photographs, and for stitching images to create the photogrammetric representation of the sites and objects.

The application of visualization tools to archaeological data is part of both analysis and exhibition of the artifacts. Initially the applications are implemented by computer talented interested parties. Advances in experimenting these tools show that archaeologists tend to replace the traditional conventions with new recording strategies. As the ease of use of adequate software programs is taken into account, these visualization tools would be largely used not only for visualization but also for analysis and interpretation. Automated 3D tools, as well as panoramic and photomosaic would enhance the level of interaction with the depicted objects.

To date, there is no exhibition tool integrated to the information system. The Google Maps, listing tools, and preview images of the visual materials such as photographs, images, sketches, and drawings are used as the main navigation pattern in the information system. However, variety of exhibition strategies should be added to the system, coupled with an interactive interface that will attract the attention of the users from different backgrounds.

8.5. Future Features

The implementation of a virtual underwater museum requires documentation and analysis tools for the archaeologists, visualization and exhibition tools for the archaeologists and the public, and an interface for communication and interaction for all interested parties (Fig. 8.12). Among the features that will be developed in future is the conceptual discussion of the artificial intelligence of an archaeologist. This concept precedes the development of advanced visual features for designing an immersive user interface.

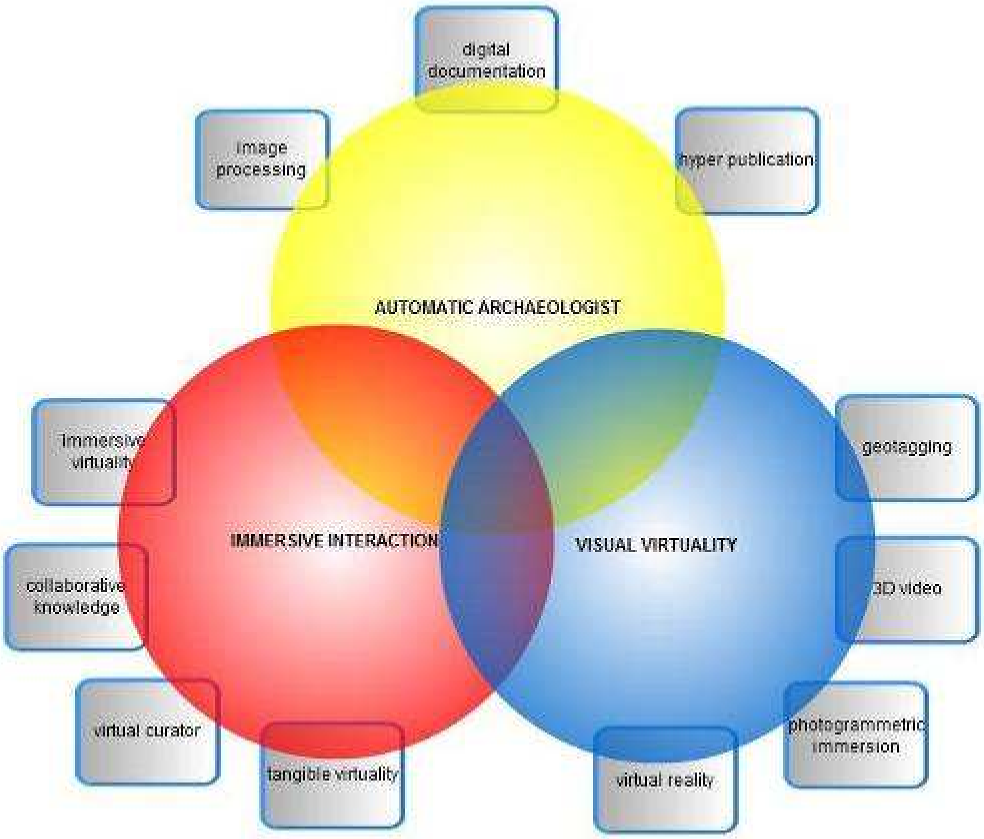


Figure 8.12. Model of a virtual museum.

8.5.1. The Automatic Archaeologist

Contrary to common belief, archaeologists do not study "artifacts as mute witness of the past", but analyze the social networks of the past (Barceló, 2007: 435). The artifacts are the produced objects left by the past culture, the concrete evidences of material culture. As historians, archaeologists are not looking for objects, but rather actions which produced objects with specific features. These features, such as the shape, size, composition and sometimes texture are clues of material culture. Discovery of objects at specific locations proves the social interactions in those places at those moments, and differences in physical properties of objects such as shape, size, composition and texture are clues of another culture's production, distribution or use.

Archaeologists are making these interpretations out of the remains of material culture. This process is called "interpretation" or "analysis" in archaeological terms, and "reverse engineering" in engineering terms. Reverse engineering is generally defined as the process of discovering the principles of a human made device, object or system through analysis of its physical properties. This process is a deduction, finding causes starting from the effects. In this study, effects are the discovered objects and causes are the questions of the archaeologists and other interested parties.

As subjects of this study are artifacts of nautical archaeology, major archaeological questions are listed as follows: Why did these ships sink? What were they carrying? Who were they? Where were they trying to go? What were the maritime routes in that specific time? What did the ship look like? This archaeological inquiry leads to historical questions on Lycian coast, specifically the region of Kaş: Since when was Antiphellos inhabited? What was the relationship between Lycians and Greeks like? How was the relationship between Phellos and Antiphellos? When was Antiphellos founded? When did the influence of Phellos started? How is it visible?

The automatic archaeologist does not mean the analysis tools of archaeometry, such as dendrochronology for dating wood and radiocarbon dating for organic materials, rather it is a computer agent that thinks and acts rationally like an archaeologist. In a sense, the automatic archaeologist is "a cognitive robot an intelligent, dynamically autonomous robot" (Barceló, 2007: 40). As a continuation of basic automation tools presented in previous sections, the automatic archaeologist should be able to think as an archaeologist for the knowledge formation process. This is an automation tool that can perceive the environment as an archaeologist, do research on the publications and answer archaeological questions. The system should be able to drive meaning out of the physical properties of the artifacts. That is both a tool for archaeologists and for users/visitors of the virtual museum. The tools for automatic archaeologist are digital documentation, image processing and hyper-publications.

By the development in information technologies, three dimensional documentation tools have brought growing amount of heritage data into the digital domain (Addison, 2008: 28). When compared to clumsy hand-held devices and techniques used in the documentation of cultural heritage, the digital domain brought several challenges. The prominent advantage of these tools is the accuracy and precision. The noises and inconsistencies in measurements and poor quality photographs and sketches may change interpretations of archaeologists. Today, there are variety of devices that can document the artifacts and sites with high accuracy and precision. However, these tools are bound to specific features. Laser scanners record the shape and the dimension, MRI or X-Rays technologies show the material content of the objects, etc. Since the material culture of nautical archaeology is not only limited to shape, dimension and content of the object, many other factors, such as environmental conditions, marine fluctuations, geography, the context of the object should be recorded all along with visual data presented in the previously mentioned technologies. If this "picture" can all be digitally documented, then the automatic archaeologist could adequately produce the information on the way to the knowledge formation.

In this knowledge formation process, the image processing can be used as an aid to archaeologists. The successful implementation of intelligent digital technologies in the archaeological domain facilitates a thorough analysis and interpretation of archaeological data. One of these is digital image processing that involves the manipulation and interpretation of digital images with the aid of a computer. This aid can be used in digitizing the find, automatizing classification and visualization, and helping information retrieval for archaeological report (Boon et al., 2009: 190). Machine learning, as a branch of artificial intelligence, can learn through the sample data to capture the characteristics i.e. the archaeological properties of an object. The major focus of machine learning is to recognize complex patterns and make intelligent decisions based on previously given patterns. Once the statistics on measurements, descriptions and visuals on the artifacts are given, image processing tools classify the information automatically. As the nature of discovered finds implies, there are varieties of ceramics, anchors, and other finds. Once the computer "learns" to classify the find types, information on the same types of find can be used to retrieve information.

Once the information is achieved through machine learning tools, the next step is to prepare publications. Following the long tradition of archaeology, publication, scholarly or popular, is a way of reconstructing the archaeological context in text format. As this tradition implies, the review on previously published materials and referencing the interpretations by archaeologists are essential tasks while conducting a research. Thus, reaching academic resources as well as information on similar museum objects is a necessity for an academic publication.

There are attempts to make information and communication technologies available to museums in the most user-friendly and cost effective way. The ultimate aim is to make museum collections more widely accessible. One example is the Remote Access to Museum Archives (RAMA) Project that is a consortium of linking European museums through telecommunication networks (Delouis, 2001). This project led to another project called Multimedia European Network of High Quality Image Registration (MENHIR) project in Europe within the European Union program ESPRIT. There are several attempts in other countries such as the CHIN project, networking of the cultural institutions of Canada. As growing number of collections became online, there are more chance to reach the digitally created documents. Once reached in digital formats, the documents can be used to create hyper-publications, the preparation of scholarly publication by the help of software programs. On the way to knowledge formation, the automated tools for referencing and editing will allow the archaeologists to disseminate the information instantly without jeopardizing quality.

The digital era has provided a more flexible medium for storytelling. In the early stages of digital technology, like hyperlinking, different paths can be followed by the user, other than the path dictated by the curator. In museology, the artifacts are arranged in collections by a curator in order to convey a linear explanation of history. However, each artifact has its own story, sometimes contradicting interpretations by different archaeologists. A good example is a discussion on the city of Troy and two opposing ideas on the importance of this city in Antiquity. Although substantial studies have been done on this well-known historical site, there are still opposing ideas based on the interpretations of archaeologists. Referring back to Foucault and his conception of truth and meaning (Foucault, 1969), different approaches should be presented on the same site and artifact by means of hyper-publication. In the virtual domain, instead of one single dominant narrative, a multitude of voices telling different stories produces a decentralized vision of virtual heritage (Refsland et al., 2007: 413).

8.5.2. The Visual Virtuality

"Visualizing" is a tool to understand and represent reality (Barceló, 2007: 446). The idea here is not only the representation of an artifact, but to decompose the artifact and its related information. That is to say, it is the reverse process of the divers collecting data out of an artifact. In a way, visualizing is a tool for the automatic archaeologist to solidify the information, to the information hidden in the location marks such as shape, size, and location and retinal properties such as texture and composition. Alternatively, visualizing is a tool for users to experience the environment virtually. Whether it is composed of the computer reconstructions of the museum objects and of the photographic realities of panoramic immersion, virtual environment empowers the visualizing process. As the methodology followed during surveys implies *in situ* preservation, the geographical information of the artifacts should be displayed along with these visualization tools. Thus, rather than a dictated navigation, this virtual system should have multiple narratives according to the interest of users.

Previously named artificial reality by Myron Krueger in the 1970s, virtual reality by Jaron Lanier in 1989, cyberspace by William Gibson in 1984, virtual worlds or virtual environments in 1990s and enhanced or augmented reality in the1990s, virtual reality has a wide variety of applications (Pujol, 2004: 2). Associated with immersive, highly visual 3D environments, VR includes the experiences of simulation, interaction, artificiality, immersion, telepresence, full-body immersion and network communication (Heim, 1993). The initial step for preparing VR applications is to recreate the reality in the virtual domain. In the heritage domain, digital reconstructions of finds and sites allow users to experience the 3D qualities of the depicted scene.

VR technologies have been used in the museology for more than two decades (Barceló et al., 2000). The reconstruction of the remains, rather than the digital documentation brings the interpretations of the archaeologists. Rather than the photorealism below, the creative thought of the archaeologist is emphasized in these 3D reconstructions. These VR applications based on videogame technologies can be both used as an interpretation tool for the archaeologist, and a more immersive interactive fluid environment for the user (Bruno et al., 2010).

Figure 8.13. Photogrammetric immersion

The emergence of the photogrammetric immersion is based on the desire to design a virtual environment that can be inhabited by the viewer to maximize a sense of immersion and ultimately "presence" in the recreated world (Kenderdine, 2007: 301). Photogrammetric immersence covers the panoramic images, photomosaic images and any other photogrammetric tools based on conventional digital photographs (Fig. 8.13). The reason to emphasize the supremacy of photographs is based on the conception of photographic truth. As many theories on photography imply, photography is the "reification of spectacle and the regime of visual controls" (Kenderdine, 2007: 303). When the common criticism of "Disneyfication of culture" of the virtual and augmented reality technologies are taken into account, the potentialities of these photographic tools should be explored. The photogrammetric immersion is closely interwoven with photography. Means to create a more illusionist immersion should be explored. The creation of panoramic 3D vision systems can be achieved through omni-directional cameras that mimic the real world. Computer science is directing research for the problem of capture and display of this 3D world.

The 3D visualization provides to museum curators to disseminate the data to a wider public. These 3D models can also be used for museology to reconstruct an object or a scene using photographs and videos. As in the case of photographs taken in a sequence, the moving images, called as video images can be used as image resources. Starting from a sequence of images, the first step is relating the images and the relative motion between them. By matching the video images, the 3D reconstructions of the images can be realized (Pollefeys et al., 2003)

Using geomatics, the discipline of gathering, storing, processing and disseminating geographic information or spatially referenced information, the geographically distributed finds and sites can be displayed in the fourth dimension. The virtual navigation between reconstructed sites can mimic the voyage of a ship in various time periods. Once the time frame of the finds are determined, the time periods as well the geographical data can be combined and be reconstructed in the virtual worlds by animations, 3D models and other tools .

To date, the discussion was based to the applications for a static computer user. However, the mobile computer applications became wide spread used. Due to widespread use of highly inexpensive usable technology such as data-capture cellular phones such as Smartphone with GPS features receivers, the notion of location-encoded media has begun to be used in the public domain (Refsland et al., 2007: 409). The ubiquity of location-aware technology became a standard feature of wireless devices. Setting aside the Big Brother theories to be watched and caught of a cellular phone technology, this ubiquity has two major advantages for a future virtual museum: advantages in data collection and in exhibition experience. When the user encounters an artifact, data can be gathered and uploaded to the virtual museum through the recording technologies available for that location-aware device such as photograph, video, etc with location information. By this method, more data can be gathered, if the underwater positing fixing technology can be available for these smart phones. Called underwater acoustic positioning system, this technology is for tracking and navigation of underwater vehicles and divers by means of acoustic distance and direction measurements. The second usage is for the ubiquitous exhibition of the artefacts. Knowing that there are some technological researches on converting Smartphones into dive computers[20], these local-aware devices can display information on a find encountered during a dive, when

[20] A dive computer is a device used by SCUBA divers to measure the time and depth of a dive so that a safe ascent profile can be calculated and displayed so that the diver can avoid decempression sickness. Today, a dive computer has become more widespreadly use among divers.

the diver reach that location (Egi et al., 2009). By the image processing tools, the online contributors can upload and consecutively process the data they discovered. Although this technology would be available for divers only, this ubiquitous experience can be applied to the remains on land, when the virtual museum system includes data on archaeological remains on the land in the future.

8.5.3. The Immersive Interaction

The ease of digitizing artifacts and their wide spread use by WWW has led to an explosion of information. In the field of museology, the virtual museum usually meant the representation of an artifact or a site with an image, movie or animation. However, the real object can never be fully represented. The absence of experiential interactions is the biggest gap in most of the WWW applications. Based on the visual qualities of the object, experience is limited to vision. Moreover, the interaction is based on hand movement through a user interface that is based on mouse clicks or keyboard typing. However, other than the visual experience, tangible experience should be emphasized in a virtual underwater museum. Not commonly used especially in the WWW, there are adequate technologies to convey the haptic experience.

Our body is the first interface between the world and the inner self. The connection to the outer world is through the senses. In the virtual domain of WWW, the senses are limited to visual and audible experiences. Moreover, the interaction is bound to some devices, as mouse and keyboard, through the graphical user interface (GUI). However, even with the currently available hardware and software, it is possible to change the quality and quantity of interactions in the virtual environment. As Milekic stated, "multimodal interaction" have three modalities, two of which will be the focus of this section (Milekic, 2007: 375): tactile and kinesthetic. Tactile experiences identify how something feels, and kinesthetic experiences imply gesture and movements. Before giving suggestions on how to make virtual information interactive, it is useful to have an overview of tangible and immersive properties of the digital medium and inherent problems.

Our bodies can be considered as the first interface between the world and ourselves (Milekic, 2007: 371). Through the senses, actions, observations, and sometimes tools, it is possible to communicate with the outside world. Likewise, a human-computer interface has rules and constraints to communicate. As opposed to the first human-computer interfaces that were abstract, efficient and accessible only to expert users, graphical user interfaces (GUI) included tangible properties. As such, one of the commercially available devices that provide haptic feedback is a mouse. It allows the users to "touch" different objects and "act" in the traditional GUI interactions. In conventional "point-and-click" interface, the feedback is visual that creates a separation between the hands and the eyes.

There more than nine commercially available haptic-enabled interaction devices in the market. These devices are described as "doing for the sense of touch what computer graphics does for vision" (Robles-De-La-Torre, 2009). One instance for this tactile feedback technology is products of iFeelPixel Association (2002) that allows people to use their sense of touch when operating through the user interface. For the best knowledge of the author, there is no instance of their use in museum web environment.

Figure 8.14. Tangible interface of the virtual museum.

Archaeologists want to touch the artifacts for a tangible virtual experience (Fig. 8.14). This tactile experience brings an enhanced understanding of the texture, shape and thus the physical settings of the object for better interpretations. Besides archaeologists, visitors want to feel museum objects. Displaying them in a traditional manner, in a glass box, would allow the viewing of only limited properties from a certain perspective. However, underwater environments and the artifacts displayed *in situ* should convey multimodal information. In other words, they should not be enclosed in the glass box of the browser with traditional GUI devices. It should be taken into account that when introducing new ways of interaction bring the need for unlearning adopted conventions. As such, conventional ways of navigation in this virtual environment should also be included alongside the new immersive ways.

Immersion is described as the experience of entering into the simulation or suggestion of three-dimensional environment. As such, it is the total inclusion of the body. In the underwater environment, the basic forms of "immersion" allow the body to interact with the environment. Moreover, by breath and balance, the diver body becomes united with the element, dissolving the boundaries of object/subject, inside/outside. These adjectives and phenomenon have similar effects to Osmose, the virtual reality artwork of Char Davies (1995). Osmose is noteworthy in terms of the achievement in transgressing the boundaries of virtual reality technology. Including the physical body within the virtual environment, Davies defines the term "immersant", the total body immersion in virtual environment. The effect is to create a meditative experience for the participant, who is generated by the unconscious movements of the body. Navigation is based on the participant's breath and balance, which are analyzed by a complex computer system linked to the body via an interface vest and stereoscopic head-mounted display (Varinlioğlu, 2003: 43).

This analogy of underwater environment in virtual reality technology reminds the lack of conveying gestures and body movements in virtual environment. As usually neglected to capture gestures in traditional digital environments, the use of gestures is an important part of everyday communication. It is for pointing, as descriptors, to indicate agreement or disagreement, or to convey an emotional state (Milekic, 2007: 377). As mentioned before, the navigational mechanism used for browsers and many digital documents is based on mouse. Another way of capturing natural gestures is by using touch-sensitive surfaces that can be integrated with computer monitors. One commercial example is SmartBoard from SmartTechnologies (2010). There are some of the touch screens are capable of the amount of pressure the user applies. Even beyond the touch screen technologies, a more sophisticated gesture recognition device can be the webcams. By commercially available programs using webcams as a motion detection system, objects on the screen of the virtual museum can be more interactive. Using the analogy of a diver, totally immersed in underwater environment, using legs and breath for navigation, gestures of the user can be conveyed to the virtual environment through the use of a cheap webcam as motion detection system.

Besides the immersive virtuality tools, the digital domain of virtual museum offers a collaborative environment (Fig. 8.15). The collaborative tool to share and build up data like Wikipedia can be added to the system. As in the case of web 2.0 systems where the information is created by the data added by the interested parties, the system will include the comments, opinions and interpretations of the archaeologists and other users. In web 2.0 environments, communication between users are achieved by blogs, comments, and social tagging. The system should integrate other photo and video sharing platforms and should include an editorial system for the control of the interactively uploaded visuals, comments, etc.

Figure 8.15. Collaborative knowledge formation.

There is a tendency to create multiuser and role-playing environments in virtual heritage projects. Users have something roles above and beyond moving and looking around. Their active role with interacting with others makes them an essential design element. Thus besides a three-dimensional setting, multi-layers of interaction, i.e. awareness of others, causality, moveable artifacts are introduced in interactive digital environments (Champion and Dave, 2007: 335).

As suggested earlier, web 2.0 technologies refers to a new wave of web applications built for users to add content and to accommodate new data (Baumann, 2006: 38). More recently, blogs, wikis, and social networking sites, such as facebook, allow ordinary users to post content online. Web 2.0 technologies not only allow the users to participate in knowledge forming process, but also actually "see" each other. This collaborative interaction should be duplicated in the virtual museum. In addition to the autocratic narrative of the museum curator, users should see each other's comments.

A shift from authored information and text-based descriptions to a greater inclusion of interpretative navigation is the role of the virtual curator (Cameron and Robinson, 2007). Based on the user's preferences and contexts the system can include more of suggested routes of display, instead of an autocratic exhibition. Likewise, with links of the displayed objects, different users can have different navigation patterns. Thus the virtual curator becomes the facilitator of an exhibition rather than the person in charge of a dictated navigation in the virtual museum.

8.6. Discussion

Along with the techniques used in the analysis, visualization and communication of the collected data, basic methods that are necessary for the creation of the virtual museum as well as the methods that are followed and the examples that are created by online users working in collaboration are investigated. Users of this information system participated in the collaborative process by using a limited number of open source software programs that are not integrated to the information system. In visualizing the data, the emphasis was on the photogrammetry because of its ease of use and availability. The 3D modeling was done at a basic level, as “blank” models.

However, three-dimensional digital models are required in applications of inspection, navigation, object identification, visualization and animation. In 3D modeling, photogrammetry has limited use. 3D computer graphics are by no means equivalent to the reconstructions and animations used in the movie and gaming industry. Once a 3D model is created, further computer graphic applications can be added to the system. However, the Disneyfication effect of the gaming and animation industry is criticized mostly in the field of archaeology. These highly stylistic animations are not considered scholarly. Therefore, in addition to reconstructions, archaeological documentation data and the photogrammetric depictions should be included in the system.

On the way from a museum *per se* to a virtual museum, future features should be added to the system. Automation features such as digital documentation, image processing, and hyper-publishing should be available for collection and analysis of archaeological data. Computer reconstructions of the virtual reality as well as the photographical realities of panoramic immersion bring a more visual virtually. As virtual museum implies *in situ* preservation, the geographical information should be displayed along with these visualization tools. All of above mentioned tools help the users to thoroughly visualize the information displayed. However, multimodal interactions imply modalities such as tangible experiences in an immersive environment. Moreover, collaboration and interaction of users are elements of placemaking for this virtual museum. Futuristic concepts of automated, immersive and interactive tools redefine the virtual museum of underwater cultural heritage as well as the discipline of nautical archaeology.

CHAPTER 9

9. Conclusion

The methodology of data collection and the web-based information system contributed to the model of a future virtual museum. The data collected during underwater surveys along the Lycian coast of Turkey is stored and shared in a web-based environment. This system facilitated the visualization, communication and exhibition of information on the underwater cultural heritage of Turkey by the contribution of all interested parties in a collaborative manner. Although the tools for data analysis, visualization and communication are separately developed using open source software programs, these have not been yet integrated into the information system. It should be noted that these tools are essential for the creation of a virtual museum in the future. Some automation tools for analysis and immersive interactive features necessary for a future virtual underwater museum are presented and discussed. The methodology and tools developed in this project illustrate the integration of nautical archaeology and museology with information technology.

While conducting the surveys, the main concern was *in situ* preservation. Unlike the methods of data collection used in conventional archaeological excavations and surveys, the artifacts were kept at their original underwater contexts. When the constraints of underwater environment such as time limits, visibility, light condition, fluid environment etc. are considered, most of techniques and tools used in land archaeology were irrelevant. The constraints of *in situ* preservation without dislocating the material culture necessitated the development of optimized solutions for data collection. These constraints were considered as a challenge in designing and conducting an archaeological survey unique in its methodology along Kaş coastal area. To the best knowledge of the author, such an intensive nautical archaeological survey using *in situ* preservation has not yet been carried out in Turkey.

Considering the costly nature of efforts on the sea and underwater, the UCH Project relied on a team of divers using simple and standard tools for scanning the bottom profile and recording underwater features. These tools consisted mainly of buoys for marking findspots, plastic meters for taking measurements, metric scales and north signs for photographic recording, and plexiglass boards for underwater sketching and note taking. As there is a vast amount of underwater cultural heritage along Turkish coasts, the main objective was to develop a strategy of a sustainable methodology to search, survey and record. For this reason, during the project, most of the developed techniques were quotable by different groups of divers. Keeping the methods simple helped to cover more nautical miles along the coast. However, by the invention of new technologies, this data collection process can include advanced technological tools for recording.

With the participation of almost one hundred divers from a variety of backgrounds, as data collection agents, new surveying methods were developed for nautical archaeology. First, when compared to the limited number of nautical archaeologists to thousands of recreational divers, these agents brought great amount of data from the depths where average skilled diving archaeologists could not reach easily. Systematizing the collected data helped formulated a framework for the data collection using *in situ* preservation. Second, the participation of recreational divers and the local people living in Kaş raised the awareness about cultural heritage. This will allow the sustainability of the project for the preservation of the underwater cultural heritage. As the project intended to include divers from different groups, the methodology of data collection can be transferred from the experienced project participants to other interested participants.

Driven by this data collection methodology, a web-based information system was designed and implemented with the objectives of preservation, accessibility, user-friendliness and integration. The information system provided a comprehensive database on the material remains of nautical activity, capable of storing and sharing typological and measurement data on ceramics, anchors, and other miscellaneous finds as well as on sites and dive logs. The visuals included initial sketches, filed notes and photographs as well as the images and drawings based on the analysis of the collaborative users. Combined with GPS locations of sites and find-spots, the resulting integration of the database with Google Maps illustrated the distribution of significant sites along the Kaş shoreline. By this system, various data types are successfully transferred, stored and shared in the digital domain.

The information system discussed in this dissertation was the first web-based collaborative and open-content platform for raw data of nautical archaeology in Turkey: In this respect, it was a pioneering and unique project for the underwater cultural heritage preservation of Turkey. The flexible record relation mechanism allowed visual materials, associated measurements, and observations to be interlinked and be accessible from a single data resource. The developed information system can be improved by means of the introduction of new discoveries and relevant information. Due to its web-based open-content feature, the system is open to new entries by groups of divers other than the project participants.

There has been a long tradition of presenting and reporting surveys and excavations conducted in Turkey during the annual symposiums organized by the MoCT. When current practice of archaeologists related to publications is examined, significant deficiencies may be observed in relation to time and content. Although the sites are destroyed by scientific research, the publications appear late and are presented to a limited audience. It is clear that such problems would not occur if data was collected in electronic form and stored and shared online. Information systems are important tools in this respect, and should be available before any cultural heritage management project is carried out. Based on the analysis of the datasheets and later the database, this information system met the majority of the needs of archaeologists; hence the possibility of its use should be considered by the MoCT, which aims to put a regulation similar to the currently available information systems into practice. Thus, the archaeological data collected during the surveys can be used to prepare an official underwater archaeological repository of Turkey. Currently, there is neither national nor international repository that is publicly available and based on *in situ* preservation on nautical archaeology or land archaeology.

The open structure of the information system and its web-based nature allowed the collection of archaeological data in a collaborative manner, even if a competent authority, an archaeologist was not involved in the process. In the current state, the system is a unique data source in terms of the available content. As the usage of the system improved, its content can also be enriched with contributions by the interested divers. Consequently, it will become a more valuable resource. The continuity of the system is important in this respect. Although the components of the information system had been designed according to the material remains generally found in Turkey, with little modifications, it can be adapted to other remains of material culture. Owing to the support of Google Maps, maps can be displayed to a wider extent. Hence, the developed information system can be a generic instrument not only for national needs but also for international research.

Besides archaeological aspects, the information system provided tools for further analysis, visualization and communication on the way to a virtual museum. Basic methods for further steps on the virtual museum were also given along with methods followed and examples created by the online collaborative users. Users of this information system participated in the musealization of information through separately applied analysis, visualization and communication tools by open software programs. This way, a collaborative web 2.0 environment was created in the first phase. These initial steps include demonstrated the methods for the automation of data analysis and the visual documentation, the visualization of information and communication of this knowledge. The data analysis as the first step included descriptions of the sites and finds out of the collected data, the distribution maps of the finds and some statistical analysis on these maps. Once meaningful information was driven from these analyses, by using various software programs, the visual material was created. The images i.e., the enhanced version of photographs were processed through the digital photo editing programs. Drawings and photogrammetric photographs were generated accordingly.

The last step was the communication of data through geo-referenced maps, the inclusion of 3D tools, photogrammetry and query.

This generic information system can be further developed. For this purpose, methodologies developed in the study to visualize the material remains do not use only the traditional methods, but also some digital documentation, visualization and communication tools available for low-budget projects. CAD tools for two and three dimensional modeling, image editing programs for enhancing photographs, panoramic and photomosaic images for visualization are presented along with the software programs used. These tools can be technically added to the software as it relies on open source software. Furthermore, in the next stages, digital documentation tools available for underwater environment should be in used in the data collection process.

However, these methods and tools were not enough for a virtual museum of the future. Under the heading of future features, automatic archaeologist, visual virtuality and immersive interaction, the available information technologies were presented at a conceptual level. The automatic archaeologist meant the artificial intelligence of an archaeologist. Through the advanced tools of digital documentation, the collected data can be processed through image processing tools in order to have meaningful information and publications. These automations will lead to immersive interactive communication through various virtual reality tools. By this tangible and virtual environment, the knowledge can be created through the collaborative environment of web. This brings the possibility of various navigation tools that is not bound to the dictated curatorship.

Once the user profiles are created, the virtual museum system can house the information about the users' history, and this will to lead a user-centered design of the museum. Other than a dictated navigation, this virtual system should have multiple narratives according to the interest of the users. This design will redefine the curatorship in the virtual domain. Everyone will be his/her own curator, so the objects, sites displayed can vary according to the previous choices of the users.

Using the analogy of underwater environment, it can also be possible to add immersive features for multimodal interactions. Including senses other than the visual such as tangible experiences, the ubiquity of the environment can fully be achieved. Tangible experiences in an immersive environment enhance experiential features of the virtual museum. Beyond the limits of the conventional human-computer interface devices, innovative tools should be implemented to the system.

It can also be possible to use the virtual museum system for the purposes of informing the public. With some educational aspects provided by the system, public awareness of the value of underwater cultural heritage can be raised. The training sessions conducted in the field can be systematically provided in the web environment by theoretical lectures and training videos. Owing to multiuser support of the online system, data entry may be significantly facilitated if the training system of the project continues to spread this methodology of data collection voluntarily or by legal obligation. Cooperation with academic departments and non governmental organizations may provide voluntary participation, whereas support of the MoCT may provide the required legal framework.

Finally, this study emphasized the use of information technologies in the field of nautical archaeology and museology. However, the study was restricted by financial and technical support for implementing the features for a virtual museum. Future studies would involve these applications of advanced technology for automated data analysis and visualization, immersion tools for an interactive user interface. During the design of the user interface, the user evaluation analysis should be provided in order to have a widely used for the future virtual museum of underwater cultural heritage.

Bibliography

Addison, Alonzo C. 2008. "The vanishing virtual: Safeguarding heritage's endangered digital record." In Yehuda E. Kalay, Thomas Kvan and Janice Affleck, eds., *New Heritage: new media and cultural heritage.* New York: Routledge, 27-39.

Adkins, Lesley, and Roy A. Adkins. 1989. *Archaeological illustration*. Cambridge: Cambridge University Press.

Akboy, Serra. 2007. "The Application of New Survey and Documentation Technologies for Cultural Heritage Sites: Case Study Analyses of the Digital Statue of Liberty, New York City and the Ottoman Fortress of Seddülbahir, Gallipoli Peninsula." Unpublished master's thesis. İstanbul: Koç University, İstanbul.

Akurgal, Ekrem. 1978. *Ancient civilizations and ruins of Turkey: from prehistoric times until the end of the Roman Empire*: İstanbul: Haşet Kitabevi.

Alberti, Samuel J. M. M. 2005. "Objects and the Museum," *Isis* 96(4): 559-571.

Alpözen, Oğuz, Harun Özdaş, and Bahadır Berkaya. 1995. *Bodrum Sualtı Arkeoloji Müzesi Ticarî Amphoraları* (Bodrum Underwater Museum Commercial Amphoras). Bodrum: Sualtı Arkeoloji Müzesi.

Altes, Alexander Korthals. 1976. "Submarine Antiquities: A Legal Labyrinth," *Syracuse Journal of International Law and Commerce* 4: 77.

Alves, Francisco J. S. 2008. "Underwater Archaeological Trails," *Museum International* 60(4): 81-90.

Babic, Darko, and Zeljka Miklosevic. 2009. "Liberating Narratives-Museums and Web 2.0," Paper presented at the INFuture2009: "Digital Resources and Knowledge Sharing" Conference. Zagreb, Croatia, November 4-6.

Ballard, Robert and et al. 2001. "Deepwater Archaeology of the Black Sea: The 2000 Season at Sinop, Turkey," *American Journal of Archaeology* 105(4): 607-623.

Barceló, Juan Antonio. 2001. "Virtual reality for archaeological explanation beyond "picturesque" reconstruction," *Archeologia e Calcolatori* (12): 221-244.

-----. 2007. "Automatic Archaeology: Bridging the Gap between Virtual Reality, Artificial Intelligence, and Archaeology." In Fiona Cameron and Sarah Kenderdine, eds., *Theorizing Digital Cultural Heritage: a Critical Discourse*, Cambridge: MIT Press, 437-455.

Barceló, Juan Antonio, Maurizio Forte, and Donald H. Sanders. 2000. "The Diversity of Archaeological Virtual Worlds," In Juan Antonio Barceló, Maurizio Forte and Donald H. Sanders, eds., *Virtual Reality in Archaeology*. Oxford: ArcheoPress, British Archaeological Reports, International Series #843.

Barton, Jane. 2005. "Digital libraries, virtual museums: same difference?," *Library Review* 54(3): 149-154.

Bass, George Fletcher. 1961. "The Cape Gelidonya wreck: preliminary report," *American Journal of Archaeology* 65(3): 267-276.

-----. 1966. *Archaeology Under Water*. New York: Praeger.

-----. 1967. *Cape Gelidonya: a bronze age shipwreck*. Philadelphia: American Philosophical Society.

-----. 1996. *Shipwrecks in the Bodrum Museum of Underwater Archaeology*. Bodrum: Museum of Underwater Archaeology.

-----. 2005. *Beneath the seven seas: adventures with the Institute of Nautical Archaeology*. London: Thames & Hudson.

Baştanlar, Yalın, and et al. 2006. "E-Müze: Müzeler için Web-Tabanlı Gezi ve Bilgi Sistemi (E-Museum: Web-based Information System for Museums)," Paper presented at the IEEE Sinyal İşleme ve Uygulamaları Kurultayı (SIU'06). Antalya, Turkey, April 17-19.

Baudrillard, Jean. 1995. "Simulacra and Simulation (The Body, In Theory: Histories of Cultural Materialism)" In *Procession of Simulacrum*, Ann Arbor: University of Michigan Press.

Baumann, Michael. 2006. "Caught in the Web 2.0," *Information Today* 23(8): 38.

Bayari, Serdar, and et al. (in press). Submarine and Coastal Karstic Groundwater Discharges along the Southwestern Mediterranean Coast of Turkey, *Hydrogeology Journal.*

Benjamin, Walter. 1969. The Work of Art in the Age of Mechanical Reproduction. In Hannah Arendt, ed., *Illuminations*. New York: Schochen Books.

Bennett, Tony. 1995. *The birth of the museum: History, theory, politics*. New York: Routledge.

Blake, Janet. 1999. "Turkey," In Sarah Dromgoole, ed., *Legal Protection of the Underwater Cultural Heritage: National and Onternational Perspectives.* London: Kluwer Law International, 169-180.

-----. 1994. "The Protection of Turkey's Underwater Archaeological Heritage–Legislative Measures and Other Approaches," *International Journal of Cultural Property* 3(2): 273-294.

Boon, Paul, and et al. 2009. "Digital Support for Archaeology," *Interdisciplinary Science Reviews* 34(2/3): 189-205.

Bruno, Fabio, and et al. 2010. "From 3D reconstruction to virtual reality: A complete methodology for digital archaeological exhibition," *Journal of Cultural Heritage* 11(1): 42-49.

Burns, John A., and et al. 2004. *Recording Historic Structures*, 2nd ed. Hoboken, NJ: John Wiley & Sons.

Bush, Vannevar. 1945. "As We May Think," *The Atlantic Monthly* 176(1): 101-108.

Cameron, Fiona, and Helena Robinson. 2007. "Digital Knowledgescapes: Cultural, Theoretical, Practical, and Usage Issues Facing Museum Collection Databases in a Digital Epoch," In Fiona Cameron and Sarah Kenderdine, eds., *Theorizing Digital Cultural Heritage: a Critical Discourse.* Cambridge: MIT Press, 165-191.

Castro, Filipe. 2006. Nautical Archaeology Digital Library (NADL). Retrieved 26 June, 2010, from http://nadl.tamu.edu/

Champion, Erik, and Bharat Dave. 2007. "Dialing Up the Past," In Fiona Cameron and Sarah Kenderdine, eds., *Theorizing Digital Cultural Heritage: a Critical Discourse* Cambridge: MIT Press, 333-347.

CHIN (Canadian Heritage Information Network). 2009. Virtual Museum of Canada (VMC). Retrieved 24 March, 2011, from http://www.museevirtuel-virtualmuseum.ca/index-eng.jsp

Cliver, E. Blaine, and et al. 1998. "HABS/HAER at the Millennium: Advancing Architectural and Engineering Documentation," *APT Bulletin* 29(3): 31-35.

Coockson, Ben Claasz. 2006. *Arkeolojik İllüstrasyon ve Fotoğrafçılık* (Archaeological Illsutration and Photography). Ankara: Aytaşı Yayıncılık.

Crane, Georgory R. (1985, 5 February 2010). Perseus Digital Library. Retrieved 26 June, 2010, from http://www.perseus.tufts.edu/hopper/

Cultraro, M., F. Gabellone, and G. Scardozzi. 2009. "The virtual musealization of archaeological sites: between documentation and communication." Paper presented at the 3rd International Soceity of Photogrammetry and Remote Sensing (ISPRS). Trento, Italy, February 25-28.

Curryer, Betty Nelson. 1999. *Anchors: an illustrated history*. Annapolis, Maryland: Naval Institute Press.

Davies, Char. (1995, 15 February 2008). Immersence. Retrieved 11 April, 2011, from http://www.immersence.com/

Delgado, James P., and Mark Staniforth. 2002. "Underwater Archaeology," *The Encyclopedia of Life Support Systems (online encyclopedia)*. UNESCO, Paris. Retrieved 7 April, 2011, from http://www.eolss.co.uk/

Delouis, Dominique. (2001, January). Online Museums: from Research to Innovation, from RAMA to OpenHeritage. *Cultivate Interactive,* (3). Retrieved 18 January, 2011, from
http://www.cultivate-int.org/ issue3/rama/

Deshpande, Suhas, Kati Geber, and Timpson Corey. 2007. "Engaged Dialogism in Virtual Space." In Fiona Cameron and Sarah Kenderdine, eds., *Theorizing Digital Cultural Heritage: a Critical Discourse.* Cambridge: MIT Press, 261-279.

Dietz, Steve, and et al., 2003. Virtual Museum (of Canada): The Next Generation. Montreal: Canadian Heritage Information Network (CHIN).

Dorrell, Peter G. 1994. *Photography in archaeology and conservation.* (2 ed.). Cambridge: Cambridge University Press.

Egi, Murat S., and et al. 2009. "Implementation of a dive computer using mobile phones: the divephone." Paper presented at the Proceedings of XXXVth Annual Meeting of EUBS on Diving and Hyperbaric Medicine. Aberdeen, Scotland. June 2.

Erkut, Osman. 2006. "Deneyden Öte: Uluburun II (Beyond and Experiment: Uluburun II)." In Yalçın Ünsal, Cemal Pulak and Rainer Slotta, eds., *Uluburun gemisi (3000 Yıl Önce Dünya Ticareti).* İstanbul: Ege Yayınları, 327-332.

FileMaker. (1994, February 2011). FileMaker Pro Retrieved 2011, 28 March, from http:// www.filemaker.com/products/filemaker-pro/

Forte, Maurizio. 1997. Introduction. In Maurizio Forte and Alberto Siliotti, eds., *Virtual Archaeology: Great Discoveries Brought to Life Through Virtual Reality*. London: Thames and Hudson Ltd, 9-13.

Foucault, Michel. 1969. *The Archaeology of Knowledge*. In A. M. Sheridan Smith, trans., London and New York: Routledge, 2002: 65–67.

-----. 1970. *The order of things: an archaeology of the human sciences.* New York: Vintage Books.

-----. 1986. "Of Other Spaces," *Diacritics* 16(1): 22–27.

-----. 1998. "Different Spaces." In R. Hurley, trans., *Essential works of Foucault, 1954-1984*. (Vol. 2) London: Penguin Books, 175-185.

Franke, Jochen, and S. M. Montgomery. 1999. "Applying photo modeler in maritime archaeology: a photogrammetric survey of the J3 Submarine Wreck," Report. Australian National Centre of Excellence for Maritime Archaeology, No. 7.

Frey, Donald A. 1984. "Turkish Coastal Survey," *INA Newsletter 10*(4): 4.

Gibbins, David. 1990. "The hidden museums of the Mediterranean." *New Scientist* 128(1739): 35.

Gibson, William. 1984. *Neuromancer*. New York: Ace Science Fiction Books.

Gifford, J. A., M. Redknap, and N. C. Flemming. 1985. "The UNESCO international survey of underwater cultural heritage," *World Archaeology* 16(3): 373-376.

Green, Jeremy. 2004. *Maritime Archaeology: A Technical Handbook* (2nd ed.). San Diego: Elsevier.

Green, Jeremy, Sheila Matthews, and Tufan Turanli. 2002. "Underwater archaeological surveying using PhotoModeler, VirtualMapper: different applications for different problems," *International Journal of Nautical Archaeology* 31(2): 283-292.

Haggrén, Henrik, and et al. 2004. "The Use of Panoramic Images for 3-D Archaeological Survey," *International Archives of Photogrammetry and Remote Sensing* 35(5): 958-963.

Haldane, David Douglas. 1984. *The Wooden Anchor*. Unpublished master's thesis. College Station, TX: Texas A&M University, College Station.

Heim, Michael. 1993. *The metaphysics of virtual reality*. Oxford: Oxford University Press.

Hermon, Sorin, and Franco Niccolucci. 2000. *The impact of shared information technology on archaeological scientific research*. Paper presented at the Current Research Information Systems (Cris 2000), Helsinki, Finland, May 25-27.

Holt, Peter. 2003. "An assessment of quality in underwater archaeological surveys using tape measurements," *International Journal of Nautical Archaeology* 32(2): 246-251.

ICAHM. 1990. "Charter for the Protection and Management of the Archaeological Heritage ." Retrieved June 27, 2010, from http://www.international.icomos. org/ charters/arch_e.htm

ICOM. 2007. ICOM Statutes. *ICOM Internal Rules and Regulations*, article 2, http://icom.museum/ statutes.html2

-----. 2010. *Key Concepts of Museology*. In André Desvallées and François Mairesse, eds., Retreived 7 April, 2011, from http://icom.museum/fileadmin/ user_upload/pdf/Key_ Concepts_of_Museology/Museologie_Anglais_BD.pdf iFeelPixel. 2002. iFeelPixel Association: the Universal Digital Access Retrieved 03 March, 2011, from http://www.ifeelpixel.com

INA. 2001. *The Shipwrecks of Anatolia (SOA)*. Retrieved 08 December, 2010, from http://www.diveturkey.com/soa/english/one.html

Jones, Greg, and Mark Christal. (2002, September). "The future of virtual museums: On-line, immersive, 3D environments," *Created Realities Group*, 9. Retrieved 07 April, 2011, from http://created-realities.com/pdf/Virtual_Museums.pdf

Kadar, Manuella. 2002. "Data Modelling and Relational Database Design in Archaeology," *Acta Universitatis Apulensis* 3: 73-80

Kalay, Yehuda E. 2008. "Introduction: Preserving cultural heritage through digital media." In Yehuda E. Kalay, Thomas Kvan and Affleck Janice, eds., *New Heritage: New media and Cultural heritage.* New York: Routledge, 1-10.

Kapsch, Robert J. 1990. "HABS/HAER: A User's Guide," *APT Bulletin* 22(1/2): 22-34.

Katzev, Susan. 2008. "The Kyrenia ship: her recent journey." *Near Eastern Archaeology* 71(1-2): 76-81.

Keay, Simon. 1984. *Late Roman amphorae in the Western Mediterranean: a typology and economic study, the Catalan evidence* (Vol. 196). Oxford: Britich Archaeological Records.

-----. 2005. "Roman Amphorae: a digital resource." Retrieved June 21, 2010, from http://ads. ahds.ac.uk/catalogue/resources.html?amphora2005

Keen, Antony G. 1998. *Dynastic Lycia: a political history of the Lycians and their relations with foreign powers, C. 545-362 BC.* Leiden, Boston, Kölm: Brill Academic Publication.

Kenderdine, Sarah. 2007. "Speaking in Rama: Panoramic Vision in Cultural Heritage Visualization." In Fiona Cameron and Sarah Kenderdine, eds., *Theorizing Digital Cultural Heritage: a Critical Discourse.* Cambridge: MIT Press, 301-331.

Komas, Tanya Wattenburg. 2005. "Historic Building Documentation in the United States, 1933-2000: The Historic American Buildings Survey, a Case Study." Unpublished Ph.D thesis. College Station, TX: Texas A&M University, College Station.

Kunze, M. 1998. "Let There be Light, LAMP: Freeware Web Publishing System with Database Support," *C't (magazin für computertechnik) 12*: 230.

Lévy, Pierre. 1998. *Becoming virtual: reality in the digital age*, In Robert Bononno, trans., New York Plenum Trade.

LoC (Library of Congress). 2009. "Built in America; Historic American Buildings Survey/Historic American Engineering Record/Historic American Landscapes Survey, 1933-Present." Retrieved June 21, 2010, from http://memory.loc.gov/ammem/ collections/habs_ haer/index.html

Lord, Beth. 2006. "Foucault's museum: difference, representation, and genealogy," *Museum and Society* 4(1): 1-14.

Ludvigsen, Martin, and et al. 2007. "Applications of geo-referenced underwater photo mosaics in marine biology and archaeology," *Ocenography* 20(4): 140-149.

Malpas, Jeff. 2008. "Cultural Heritage in the Age of New Media." In Yehuda E. Kalay, Thomas Kvan and Jane Affleck, eds., *New Heritage: New media and Cultural heritage.* New York: Routledge, 1-10.

Malraux, André. 1947. *Le musée imaginaire.* Paris: Gallimard.

Manovich, Lev. 2001. *The language of new media.* Cambridge: The MIT Press.

Martin, Colin J. M., and Edward A. Martin. 2002. "An underwater photomosaic technique using Adobe Photoshop™," *International Journal of Nautical Archaeology* 31(1): 137-147.

Massey, James. 2003. "The Historic American Buildings Survey Turns 70," *The Old-House Journal* 31: 125.

Meyer, Élise, and et al. 2007. "A web information system for the management and the dissemination of Cultural Heritage data," *Journal of Cultural Heritage* 8(4): 396-411.

Middleton, Michael, and Julie Lee. (2007, November). "Cultural Institutions and Web 2.0." Smart Internet Technology CRC. Retrieved 07 April, 2011, from http://eprints.qut.edu. au/10808/1/Cultural_Institutions_and_Web_2_0.pdf

Milekic, Slavko. 2007. Automatic Archaeology: Bridging the Gap between Virtual Reality, Artificial Intelligence, and Archaeology. In Fiona Cameron and Sarah Kenderdine, eds., *Theorizing Digital Cultural Heritage: a Critical Discourse.* Cambridge: MIT Press, 367-388.

MoCT. 1983. *2863 Kültür ve Tabiat Varlıklarını Koruma Kanunu (Law for the Protection of Cultural and Natural Property).*

Monroy, Carlos, and et al.. 2006. "The Nautical Archaeology Digital Library." Paper presented at the 10th European Conference, ECDL 2006, Research and Advanced Technology for Digital Libraries. Alicante, Spain. September 17-22.

Monroy, Carlos, Richard Furuta, and Filipe Castro. 2007. "A multilingual approach to technical manuscripts: 16th and 17th-century Portuguese shipbuilding treatises." Paper presented at the ACM-IEEE Joint Conference on Digital Libraries. Vancouver, British Columbia, Canada, June 18-23.

-----. 2009. "Ask Not What Your Text Can do For You. Ask What You Can do For Your Text (a Dictionary's perspective)." Paper presented at the Digital Humanities 2009. University of Maryland, College Park, June 22-25.

NAS (Nautical Archaeology Society). 2008. "Big Anchor Project." Retrieved June 28, 2010, from http://www.biganchorproject.com/

-----. 2009. *Underwater Archaeology: The NAS Guide to Principles and Practice* (2 ed.). Portsmouth: Wiley-Blackwell.

Nelson, Ted. 2002. "Computer Lib/Dream Machines (1974)." In Randall Packer and Ken Jordan, eds., *Multimedia: from Wagner to virtual reality.* New York: WW Norton & Company, 160-172.

NetCraft. (2010, June 16). "Web Server Survey." Retrieved 28 March, 2011, from http://news.netcraft.com/archives/2010/06/16/june-2010-web-server-survey.html

O'Reilly, Tim. 2005. "What is Web 2.0: Design patterns and business models for the next generation of software." Retrieved 07 April, 2011, from http://oreilly.com/web2/ archive/what-is-web-20.html

Oxley, Ian, and David O'Regan. 2001. "The marine archaeological resource," *Institute of Field Archaeologists (IFA)* 4: 1-28.

Özdaş, Harun. 2007. "Ege ve Akdeniz Bölgeleri Sualtı Araştırması 2005 Yılı Çalışmaları (Underwater Survey Studies of the Aegean and Mediterranean Regions -2005 Season." Paper presented at the 24. Araştırma Sonuçları Toplantısı 2006, Ankara, Turkey. May 29- June 02.

Özhan, Erdal. 2005. "PAP/RAC: Coastal Area Management in Turkey." Priority Actions Programme Regional Activity Center, Split.

Parker, A. J. 1992. *Ancient Shipwrecks of the Mediterranean and the Roman Provinces* (Vol. 580): British Archaeological Reports (BAR) International Series.

-----, A. J. 1981. "Stratification and contamination in ancient Mediterranean shipwrecks," *International Journal of Nautical Archaeology* 10(4): 309-335.

Parry, Ross. 2007. *Recoding the Museum: Digital Heritage and the Technologies of Change.* New York: Routledge.

Peacock, D. P. S., D. Hill, and M. Jesson. 1971. *Roman amphorae in pre-Roman Britain*. 161-188.

Pollefeys, Marc, and et al. 2003. "3D Capture of Archaeology and Architecture with a Hand-held Camera," *International Archives of Photogrammetry Remote Sensing and Spatial Information Sciences* 34(5/W12): 262-267.

Pujol, Laia. 2004. "Archaeology, museums and virtual reality," *Digithum* 6: 1-9.

Pulak, Cemal. 1998. "The Uluburun shipwreck: an overview," *International Journal of Nautical Archaeology 27*(3): 188-224.

Razdan, Anshuman, and et al. 2001. *Using Geometric Modeling for Archiving and Searching 3D Archaeological Vessels.* Paper presented at the CISST, Las Vegas, NV.

Refsland, Scot T., Marc Tuters, and Jim Cooley. 2007. "Geo-Storytelling: A Living Archive of Spatial Culture." In Fiona Cameron and Sarah Kenderdine, eds., *Theorizing Digital Cultural Heritage: a Critical Discourse.* Cambridge: MIT Press, 409-416.

Reilly, Paul. 1992. "Three-dimensional modelling and primary archaeological data." In Paul Reilly and Sebastian Rahtz, eds., *Archaeology and the information age: a global perspective.* London, New York: Routledge, 147-173.

Renfrew, Colin. 1997. "Foreword." In Maurizio Forte and Alberto Siliotti, eds., *Virtual Archaeology: Great Discoveries Brought to Life Through Virtual Reality.* London: Thames and Hudson Ltd, 7.

Renfrew, Colin, and Paul G. Bahn. 1991. *Archaeology: Theories, Methods and Practice.* London: Thames and Hudson.

Richards, Julian D. 1998. "Recent Trends in Computer Applications in Archaeology," *Journal of Archaeological Research 6*(4): 331-382.

Robles-De-La-Torre, G. (ed.) 2009. *Encyclopedia of Perception* (Vol. 2). Thousand Oaks, CA: Sage Publications.

Ryan, M. L. 2001. *Narrative as virtual reality: Immersion and interactivity in literature and electronic media.* Baltimore: Johns Hopkins University Press.

Sanders, Donald H. 2002. "Virtual Archaeology and museums: where are the exhibits?." *British Archaeological Records International Series. 1075*: 187-194.

-----. 2009. "Virtual Heritage," *Near Eastern Archaeology 72*(1): 16.

Schweibenz, Werner. 1998. "The 'virtual museum': New perspectives for museums to present objects and information using the Internet as a knowledge base and communication system." Paper presented at the Knowledge Management und Kommunikationssysteme, Workflow Management, Multimedia, Knowledge Transfer. Internationalen Symposiums für Informationswissenschaft (ISI 1998), Prag, Czech Republic. November 3,7.

-----. 2004. "The development of virtual museums," *Icom News 57*(3): 3.

Scott-Ireton, Della A. 2006. "Florida's Underwater Archaeological Preserves: Preservation through Education," *Heritage at Risk: Underwater Cultural Heritage at Risk: Managing Natural and Human Impacts*, 5-7.

Shanks, M. 1997. "Photography and archaeology." In Brian Leigh Molyneaux, ed., *The Cultural Life of Images. Visual Representation in Archaeology.* London: Routledge, 73-107.

Shepard, Anna Osley. 1956. *Ceramics for the Archaeologist* (Vol. 609). Washington, DC: Carnegie Institution of Washington.

Singh, Hanumant, and et al. 2000. "Imaging Underwater for Archaeology," *Journal of Field Archaeology 27*(3): 319-328.

Smart. 2010. "Smart Board." Retrieved 11 April, 2011, from http://smarttech.com/

Smith, Wayne C. 2006. "The Electronic Darkroom: Improving Artifact Presentation," *Technical Briefs in Historical Archaeology* 1(6-10).

Sprinkle Jr., John H. 2003. "Uncertain Destiny, the Changing Role of Archaeology in Historic Preservation." In Robert E. Stipe, ed., *A Richer Heritage: Historic Preservation in the Twenty-first Century*. Chapel Hill: University of North Carolina Press, 253-278.

Staniszewski, Mary Anne. 1995. *Believing is seeing: Creating the culture of art*. New York: Penguin Books.

Street, T. 2006. "Underwater Cultural Heritage Policies of the United States Coastal Zone," *Coastal Management* 34(4): 467-480.

Sutherland, Ivan. 1965. "The Ultimate Display." *Proceedings of the International Federation of Information Processing Congress,* 2: 506-508.

TAMU-NAP. 1976. "The Nautical Archaeology Program at Texas A&M University." Retrieved March 31, 2011, from http://nautarch.tamu.edu/academic/

TAY. 1998. "TAY Archaeological Settlements of Turkey." Retrieved June 23, 2010, from www.tayproject.org

Telhan, Orkan. 2002. "Virtual Realities and Real Virtualities." Unpublished master's thesis. Ankara, Turkey: Bilkent University, Ankara.

UNESCO. 2001. "Convention on the Protection of the Underwater Cultural Heritage." Retrieved June 28, 2010, from http://unesdoc.unesco.org/images /0012/001260/ 126065e.pdf

-----. 2003. "Convention for the Safeguarding of the Intangible Cultural Heritage." Retrieved March 23, 2011, from http://unesdoc.unesco.org/images/ 0013/001325/ 132540e.pdf

-----. 2008. "Definition of the Cultural Heritage." Retrieved June 21, 2010, from http://portal. unesco.org/culture/en/ev.php-URL_ID=34050&URL_DO=DO_PRINTPAGE&URL_SECTION=201.html

University of Maryland. 1997. Landsat GeoCover Mosaics. Retrieved 28 June, 2010, from http:// glcf.umd.edu/data/mosaic/

Upham, N. E. 2001. *Anchors*. Buckinghamshire: Shire Publications.

Van Dyke, Ruth M. 2006. "Seeing the past: Visual media in archaeology," *American Anthropologist 108*(2): 370-375.

Varinlioğlu, Güzden. 2003. "The Fluid Experience of Space: Physical Body in Virtual Spaces Over an Analysis of Osmose." Unpublished master's thesis. Ankara, Turkey: Bilkent University, Ankara.

-----. 2007. "Sualtı Kültür Mirası Sanal Müzesi: Kaş Arkeopark Pilot Projesi (Virtual Museum of Underwater Cultural Heritage: Kaş Archeopark Pilot Project)." Paper presented at the *Museology in Turkey from Past to Future I*, Ankara, Turkey, 21-22 May.

-----. 2008. "Experimental Archaeology: Kaş Underwater Arkeopark Project and Underwater Research Methodologies." *SOMA 2008: Proceedings of the XII Symposium on Mediterranean Archaeology.* British Archaeological Records (BAR), 56-59.

-----. 2009. "The Virtual Museum of Turkish Underwater Cultural Heritage: The 2007 Survey Season," *Skyllis* 2: 188-190.

-----. 2011. Data Collection for Virtual Museum on the Underwater Survey at Kaş, Turkey *International Journal of Nautical Archaeology, 40*(1): 182-188.

-----. (in press). Denizel Arkeolojide Yeni bir Yaklaşım: Sualtı Kültür Mirası Sanal Müzesi Kaş Pilot Projesi – 2010 (A New Approach in Nautical Archaeology: Virtual Museum of Underwater Cultural Heritage of Kaş, 2010 Season) . *Anadolu Akdenizi Arkeoloji Haberleri (ANMED).*

Varinlioglu, Guzden, Elif Denel, and Osman Erkurt. 2008. "Experimental Archaeology: Uluburun II." Poster presented at the 3th International Congress on Underwater Archaeology (IKUWA), London, UK, 9-12 July.

Varinlioğlu, Güzden, Gerd Knepel, and Michaela Reinfeld. 2010. "Underwater Archaeological Trainings in Kaş Arkeopark, Turkey." Paper presented at the 15th conference of the German Association for the Promotion of Underwater Archaeology (DEGUWA), Poseidons Reich XV, Byzanz zur See. Innovation und Tradition. Vienna, Austria. February 19-21.

Varinlioğlu, Güzden, Michaela Reinfeld, and Burak Özkırlı. 2011. "Preservation and Promotion of the Cultural Heritage: The Young Archaeopark Project in Kaş, Turkey. Paper presented at the In Poseidons Realm XVI: Early Seafaring of the Mediterranean Sea -From the Beginning until the late Bronze Age 800 BC -. Heidelberg, Germany. February 18-20.

VENUS. 2006. Virtual Exploration of Underwater Sites Retrieved 1 March 2011, from http:// sudek.esil.univmed.fr/venus/

Vergo, Peter. 1989. *The new museology*. London: Reaktion books.

Vinson, I. 2001. "Museums and heritage: a major issue in the UNESCO World Culture Report 2001," *Museum International* 53(1): 61-64.

VIZIN. 2003. "The Institute for the Visualization of History." Retrieved 2010, 30 June, from http://www.vizin.org/

Wachsmann, Shelly, and George Fletcher Bass. 1998. *Seagoing ships and seamanship in the Bronze Age Levant*. College Station: Texas A&M University Press.

Warden, Robert, and David Woodcock. 2005. "Historic Documentation: A Model of Project Based Learning for Architectural Education," *Landscape and Urban Planning* 73(2-3): 110-119.

Webb, Colin. 2003. "Guidelines for the preservation of digital heritage." Retrieved April 7, 2011, from http://unesdoc.unesco.org/images/0013/001300/130071e.pdf

Weeks, Kay D., and Anne E. Grimmer. 1995. *The Secretary of the Interior's Standards for the Treatment of Historic Properties: With Guidelines for Preserving, Rehabilitation, Restoring & Reconstructing Historic Buildings*. Washington D.C.: U.S. Department of the Interior, National Park Service, Cultural Resource Stewarship and Partnerships Heritage Preservation Services.

Wiley, David. 1998. "Open Content." *Creative Commons Attribution 3.0 United States* Retrieved March 28, 2011, from http://www.opencontent.org/definition/

Yalçın, Ünsal, Cemal Pulak, and Rainer Slotta. 2006. *Uluburun Gemisi: 3000 Yıl Önce Dünya Ticareti* (Uluburun Ship: World Trade 3000 Years Ago). İstanbul: Ege Yayınları.

Yamaç, Ali, and Oğuz Tanındı. 2009. "Publish or Perish." *Excavations vs. Publications.* Retrieved April 7, 2011, from http://www.tayproject.org/kazilar_e.htm

Yıldız, Yaşar. 1984. *1983 Sualtı Batık Gemi Araştırmaları* (Underwater Shipwreck Surveys 1983). Paper presented at the 2. Araştırma Sonuçları Toplantısı, İzmir, Turkey, April 16-20.

Zimmermann, M. 2005. "Eine Stadt und ihr kulturelles Erbe. Vorbericht über Feldforschungen im zentrallykischen Phellos 2002-2004: mit einem Beitrag von Christof Schuler," *Istanbuler Mitteilungen* 55, 215-270.

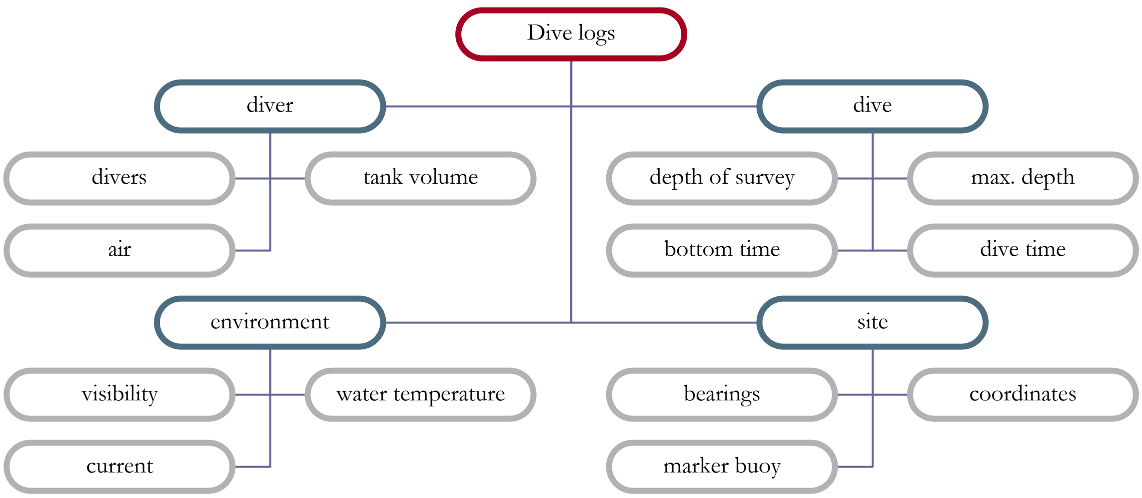
Appendix A

Data Collection Methodologies

Varying according to the find types, a data collection methodology is developed through the datasheets illustrated in Appendix B. The general information about the related dive log, such as date, dive time, and divers; the site and pile, such as site, findspot, pile number, width, width direction, length, length direction, and depth; about the bottom characteristic and preservation condition is noted for each datasheet.

A.1 Data Collection Methods of Dive Logs

Careful notes are taken about date and time of dives, dive number, divers and their air consumption, specific information about the site including bearing, and GPS coordinates. Divers' observations, specific information about the dive such as total and bottom time as well as visibility, water temperature, and current are recorded. Further comments are added to the notes section. The last version of the datasheets on dive logs is given in Appendix B.1.

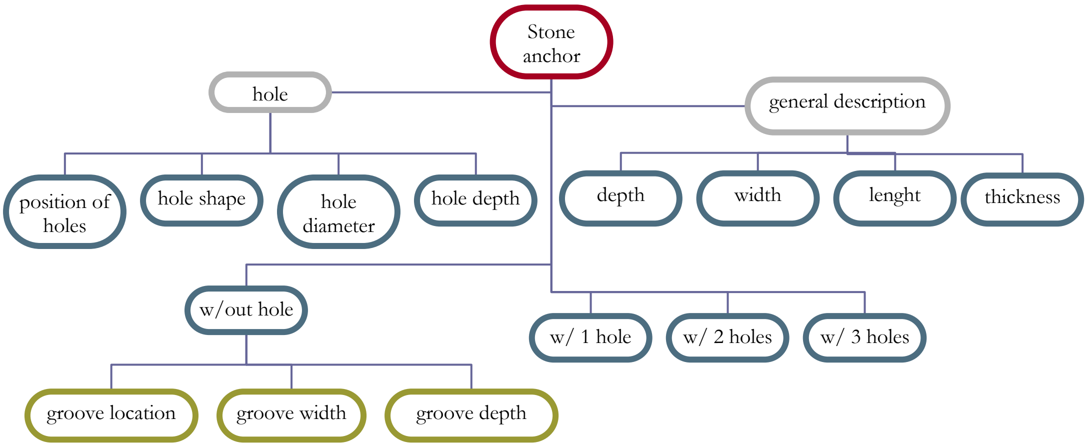


Organization schema of the dive logs.

A.2 Data Collection Method of Anchors

Since anchors are considered symbols of the maritime world, it is surprising that few studies have been published on anchors. Based on some projects and publications on the anchors, anchor investigation forms are developed throughout these four years, from a very broad definition to a more site specific methodology. On the Lycian coast of Turkey, the mostly encountered anchor types are stone and stock anchors. The last versions of the datasheets on anchors are given in Appendix B.2.

Stone Anchor



Organization schema of the stone anchors.

Stone anchor is the earliest type of anchor in the maritime history and is still in use today (Curryer, 1999; Wachsmann, 1998: 255-293; Upham, 2001). This type is particularly difficult to date because of its widespread use throughout centuries. It sometimes recycles and reuses other materials such as fishing weights, quern and millstones (NAS, 2009: 98). Hence, any kind of data for stone anchor is precious for completing the puzzle of maritime history. So far, according to NAS handbook, five basic types of stone anchor have been recorded throughout the word. Except from the one type typical of Indian Ocean, the four types encountered in Mediterranean waters are: stone anchors without hole, with one hole, two holes and classical type with three holes. Measurements for the general description of anchors such as depth, width, length, thickness, and shape are taken for four types in addition to their specific characteristics.

No hole

Instead of a hole drilled through its body, this stone anchor type has sometimes a long narrow channel called "groove". Besides its use as an anchor, this type is also used as a weight for wooden anchors, fishing nets, and buoy weights. It is encountered in various shapes, from raw shape of stone to a worked rectangular or rounded stone. The data on groove such as the position, width and depth is noted to identify this type (NAS, 2009: 198).

One hole

With a single hole through its body, this type is used to weigh down a wooden anchor. Small versions less than 30 cm in length are used for nets and very small versions with maximum length of 12 cm are used for lines (NAS, 2009: 199). According to the place of the hole, this stone anchor has two types, a centered hole or a hole at one end. The position, shape, diameter and depth of the hole are noted to differentiate from millstones, another stone artifact with a central hole.

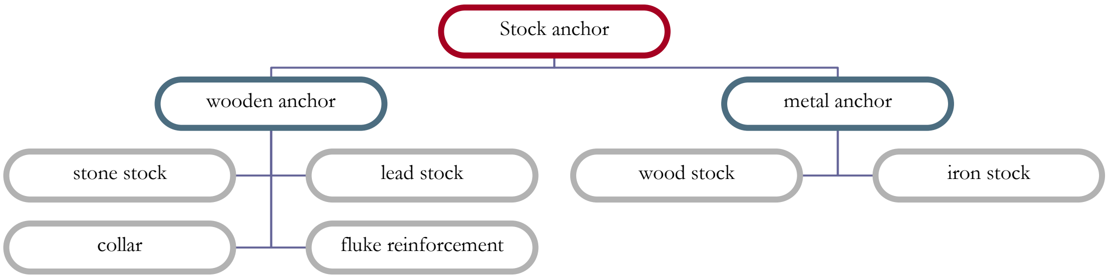
Two holes

This type has two holes at each end of the anchor. Holes through the stone are for holding a rope and for holding an arm of the anchor usually made out a wood. The data on the description of the holes is noted to define its use.

Classical (three holes)

This type or various shapes has three holes forming a triangle. The upper hole, which took the rope, can be in the same plane or can run across the stone; the lower holes are usually in the same plane. This anchor was commonly used in the Mediterranean by both Greek and Roman ships and referred as 'classical' or 'roman' although there is evidence that it is used long after Roman Empire. As in the previous types with hole(s), the positions, shapes, depths and diameters are noted in addition to general descriptions and dimensions.

Stock anchors



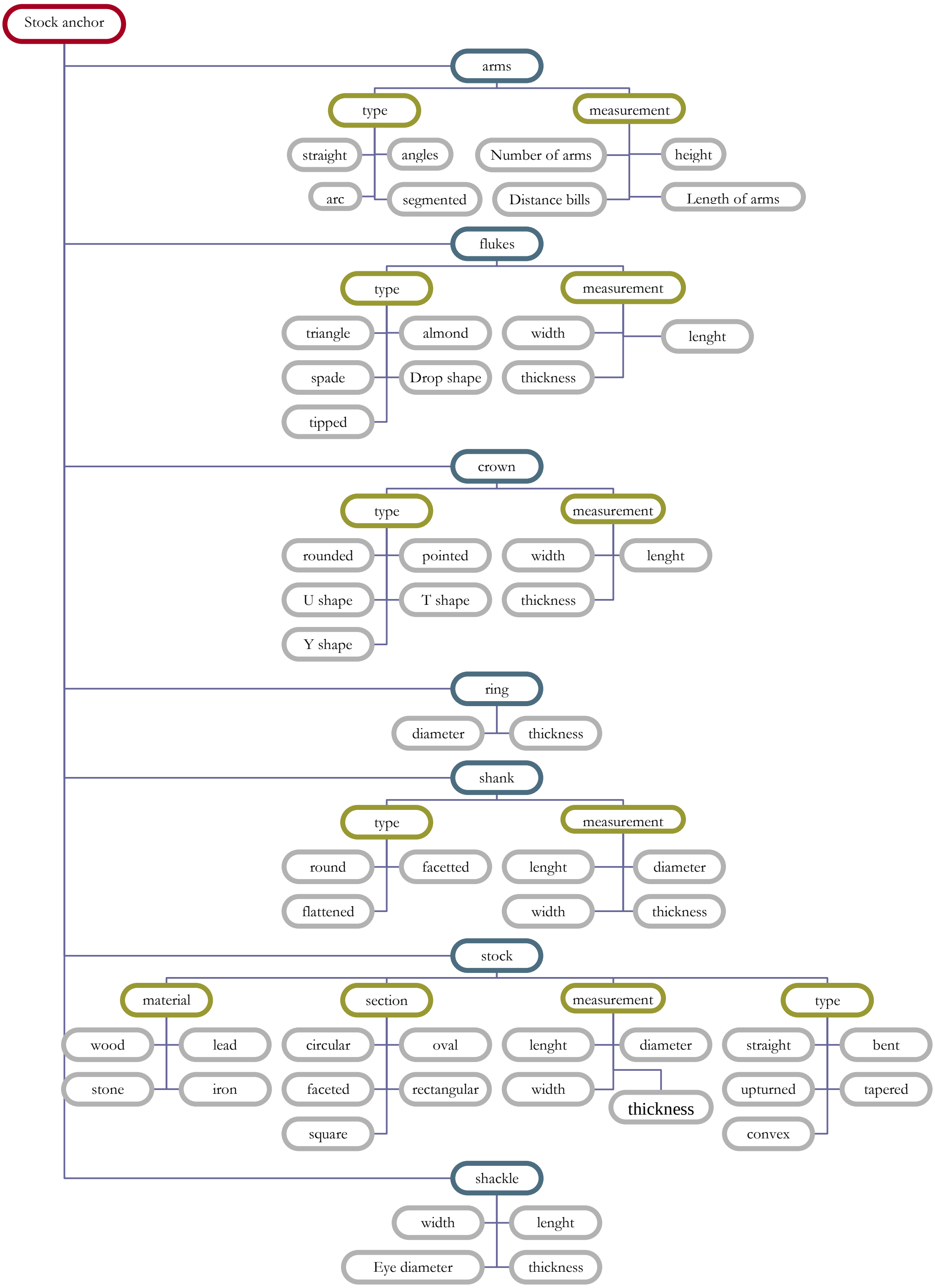
Organization schema of the stock anchors.

As opposed to unchanged shape of stone anchors of c. 4000 years of history, stock anchors are developed in shape and material throughout the history. Formed of the vertical stem or "shank", the arms terminating in blades or "flukes", the cross bar or "stock", tripping palms on the head or "crown", stock anchors are the frequently encountered anchor types (Upham, 2001: 3).

According to material of the stocks, these anchors can be examined in two separate types: wooden stock and metal stock.

Wooden anchors

The wooden anchor employs several non-wooden parts: a stone or lead stock, bronze or iron fluke points and lead reinforcement collar at the arm/shank junction. When an anchor is lost on the seabed, its wooden part disintegrates, leaving only the non-wooden parts (Haldane, 1984: iii). When the non-wooden parts are found, it is hard to estimate the reconstruction of the anchor. Nevertheless, out of an intact wooden anchor found in Italy, two basic types of wooden anchor are revealed: the stone stock and lead stock (Haldane, 1984: 1). The lead and stone stock parts, collar and fluke reinforcement parts and sometimes pieces like ring are the commonly discovered remains.



Organization schema of metal stock anchor

Metal anchors

It is believed that stocked anchors have been in use since at least 500 BC. Over the centuries, anchors have been designed in different sizes, shape and material. They were generally made of metal or wood. The wooden parts, the stocks disintegrate quickly, the remains of metal stock anchors are arms, shanks, flukes, crown, ring and sometimes shackles. The second type, metal stocked anchor type began to be used in the 19th century. As all parts are formed of metal including the stocks, usually iron, the remains are found in concretion, which is stone-like encrusted conglomerate created by the natural elements around an artefact, often rusted iron. Although the iron disintegrates, owing to concretion, the original form of the anchor is predictable.

Modern Anchors

Usually designed as stockless anchors, they are mostly used in the 20th century. In the project, only general types, such as bruce, plough, danforth, grapnel, stocked, and hall are noted besides the photographic data.

A.3 Data Collection Methods of Ceramics

Ceramic or pottery is among the oldest and most significant technological innovations in the history, as it is the first truly artificial material. Made of earthenware of various forms, it offers ready surfaces for decoration. Found in many archaeological contexts, ceramic material is the main empirical data for defining the origin and destination of the finds, thus the archaeological context. Studies of variation in ceramic production, style, and use helped archaeologists both in constructing chronologies and interpreting ancient societies (Shepard, 1956).

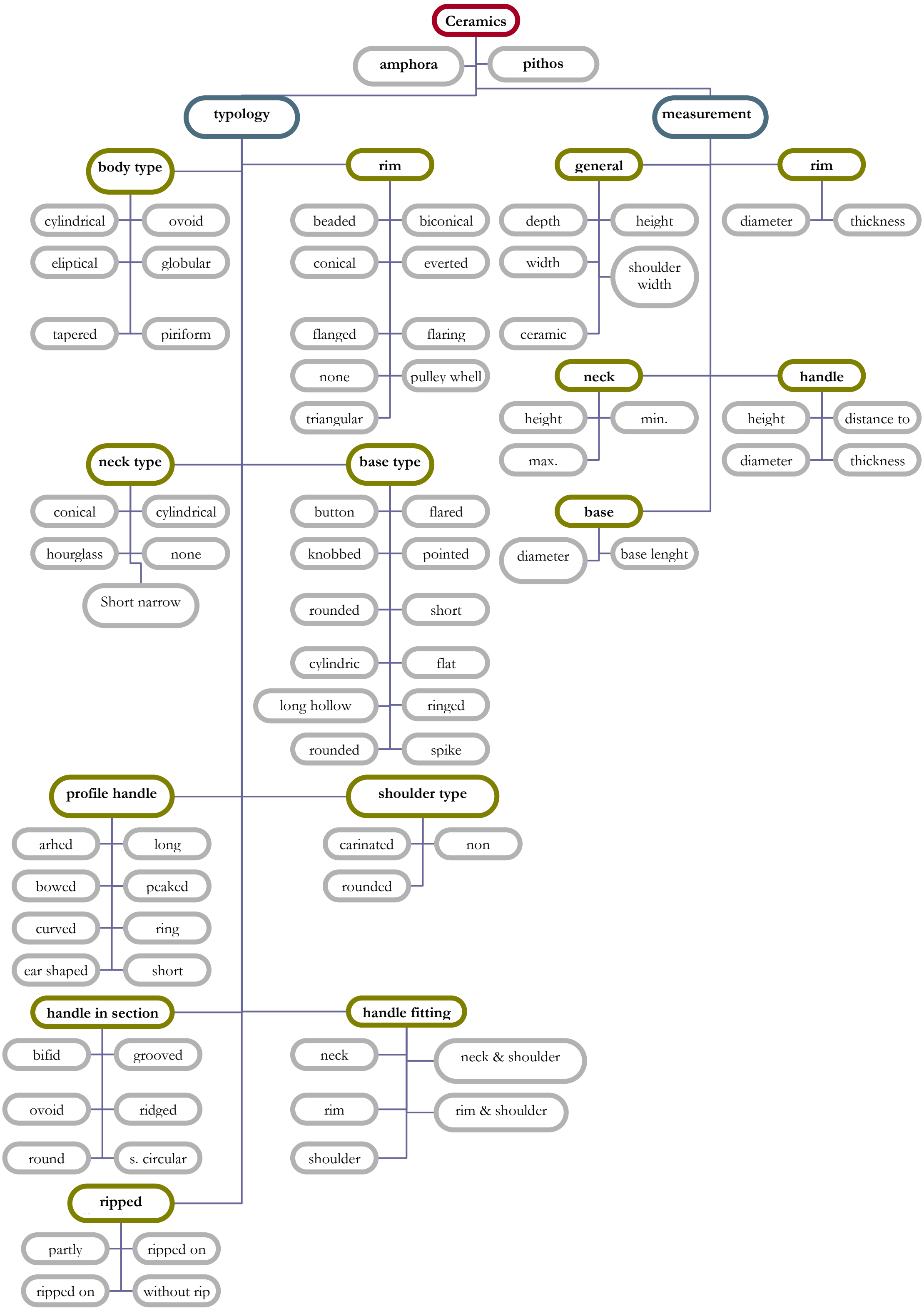
When found in underwater environment, this type made out of clay and fired to achieve hardness, does not decay. The only deformation it faces is the accumulation of living organisms on its surface. Aside from vessels and containers of all kinds, such as *amphorae*, *pithoi*, and other vessel types, other miscellaneous find types, such as ceramic tiles, are discovered during the surveys.

Amphorae

Amphora is pointed two-handled storage vessel for carrying and keeping many supplies, primarily wine and oil. The amphora types differ greatly in shape and size depending on the origin and time. Amphora was traded throughout the ancient Mediterranean and transported as cargo material over long distances. As symbols of maritime trade, these vessels support clues for dating archaeological remains. Various dating systems and theories are based on catalogues depicting their production center known through excavations on land.

Characterization of *amphorae* are originally studied and published by Dressel in the late nineteenth century showing their potential value as indicators of maritime trade. The shape of vessels became the focus of various ceramic studies. Dressel's table showing the types were renewed by Lamboglia and Almagro including new shapes recovered from archaeological excavations. These attempts lead to typological studies for referencing the origins of defined groups of *amphorae*. Important works by Peacock and Williams revealed the potential of analyzing the physical characteristics of clay in tracing origins of *amphorae*.

In field surveys, the mostly encountered material is amphora. As the *in situ* preservation forces on leaving the material in its original context, *amphorae* are examined according to visible characteristics, such as shape and apparent texture.



Organization schema of ceramics

Pithoi

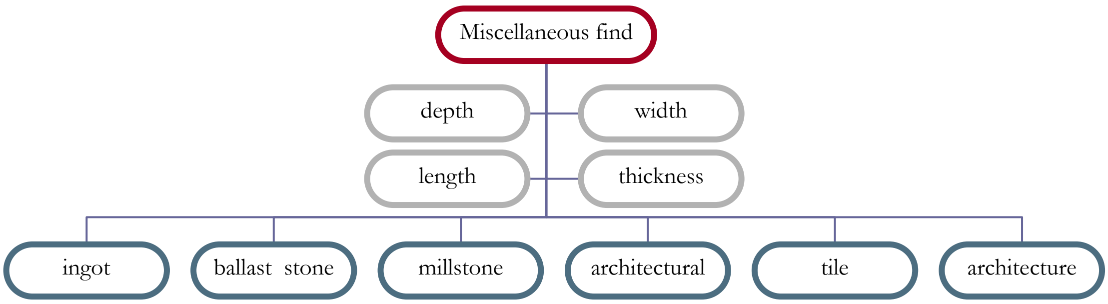
A *pithos* is a large ceramic vessel of a characteristic shape housing grains, seeds, wine and oil. As storage vessels, they are usually found in centers on maritime trade routes, which are shipped, kept and received in large quantities. With their large dimensions, usually bigger than human size, they are sometimes used as burial cases. Usually produced without handle, the ceramic thickness of a *pithos* is much thicker when compared to other ceramic vessels. The flat base types were usually found in land excavations, and pointed narrow bases and sealable smaller rims were for the maritime trade as in the case of *amphorae*.

Other Vessels

Vessels used in daily life by the crew for cooking and eating, include plates, bowls, jars, bottles or cups.

A.4 Data Collection Methods of Miscellaneous Finds

Finds other than above mentioned types are categorized as miscellaneous finds, such as millstone, ballast stone, ingot, architectural cargo, tile and architecture etc. Basic measurements such as depth, width, length and thickness are taken and details are retrieved from sketches and photographs. Further types can be added to the system when new types are discovered.



Organization schema of miscellaneous finds.

Millstone

Millstones are among the oldest devices that people have used to prepare food for grinding grain. A millstone consists of a runner stone at the top and a bed stone upon which the grain is laid.

Ballast stone

Ballast stones were used on ships to reach a sufficient depth. Without this ballast the balance of the vessel would be disturbed and the ship could capsize in heavy seas. Ballast stones are made of a material other than the usual rock under water and can be easily recognized. Moreover, they were easy to obtain, because they could be collected easily.

Architecture

Harbors, city walls and any other architectural remains are listed in this category. This sunken architecture is recorded with the remains on the land. Moreover, other architectural remains as a cargo of a ship such as columns and worked stone are classified in this category.

Ingots

A shaped or cast mass of unwrought metal, usually copper but sometimes tin, was produced and distributed widely during the Mediterranean Late Bronze Age. Although varying in shape and size, they were easily transportable overland on the backs of pack animals, and in the ships. Archaeologists found ingots in Uluburun and Cape Gelidonya shipwrecks (Pulak, 1998; Erkut, 2006; Bass, 1967).

A.5 Data Collection Methods of Architectural Sites

Depending on the site characteristics such as a cargo and anchorage site, three types of measurement methods are used: offset method, trilateration and angle/distance method.

Offset Method

Offsets are measurements that position features relative to a baseline fixed between two control points. An offset measurement positions the find using a single measured distance at right angles to the baseline from a known point. Offset measurement is effective especially in relatively smaller sites.

Trilateration Method

Trilateration measurements work by creating a triangle, taking two measurements from an artefact to two chosen points, named as control points on a baseline. When the triangle is close to equilateral, between 30 to 120 degrees, named as the angle of cut, it is most accurate. This method is quite time consuming when compared to offset measurement, however, it can be used at shallower sites.

Angle/Distance Method

Especially used in anchorage sites where the accuracy is less expected. By the help of the marker buoys, extends of the site are defined. Once within these limits, by the help of distances and angles, the place of an unknown find is defined with respect to other known one. The distances are measured by kickcyles, and the angles by underwater compass.

Appendix B

Datasheets

B.1 Dive Log Form

Date		**Start Time**		**End Time**		**Dive No**	
Site							
Wreck Bearings							
Starting Coordinate	**36°**			**29°**			
Ending Coordinate	**36°**			**29°**			
Divers							
Diver		Tank Volume (lt)		Start Air		End Air	
Diver		Tank Volume (lt)		Start Air		End Air	
Diver		Tank Volume (lt)		Start Air		End Air	
Dive							
Depth of Survey		Max. Depth		Dive Time		Bottom Time	
Visibility (m)		Water Temperature		Current	none ☐	low ☐	high ☐
Find Marker No		**36°**		**29°**			
Find Marker No		**36°**		**29°**			
Notes / Sketches							

B.2 Anchor Investigation Form

ANCHOR INVESTIGATION FORM

Date		Dive Time	AM ☐ PM ☐

INVESTIGATORS

Diver 1		Diver 2		Diver 3	

SITE INFORMATION

Site		Find Point	

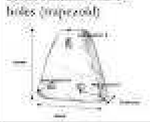
PILE INFORMATION

Pile Number							
Width (m)		Width Direction (°)		Length (m)		Length Direction (°)	
Min. depth (m)		Max. depth (m)		Bottom characteristics		Preservation	

GENERAL INFORMATION

General	Min Depth (m)		Max Depth (m)	
	Width (cm)		Length (cm)	
	Shape		Thickness (cm)	

STONE ANCHOR

Find Number					
Type of Stone Anchor	Stone Anchor without Hole (square) 	Stone Anchor with 1 Hole (round) 	Stone Anchor with 1 Hole (arched) 	Stone Anchor with 2 Holes (trapezoid) 	Stone Anchor with 3 holes (trapezoid) 

Measurements

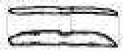
Hole	Position of Holes	A:	B:	C:
	Hole Shape (cir./dip.)	A:	B:	C:
	Hole diameter (cm)	A:	B:	C:
	Hole Depth (cm)	A:	B:	C:

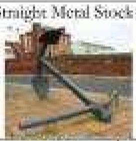
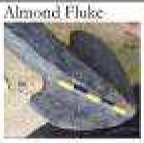
Groove Location		Groove Width (cm)		Groove Depth (cm)	

MODERN ANCHOR

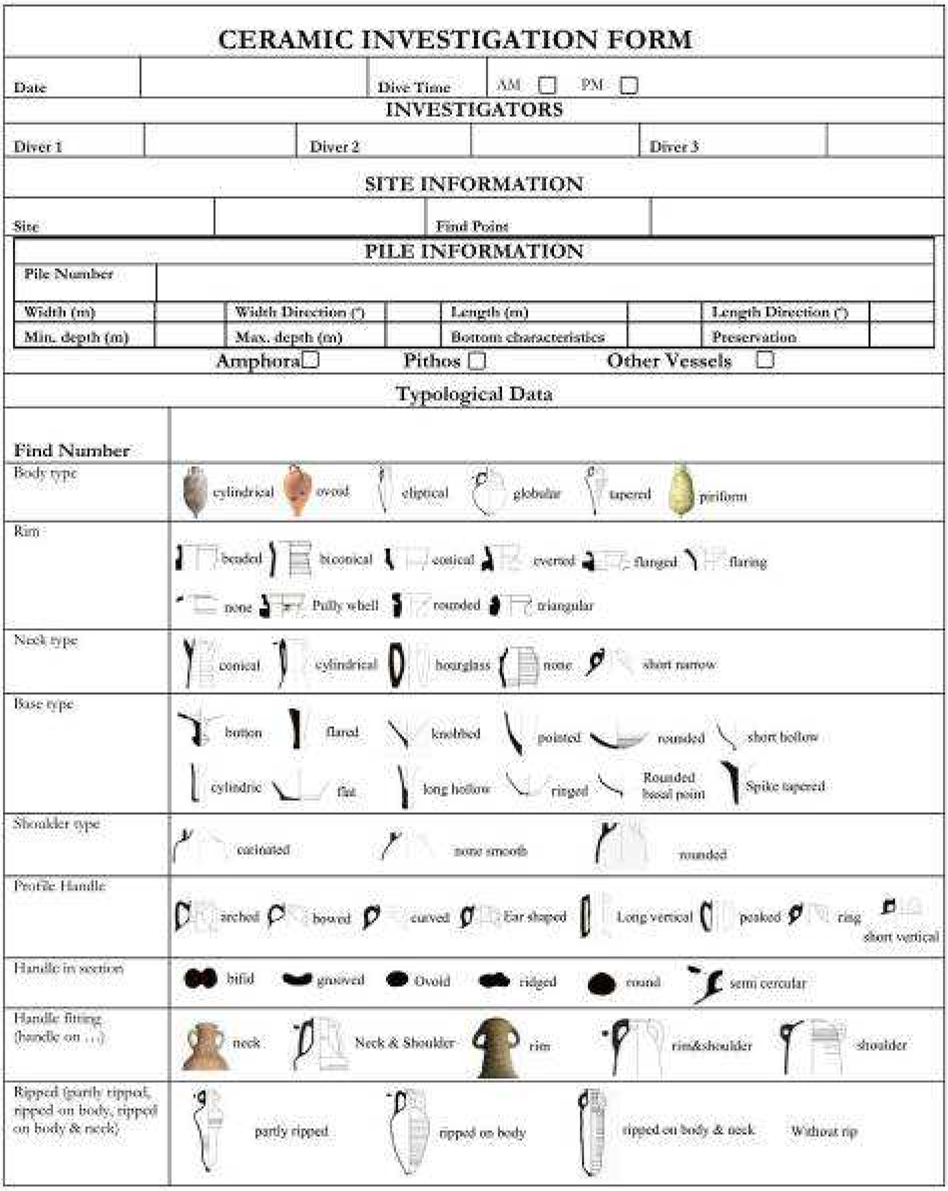
Find Number					
Bruce 	Plough 	Danforth 	Grapnel 	Stocked 	Hall 

WOODEN ANCHOR

Find Number						
Type of Wooden Anchor	Lead Stock 	Stone Stock w/Groove 	Stone Stock w/out Groove 	Reinforcement Collar 	Fluke Reinforcement 	Ring 

STOCK ANCHOR							
Find Number							
STOCK	Material	Wood	Iron	Lead	Stone	Other	
	Stock Type	Straight Metal Stock 	Metal Bent 	Upturned 	Tapered	Convex 	
	Stock Section	NONE	circular	Oval	Square	Rectangular	Faceted Edges
Measurements		Length of Stock (cm)		Diameter (cm)		Width Thickness (cm)	
SHANK	Shank Form	**Round/oval**	Facetted	Flattened	Unknown	Other	
Measurements		Length of Shank(cm)		Diameter		Width/Thickness	
ARMS	Type Of Arms	Straight 	Angled 	Arc 	Segmented arc 	Mobile 	
Measurements		Number of Arms		Length of one Arm		Height of bills	Distance between bills
FLUKES		Triangle Fluke 	Spade Fluke 	Almond Fluke 	Drop Shaped 	Tipped Spade	
Measurements		Width Fluke (cm)		Length Fluke (cm)		Thickness Fluke (cm)	
CROWN		Rounded 	Pointed 	U Shape 	Y-Shape 	T-Shape 	
Measurements		Width crown (cm)		Length crown (cm)		Thickness crown (cm)	
RING		Diameter of Ring (cm)		Diameter Eye of Ring (cm)		Thickness of Ring (cm)	
SHACKLE		Width Shackle (cm)		Length Shackle (cm)		Thickness of Shackle (cm)	Diameter Eye of Shackle (cm)

B.3 Ceramic Investigation Form



CERAMIC INVESTIGATION FORM

Date		Dive Time	AM ☐ PM ☐

INVESTIGATORS

Diver 1		Diver 2		Diver 3	

SITE INFORMATION

Site		Find Point	

PILE INFORMATION

Pile Number							
Width (m)		Width Direction (°)		Length (m)		Length Direction (°)	
Min. depth (m)		Max. depth (m)		Bottom characteristics		Preservation	

Amphora ☐ Pithos ☐ Other Vessels ☐

Typological Data

Find Number	
Body type	cylindrical, ovoid, eliptical, globular, tapered, piriform
Rim	beaded, biconical, conical, everted, flanged, flaring, none, Pully whell, rounded, triangular
Neck type	conical, cylindrical, hourglass, none, short narrow
Base type	button, flared, knobbed, pointed, rounded, short hollow, cylindric, flat, long hollow, ringed, Rounded basal point, Spike tapered
Shoulder type	carinated, none smooth, rounded
Profile Handle	arched, bowed, curved, Ear shaped, Long vertical, peaked, ring, short vertical
Handle in section	bifid, grooved, Ovoid, ridged, round, semi cercular
Handle fitting (handle on …)	neck, Neck & Shoulder, rim, rim&shoulder, shoulder
Ripped (partly ripped, ripped on body, ripped on body & neck)	partly ripped, ripped on body, ripped on body & neck, Without rip

Measurements		
General	Depth (m)	
	Object Height (cm)	
	Object Width (cm)	
	Shoulder Width (cm)	
	Ceramic Thickness (cm)	
Rim	Rim diameter (cm)	
	Rim thickness (cm)	
Neck	Neck height (cm)	
	Neck diameter Max. (cm)	
	Neck diameter Min. (cm)	
Handle	Handle height (cm)	
	Handle distance to body (cm)	
	Handle diameter / thickness & width (cm)	
Base	Base diameter Max. / Min. (cm)	
	Base Length (cm)	
	Ring Base Thickness (cm)	

Visual Data

Sketch code:

Note the characteristics of the sea base and the degree of preservation)

B.4 Miscellaneous Find Investigation Form

OTHER FINDS INVESTIGATION FORM

ARCHAEOLOGICAL PILE	☐	ARCHAEOLOGICAL SINGLE FIND	☐

Date		Dive Time	AM ☐ PM ☐

INVESTIGATORS

Diver 1		Diver 2		Diver 3	

SITE INFORMATION

Date'		Find Points	

PILE INFORMATION

Find Number							
Width (m)		Width Direction (°)		Length (m)		Length Direction (°)	
Min. Depth (m)		Max. Depth (m)		Bottom Characteristics		Preservation	

Other Finds

Ingot	☐	Ballast Stone	☐	Mill Stone	☐	Architectural Cargo (Columns, worked Stone, etc.)	☐
Tile	☐	Architecture (Stonewalls, Harbour Remains etc.)	☐				
Depth (m)		Width (cm)		Length (cm)		Thickness (cm)	

Notes / Sketch / Measurements

1

B.5 Site Investigation Form

SITE INVESTIGATION FORM

Date		Dive Time	AM ☐ PM ☐

INVESTIGATORS

Diver 1		Diver 2		Diver 3	
Site		Find Point			

FIND INFORMATION

Find number							
Width (m)		Width Direction (°)		Length (m)		Length Direction (°)	

Metal Wreck ☐	Artificial Wreck ☐	Cargo Site ☐	Archaeological Pile ☐

Measurements

Measurement Methodology	Offset ☐	Trilateration ☐
Length Baseline / Distance between Buoys		

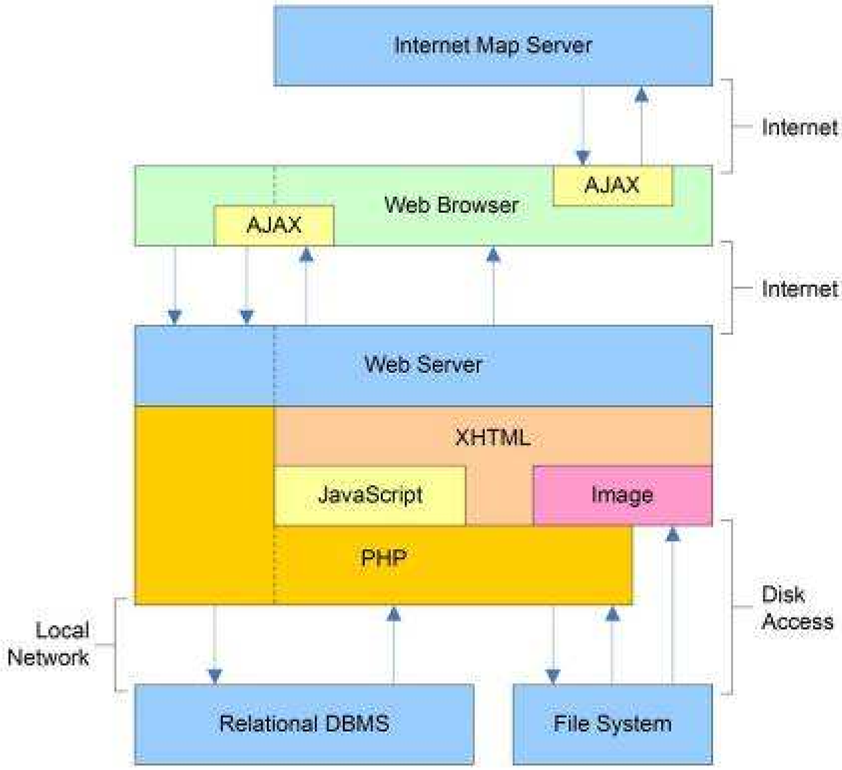
	Offset					Trilateration			
Find number	Distance on baseline	Depth of point on baseline	Distance of find to baseline	Depth of find	L/R looking from zero point	Distance of find from baseline zero point	Distance of find from baseline end point	Depth of find	L/R looking from zero point
Buoy-zero									
Buoy -end									

Appendix C

Information System

C.1 System Architecture

The information system has four structural elements: the web server, the web browser, information system programming and the database.



System architecture programmed by S. Girgin.

Web Server

A web server is hardware and software that help to deliver content to be accessed through the internet. The hardware part houses the content, while the software part makes the content accessible through the internet. The server application of the information system works on Apache Web Server, developed using PHP programming language. PHP, widely used for web-based applications, is a general-purpose scripting language that is especially suited to server-side web development where PHP generally runs on a web server.

Client side application, user interface of the system was prepared using XHTML (eXtensible Hypertext Markup Language) and supported by DOM (Document Object Model) Level 1 based, interactive JavaScript programming language. XHTML codes describing the user interface elements and behavior were generated dynamically by the server application. Similarly, graphical elements, such as icons, were either generated by the system or loaded from files stored in the native file system. In order to provide asynchronous data flow between client and server, AJAX technology has been utilized.

Web Browser

A web browser, internet browser, is a software application for retrieving, presenting and traversing information resources through the WWW. Client side application is fully XHTML 1.0 Transitional compliant and works on all major web browsers, independent of operating system and hardware configuration. Compatibility tests have been made with Mozilla Firefox, Microsoft Internet Explorer and Google Chrome web browsers on Microsoft Windows operating system.

Information System Programming

Programming libraries are mainly used to perform data visualization (i.e. mapping) and enhancement of user interface elements (i.e. Rich text editing). None of the programming libraries used for development are commercial, i.e. all libraries have licenses that are free of use. The database of the information system includes 18 data tables, which are organized in a relational structure. 16 of those tables were entered to the system through data entry forms. Hence, they are dynamic in size and number of records in the tables is growing within the life time of the information system.

Database

The information system uses MySQL Database Management System for data storage and retrieval. Being the most popular open source SQL database management system worldwide, MySQL has been selected primarily due to ease of use and widespread support. Among the data storage engines provided by MySQL, InnoDB storage engine supports relational database tables. Owing to relational database structure with foreign key constraints, all actions on records have been controlled at the database level and overall data integrity has been protected. Textual data is stored in universal Unicode UTF-8 encoding, which supports mathematical operators, and Turkish characters besides all other major alphabets used worldwide. Collations implemented in MySQL allow comparisons of characters sets to be done according to the rules of selected collation language. Hence, textual information can be queried and sorted property.

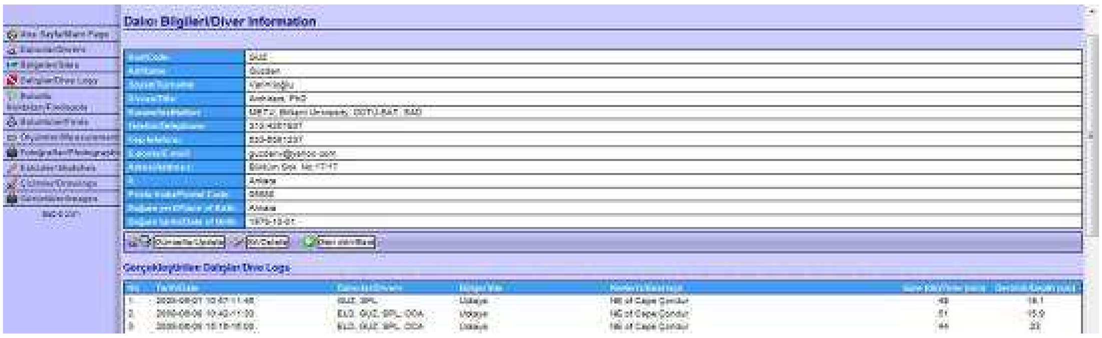
In order to display geographic information, the information system utilizes Google Maps. Owing to Google Maps' integration to the Internet, detailed satellite images for all the discovered sites during the survey are made available to the users of the information system. Although Google Earth has recently added zoom below the ocean and a view of the 3D bathymetry beneath the waves, Google Maps does not offer any bathymetric data to date. A custom-made dynamic map window gadget has been developed, which allows maps displayed on the user interface to be moved and resized freely for better navigation. The system also supports data entry in multiple coordinate formats.

C.2 System Components

The dive logs and related information such as the researchers, dives and sites and find logs and related information such as the measurements, photographs, sketches, drawings and images are listed as separate tables in the information system.

Researchers

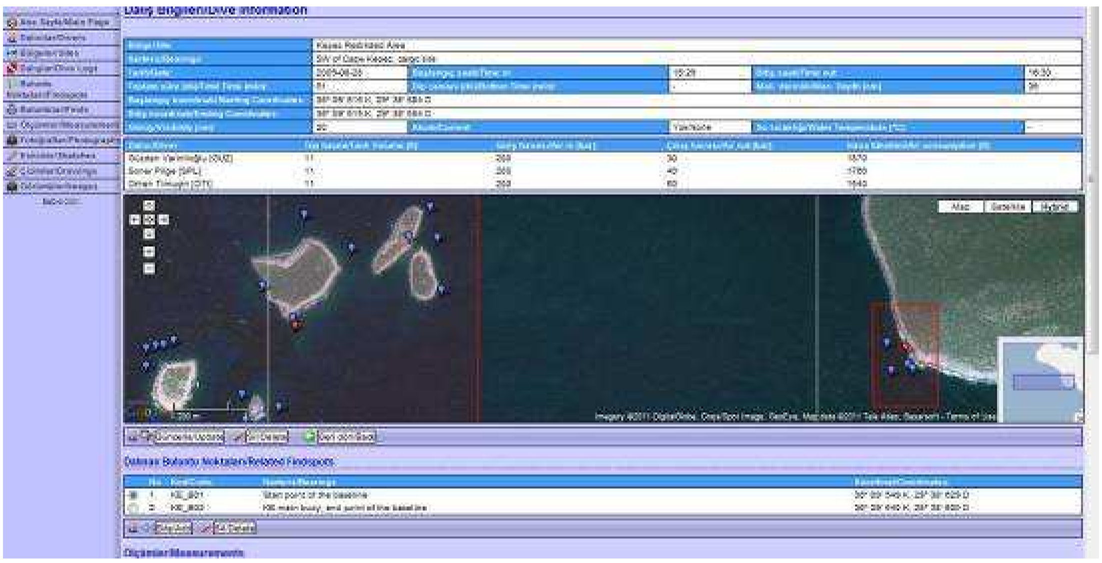
The project participants are registered on this page with personal and contact information using three-letter initial codes. Adding, deleting, updating and listing tools are available in this system component.



Researcher/Diver System Component.

Dive Logs

Dives recorded during field surveys are listed with location information, such as bearings and geographical coordinates; dive logs, such as divers, dive time, depth, and air consumption; and observations of environmental properties, such as bottom condition, current, and water temperature. On the information page, besides the dive logs, map showing the vicinity of the dives, a brief information of findspots discovered, measurements and photographs taken and sketches drawn are listed. Adding, deleting, updating and listing features for findspots, measurements, photographs and sketches are available in this system component.



Dive log information and related records.

Sites

Geographically distributed regions are listed under the site component. The abbreaviations of local names such as Oasis, Kanyon, and Üçkaya, or the location names on nautical charts such as Kaptanoğlu Sığlığı, Kovan Adası, and İnceburun are listed with their geographical coordinates. Adding, deleting, updating, and listing options are available for this system component. Distribution of the sites and find points is displayed on Google Maps page, and detailed information is achieved by clicking on the map or on the list.

Map of sites.

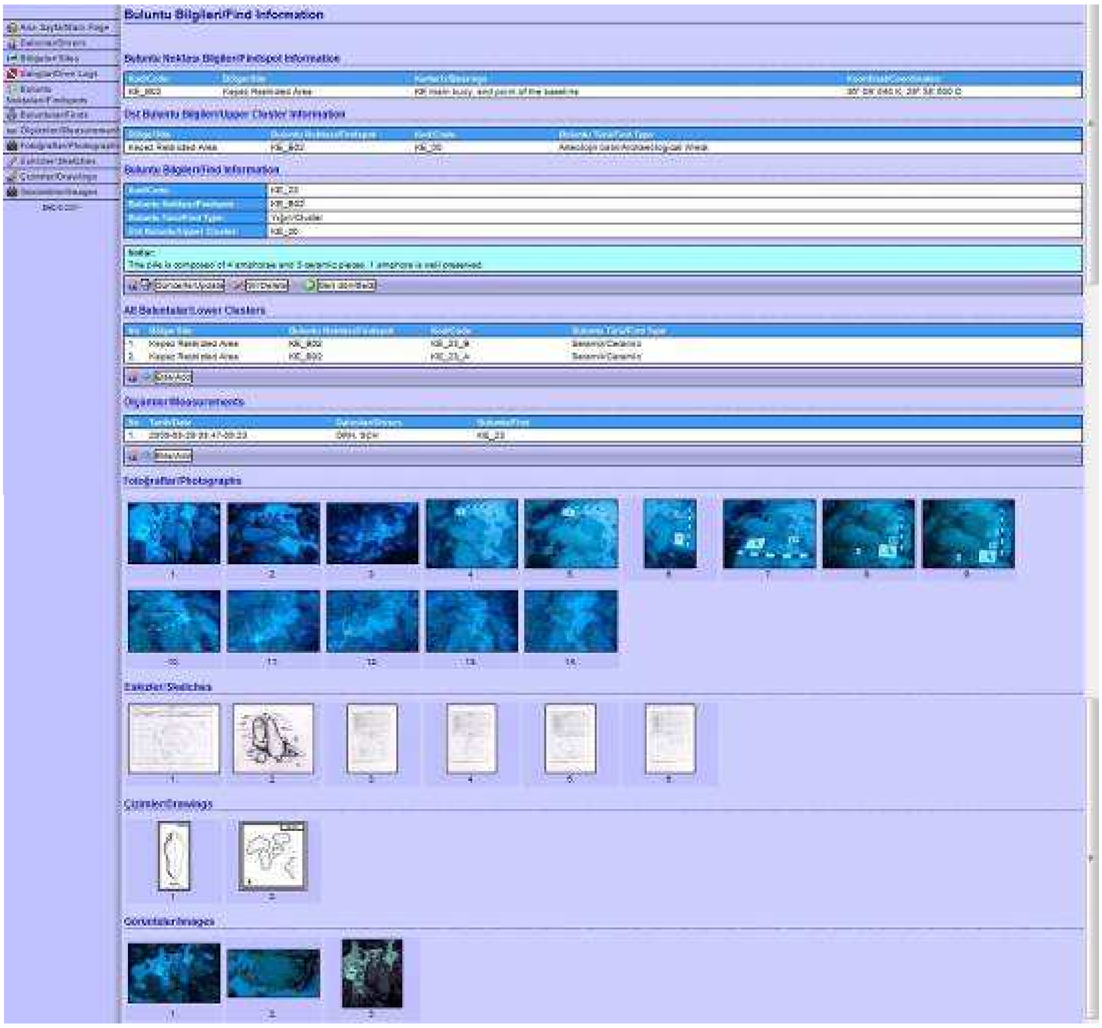
Findspots

The system component includes the geographical location of the findspots defined by geographical coordinates and bearings. The geographical distribution of the findspots is displayed on Google Maps, and listed with additional information about sites. Adding, deleting, updating, and listing options are available for this system component.

Findspot information.

Find Logs

Discovered during the dives, the finds are entered into the database with measurements, photographs and sketches. Given a user-defined code number, each find type, such as cargo sites, anchors, ceramics, miscellaneous find, etc., has different measurement information. Adding, deleting, updating and listing features are available in this system component. The finds can be listed according to the site they are discovered, the code number, and find type.



Information page on find KE-23.

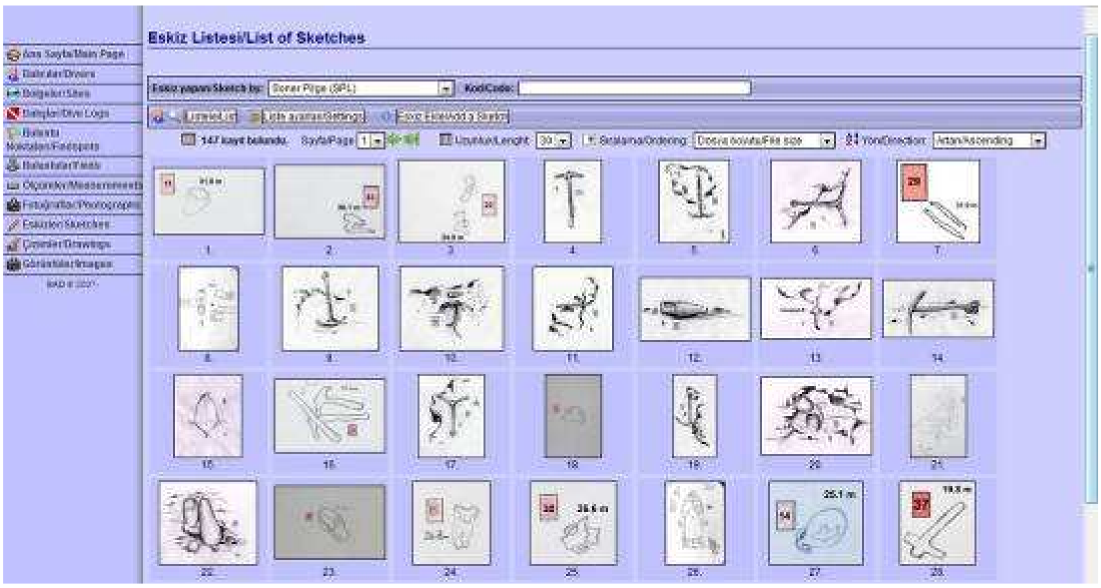
Measurements

Based on the find type chosen, measurements offer a variety of numerical and typological data on the find. The full list of measurement methods and related datasheets are given in Appendix A and B. Adding, deleting and updating the measurements are available for this system component. The details of the measurement data are given in the datasheets illustrated in Appendix B.

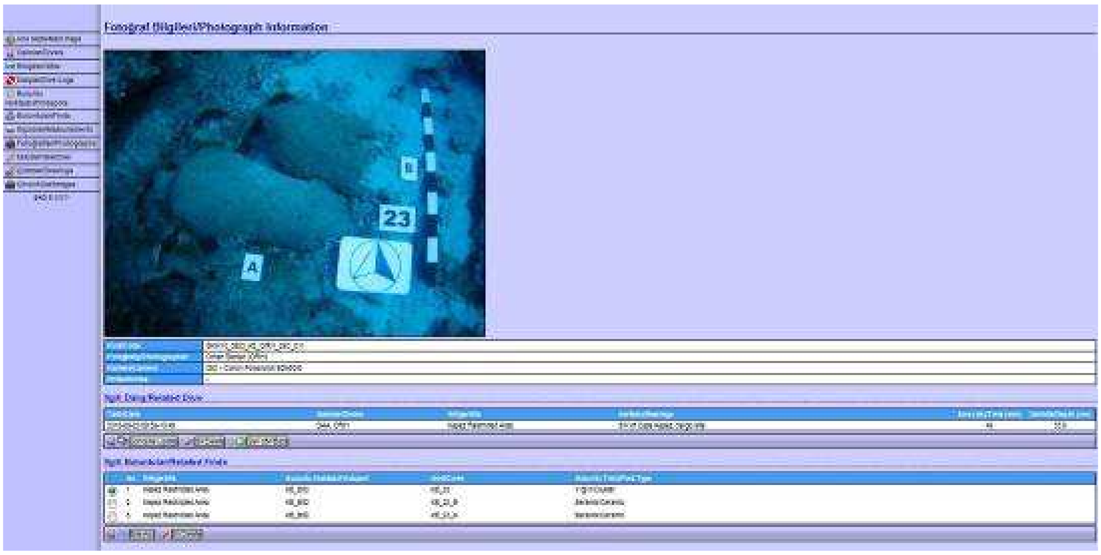
Measurement information.

Photographs and Sketches

Related to the dives, photographs and sketches are the primary sources of visual information about the finds. Access to the photographs and sketches is through thumbnails, previews and original full views. Thumbnails are small image size copies of the visuals by default 128x96 pixels in size. They are primarily used to illustrate visuals in listing pages. Previews are mid-sized reproductions of the photographs. Default size of the preview images are 640x480 pixels. They are displayed on photograph information pages replacing the original photographs to accelerate data retrieval from the server. The original full views are reached by clicking on the photograph/sketch with zooming features. The information system supports JPEG images. Thumbnails and preview images are automatically generated once the original visuals are uploaded to the system. Adding, deleting and updating the measurements are available for both photographs and sketches.



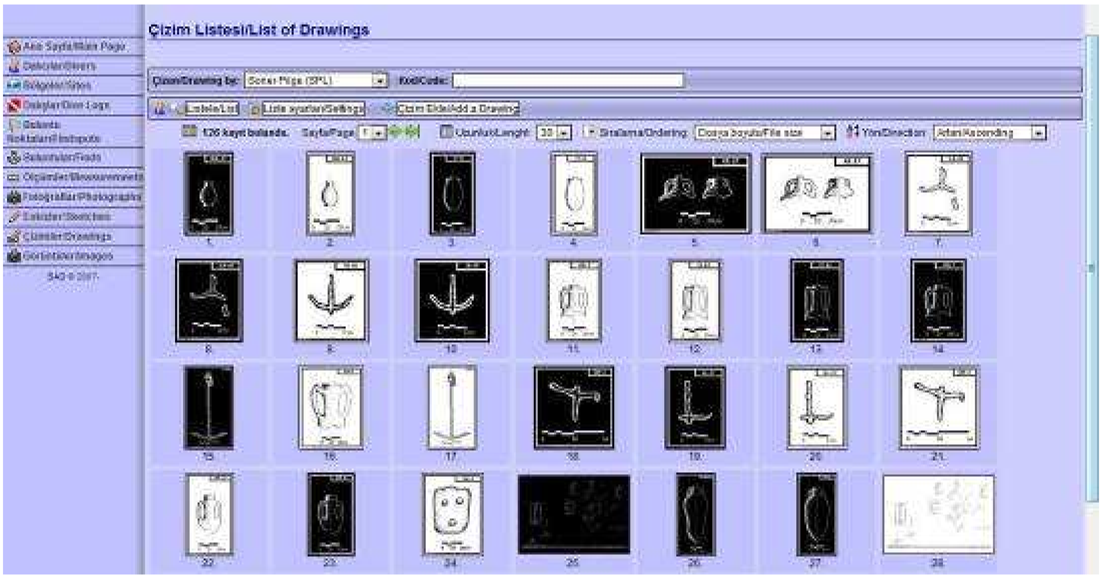
List of sketches



Information page of a photograph linked to KE-23.

Images and Drawings

Having the same characteristics of sketch and photograph system components as named above, images and drawings are visuals that are uploaded and linked to the finds after the post-processing of data. Different than the photographs and sketches, these processed visuals are produced after field surveys, based on the interpretations and studies of interested parties who participated the collaborative process of the project. .



List of drawings.

List of images.

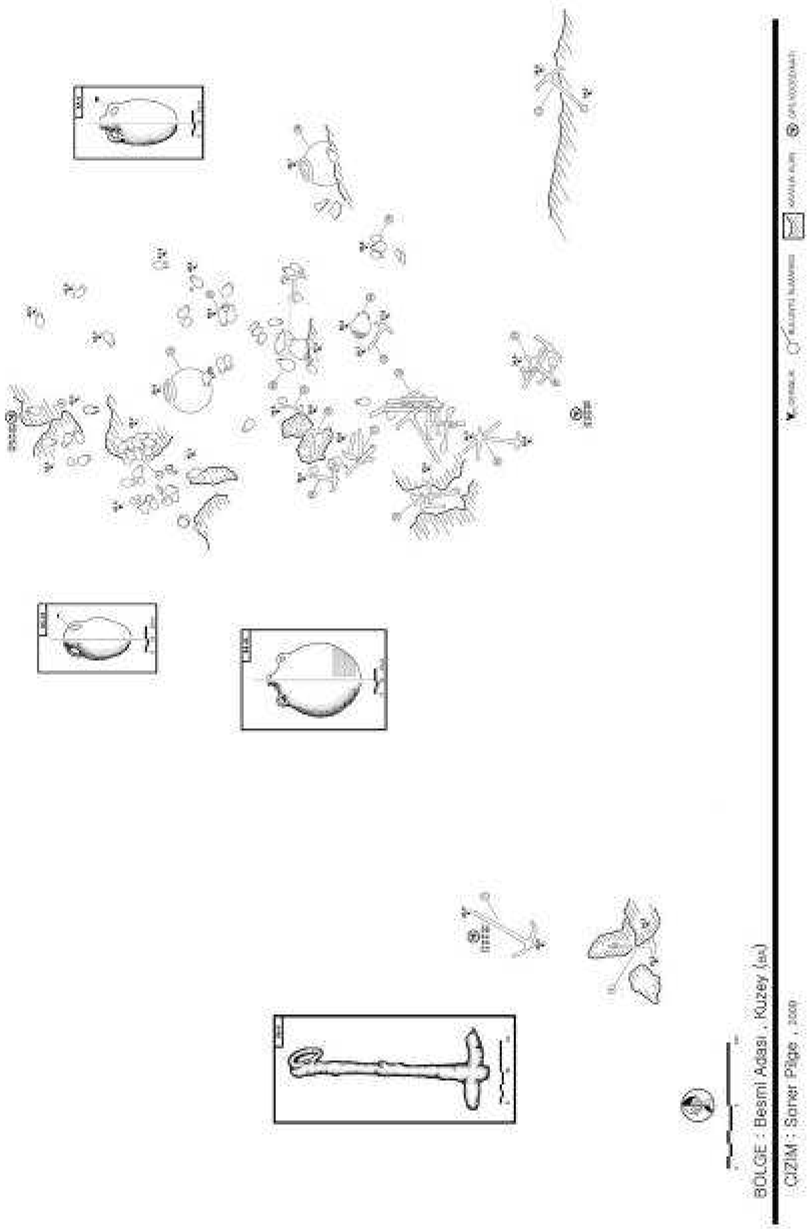
Notes

Recording personal thoughts or remarks on finds or dives give further details other than the categorized data stored in the above mentioned components. This system includes any type of data, textual or numerical, listed in the "notes" section. Currently, there are tables reserved for notes in most of the system components which allow users to share their experiences, opinions and thoughts. Valuable information can be inferred from these comments, and can be used as a collaboration tool.

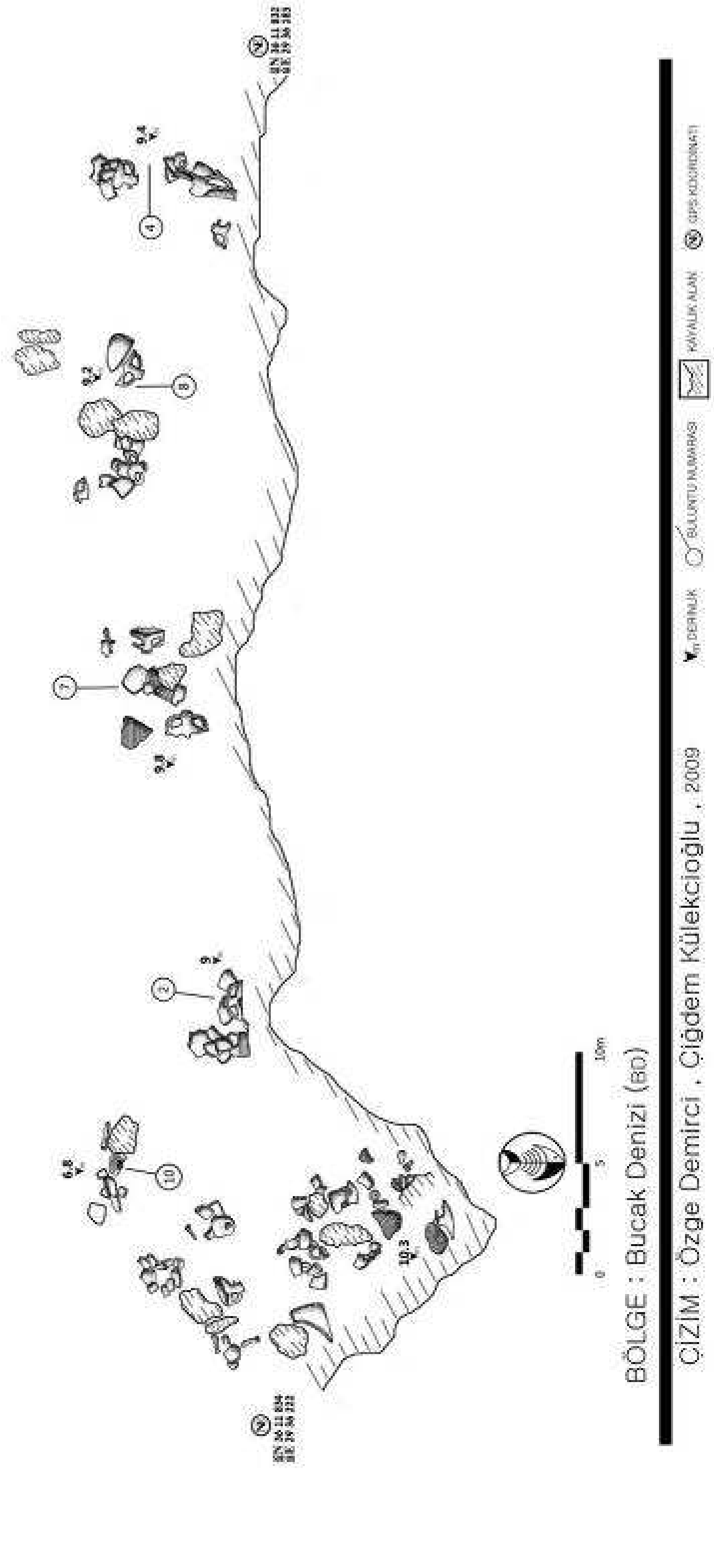
Appendix D

Archaeological Sites

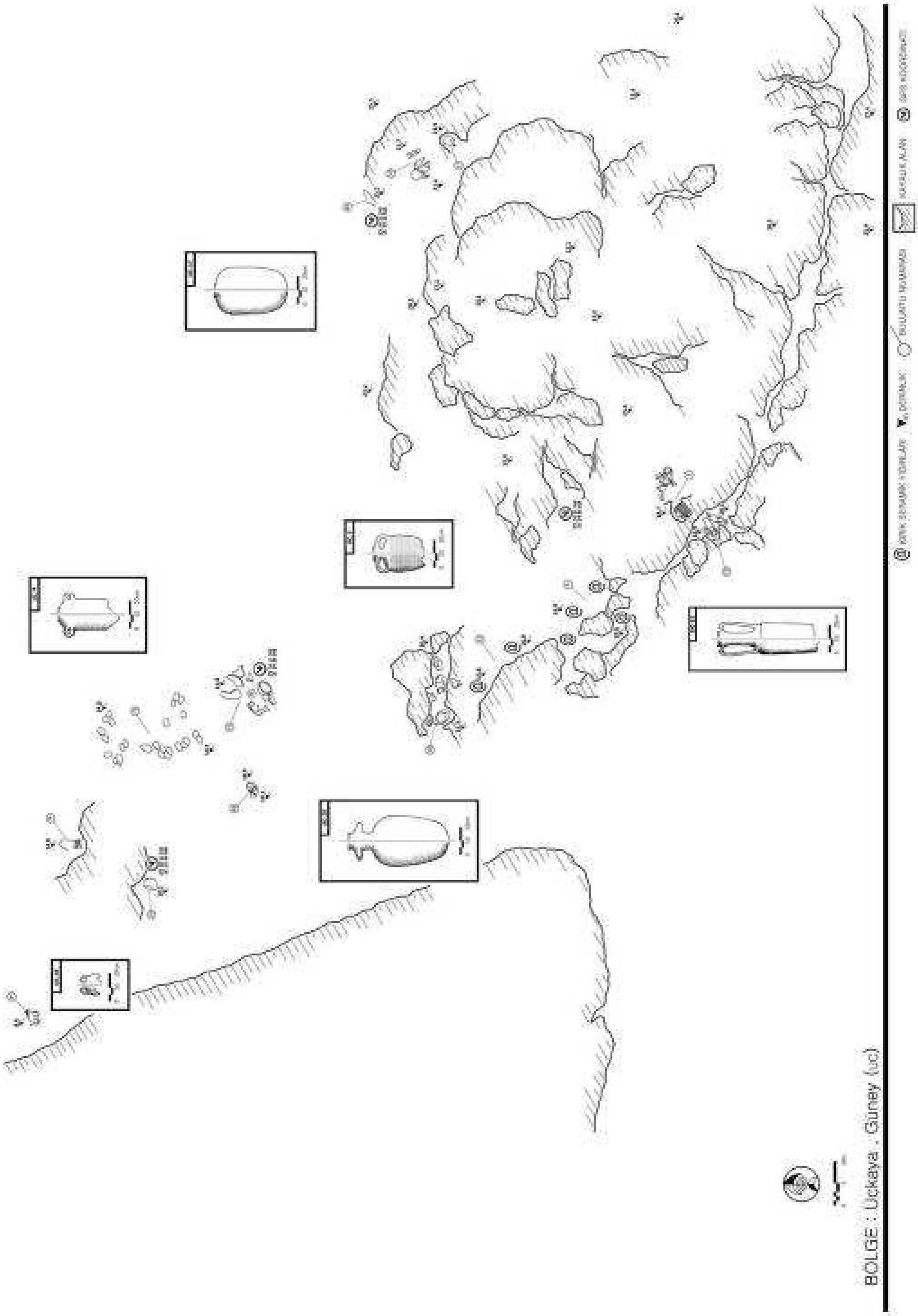
D.1 Besmi Island (Besmi Adası-BA) Cargo Site

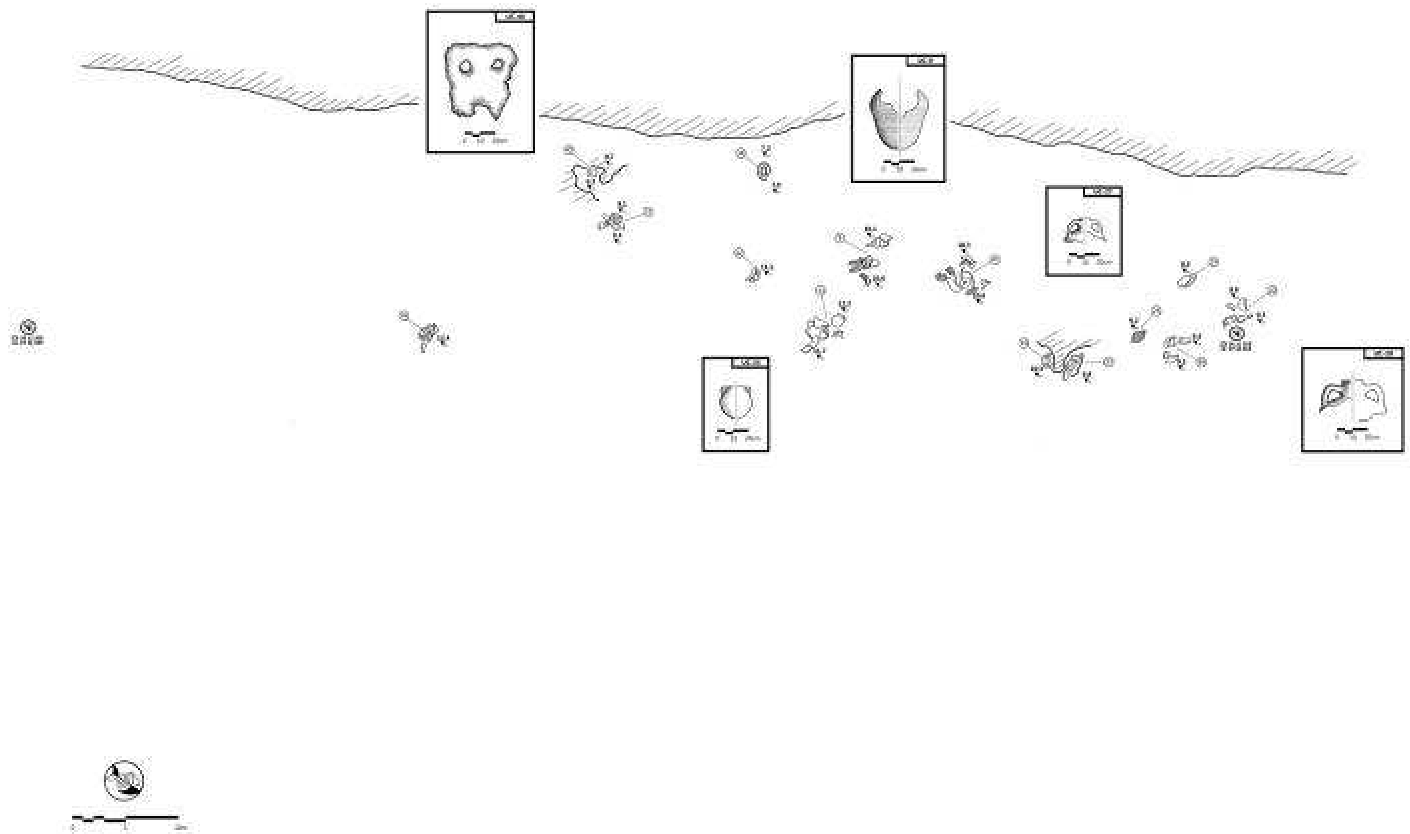


D.2 Bucak Sea (Bucak Denizi-BD) Cargo Site



D.3 Cape Üçkaya (Üçkaya Burnu-UC) Cargo Site

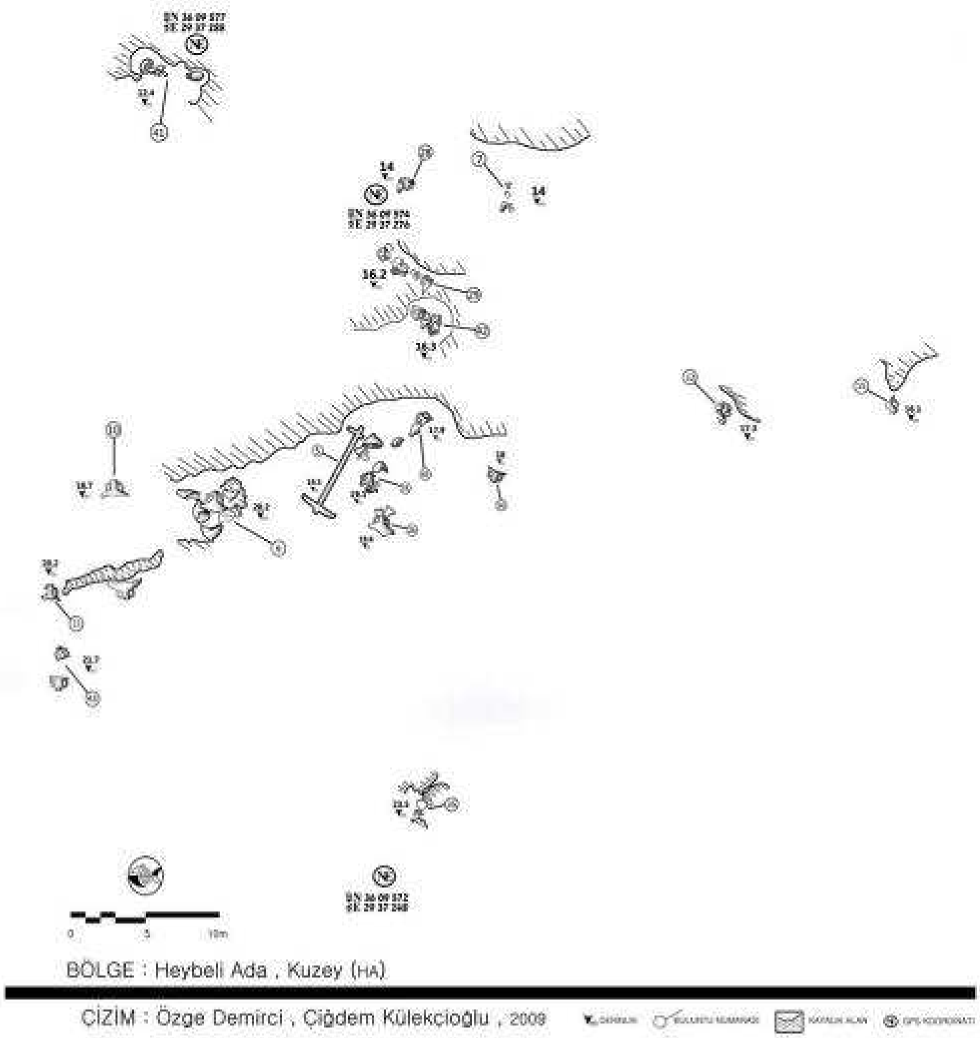




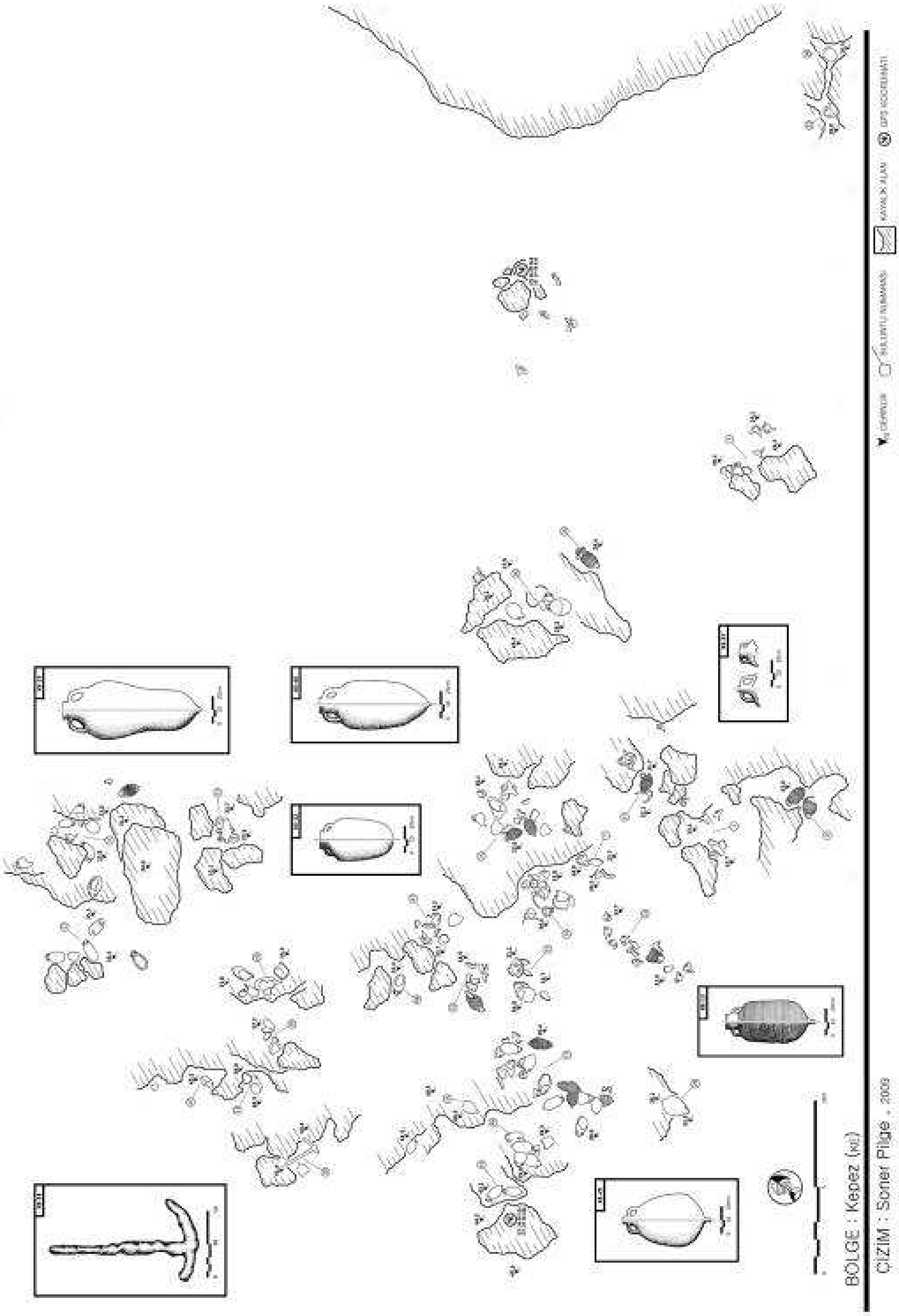
BOLGE : Üçkaya . Kuzey (üç)

KIRIK SERAMIK YIGINLARI
DERINLIK
BULUNTU NUMARASI
KAYALIK ALAN
GPS KOORDINATI

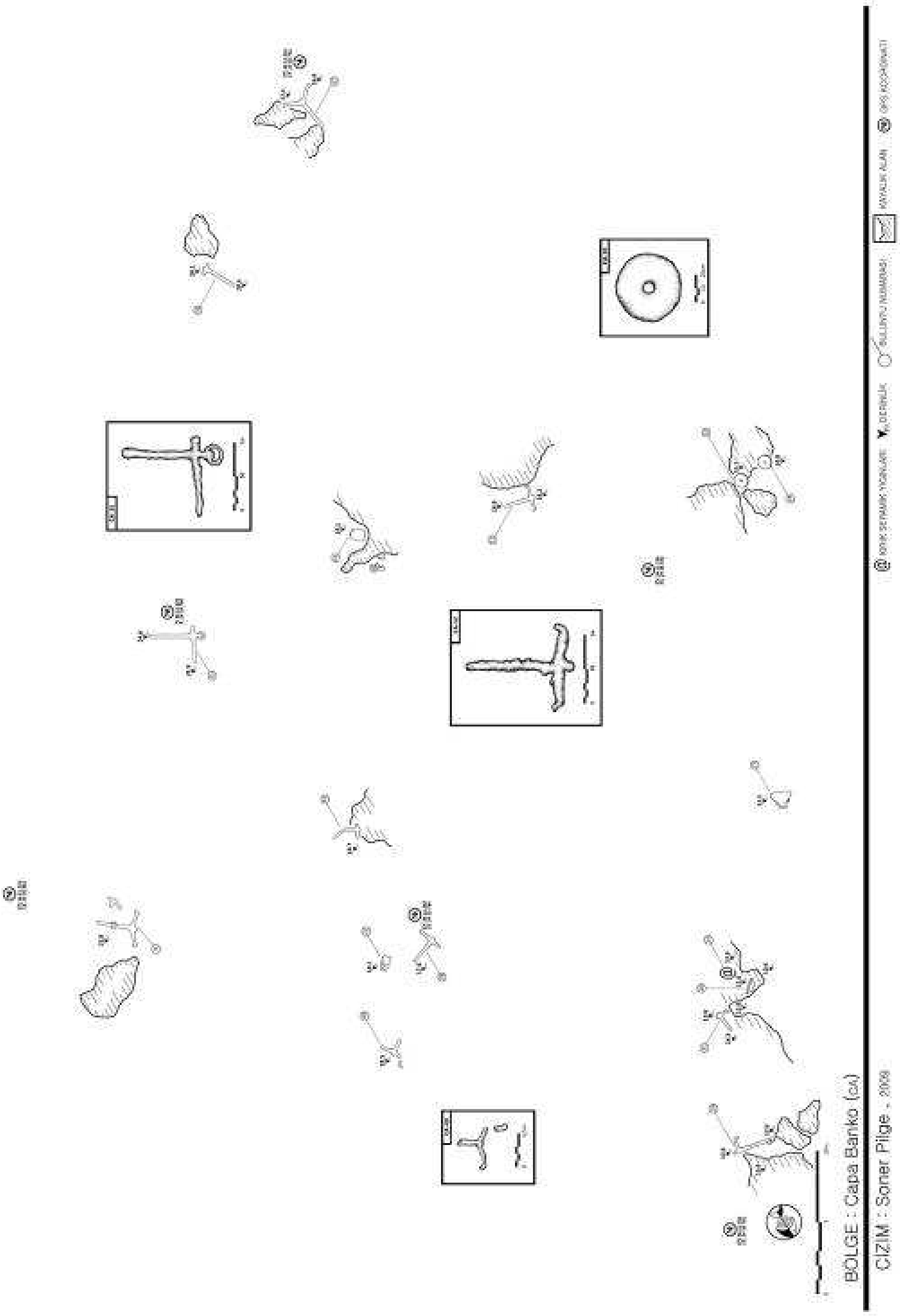
D.4 Heybeli Island (Heybeli Ada-HA) Cargo Site



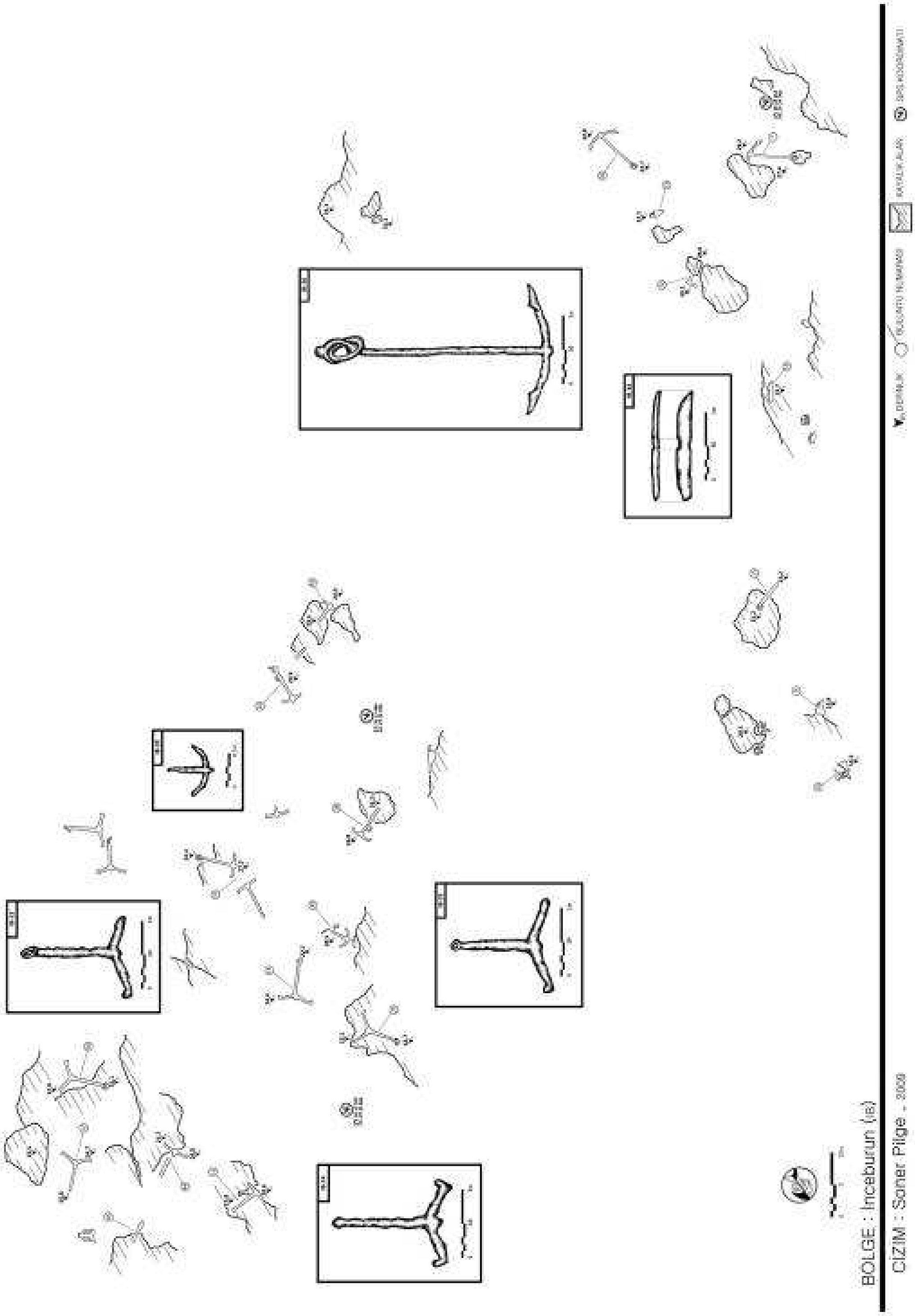
D.5 Kepez (KE) Cargo Site



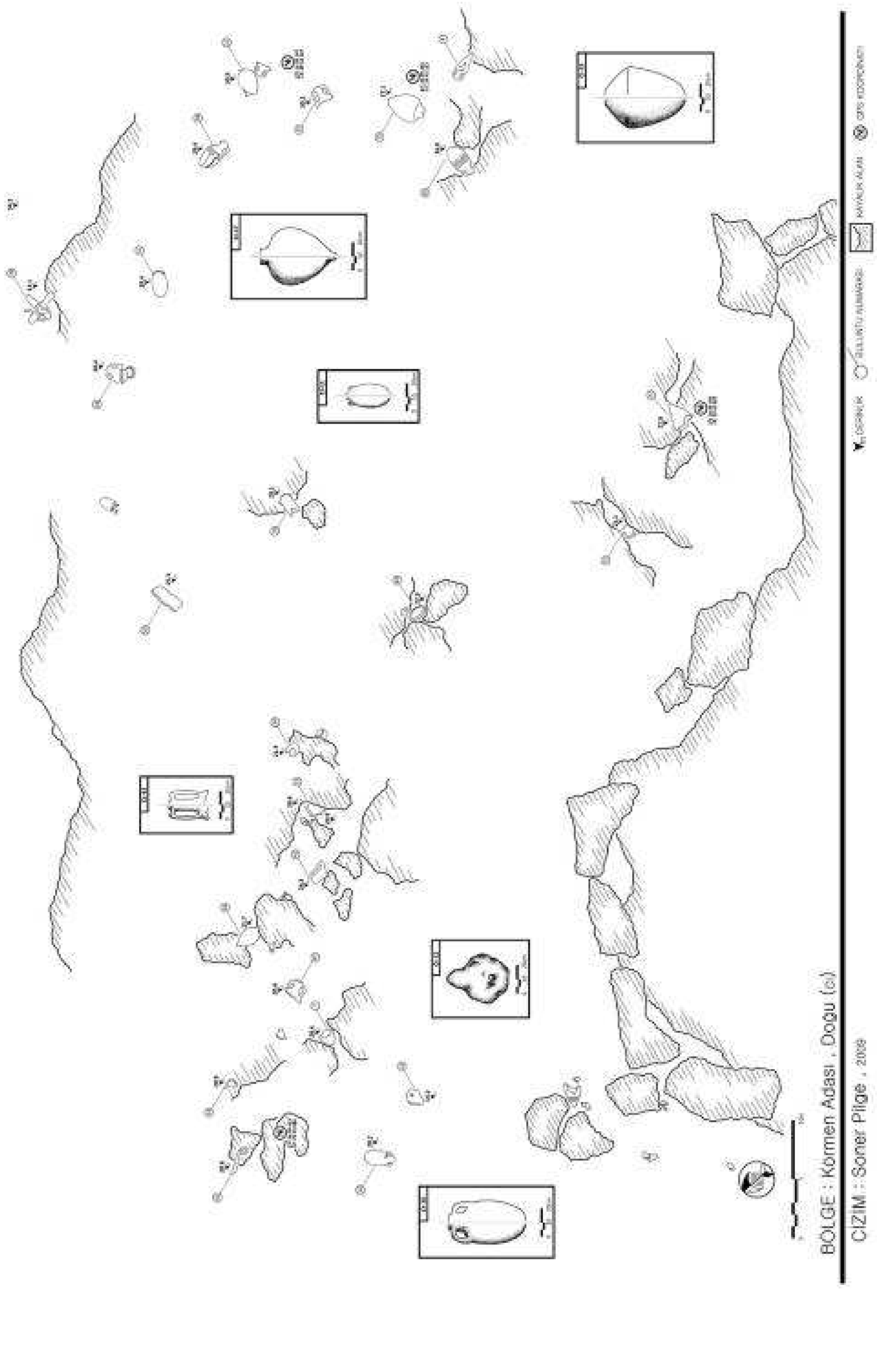
D.6 Çapabanko (CA) Anchorage Site



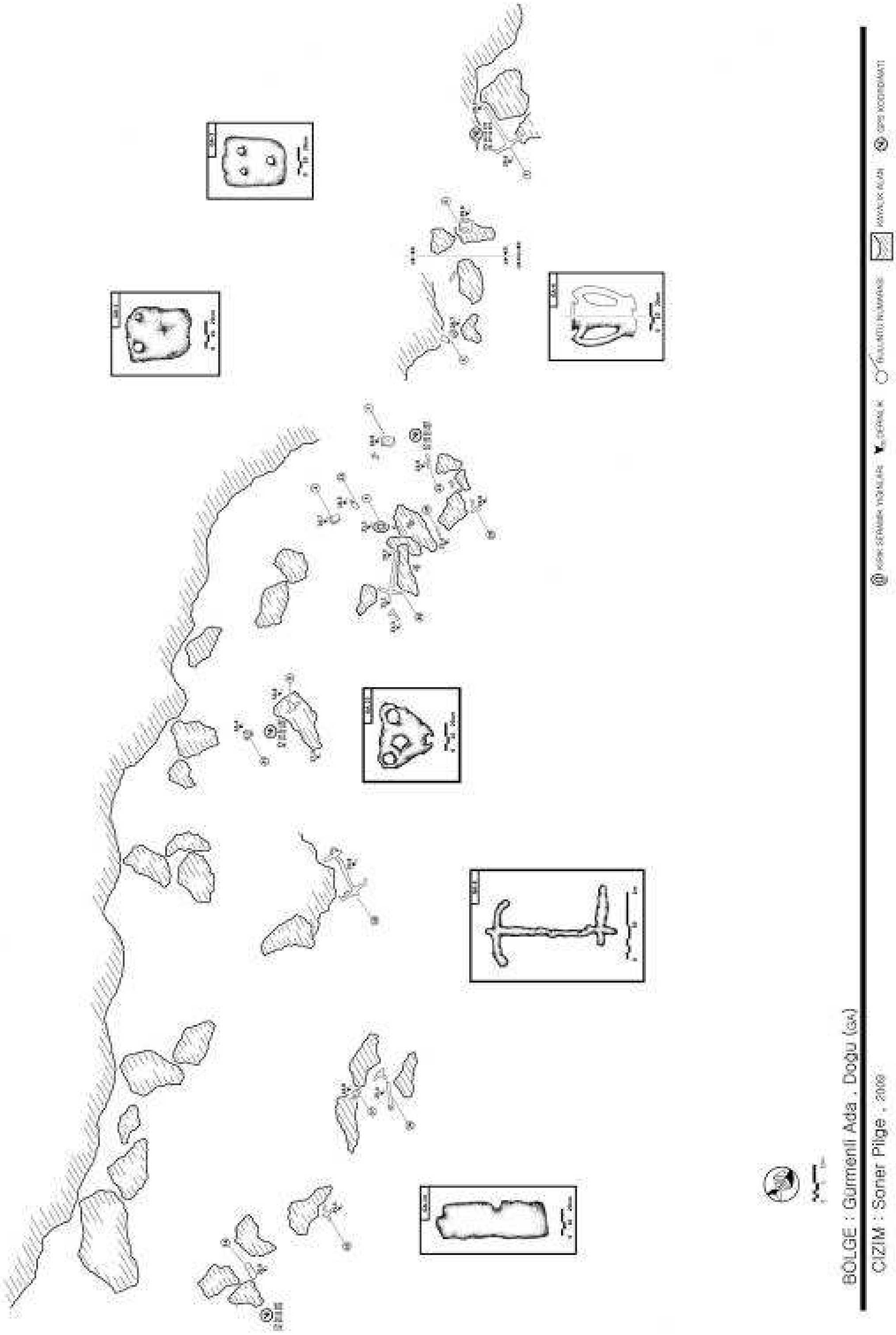
D.7 Cape İnceburun (İnceburun-IB) Anchorage Site



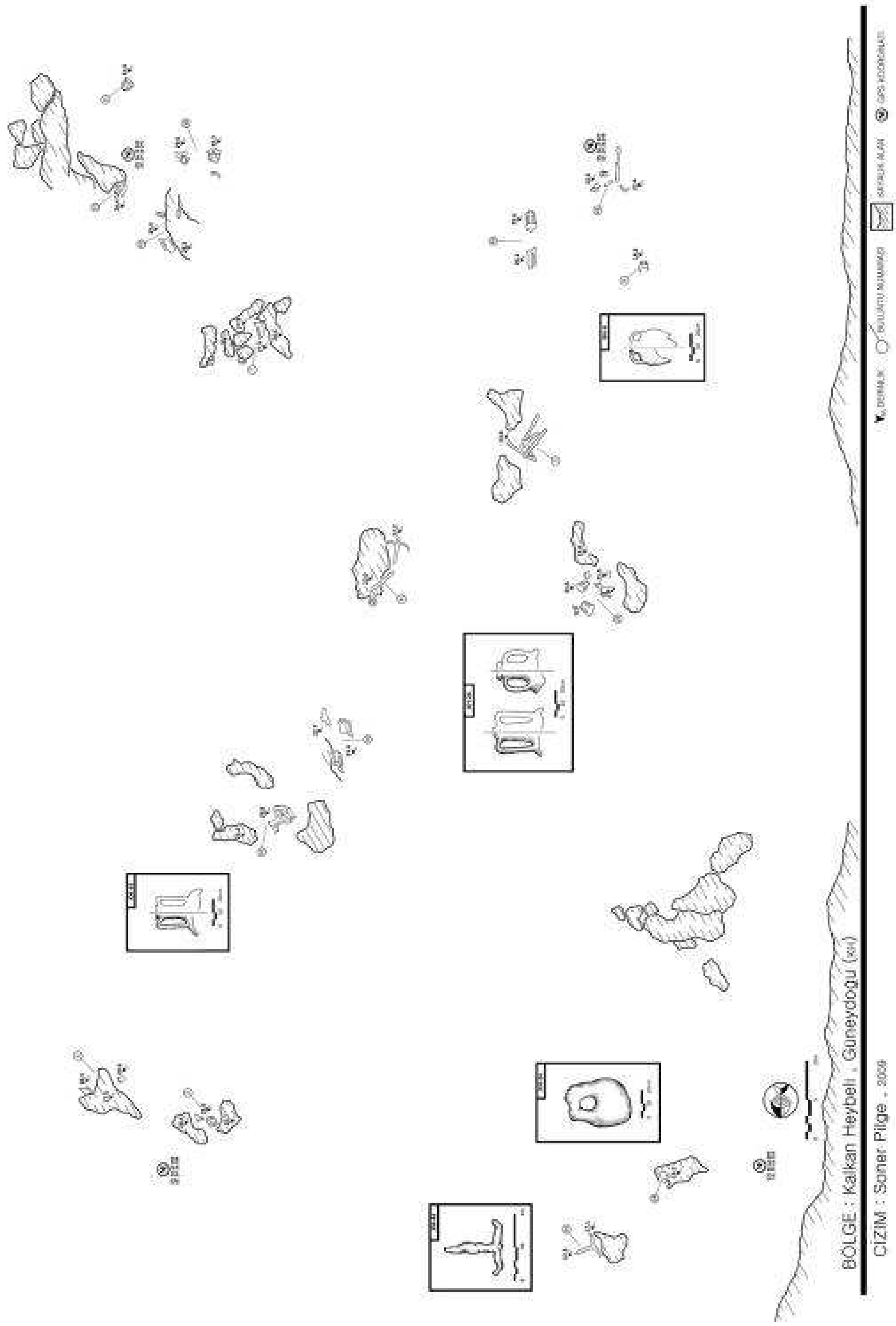
D.8 Çılpacık Island (Çılpacık Adası- CI) Anchorage Site

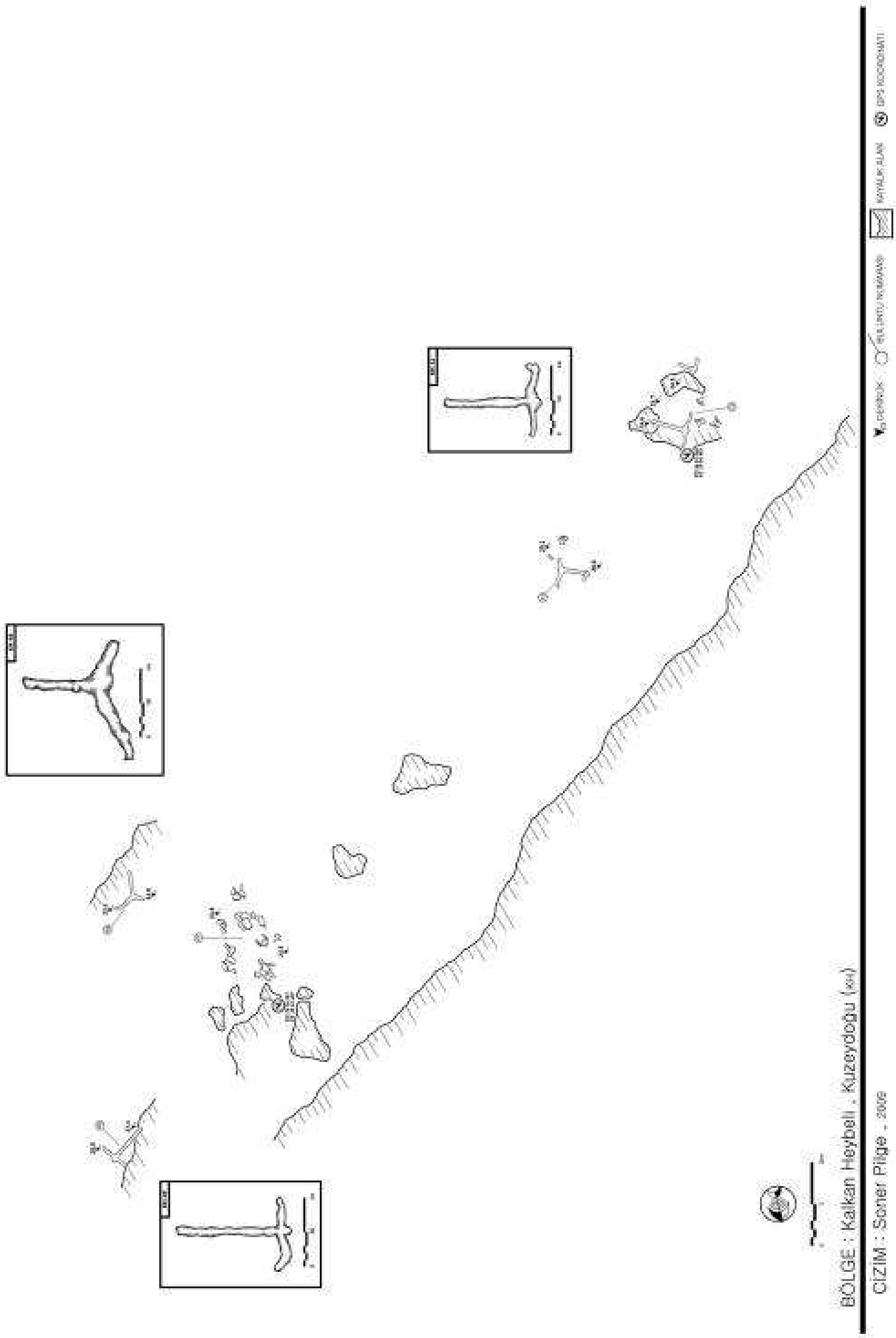


D.9 Gürmenli Island (Gürmenli Adası-GA) Anchorage Site

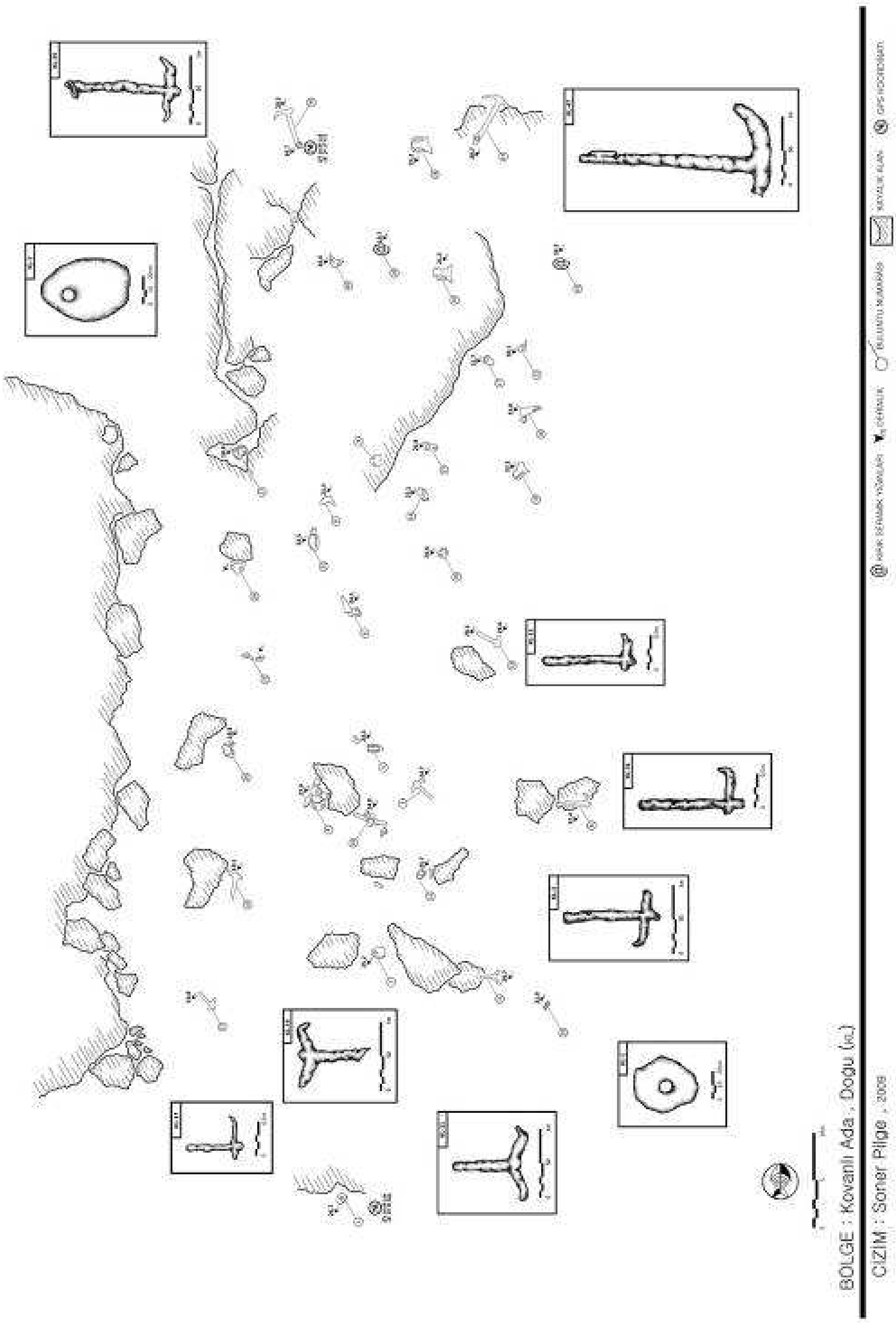


D.10 Kalkan Heybeli Island (Kalkan Heybeli Ada-KH) Anchorage Site

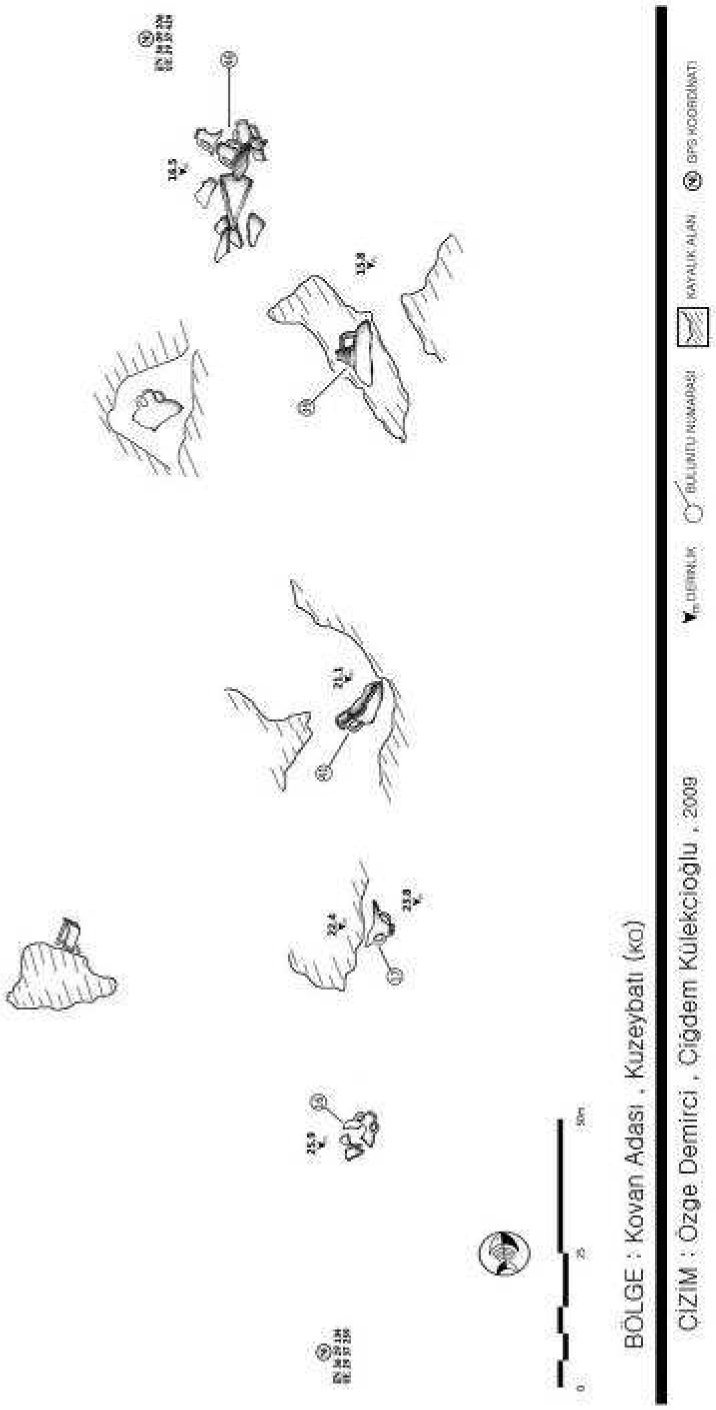



BÖLGE : Kalkan Heybeli , Kuzeydoğu (KH)
ÇİZİM : Soner Pilge , 2009

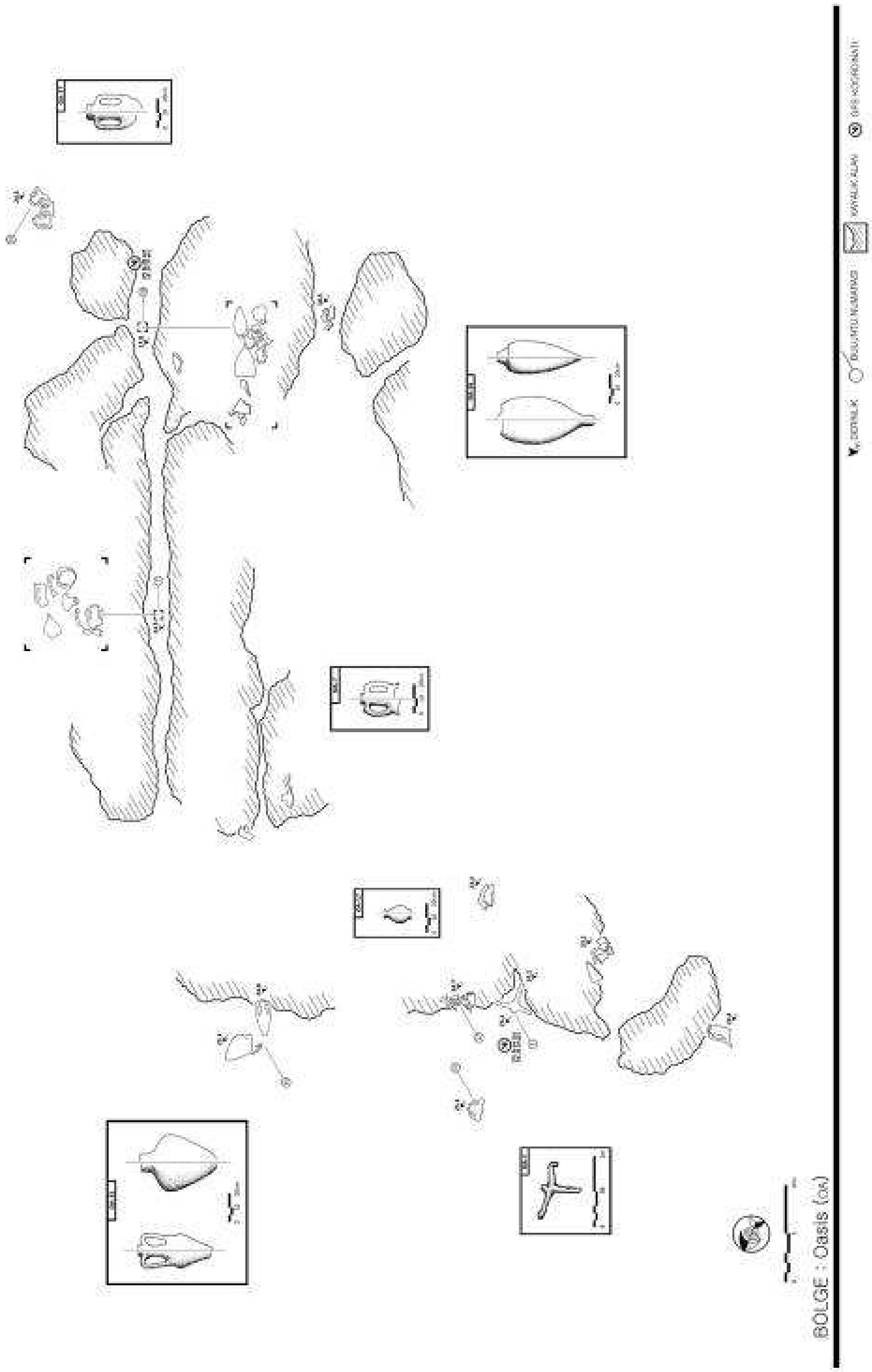
D.11 Kovanlı Island (Kovanlı Adası-KL) Anchorage Site



D.12 Kovan Island (KO) Touristic Site



D.13 Oasis (OA) Touristic Site



Appendix E

List of Participants

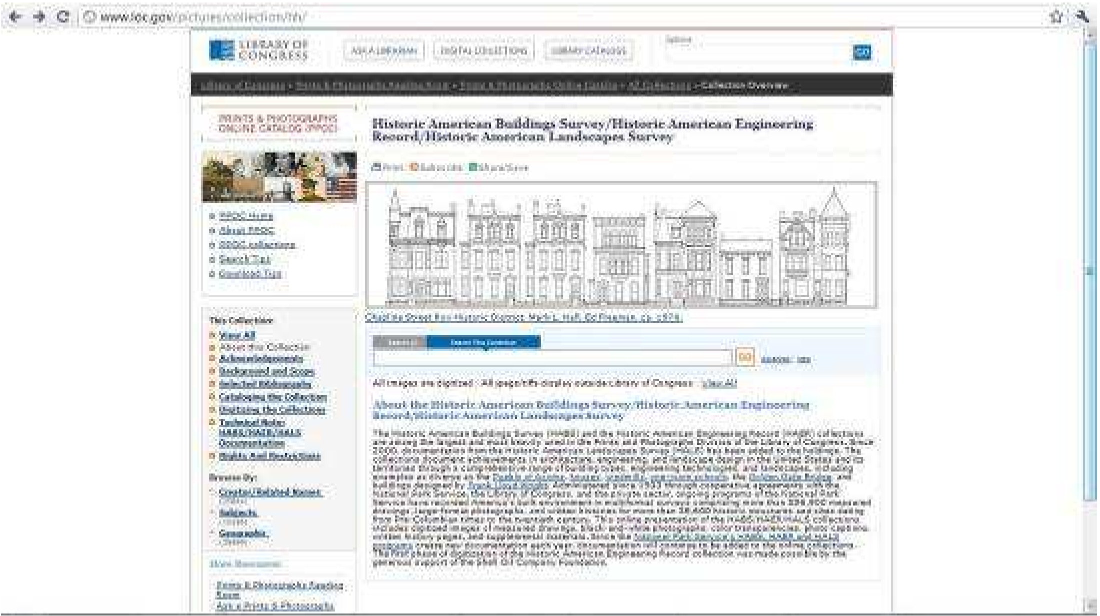
No	Code	Name-Surname	Title	Participation Level
1.	AOM	Ahmet Onur Miskbay	Mechanical Engineer	data collection
2.	AEK	Ali Ethem Keskin	Underwater Photographer	data collection
3.	ILT	Ali İlker Tepeköy	Archaeologist, MoCT	data collection/analysis
4.	ATO	Ali Tanju Oğuz	Medical Doctor	data collection
5.	AYA	Ali Yalçın Savaş	Diver	data collection
6.	ALT	Altuğ Tosun	Diving Instructor	data collection
7.	ATI	Atila Kara	Diving Instructor	data collection
8.	AYB	Ayberk Çatar	Electronic Engineer	data collection/database
9.	AYK	Aykut Fenerci	Interior Architect	data collection
10.	AYS	Ayşe Şeyda Maraş	Underwater Videographer	data collection
11.	AYE	Aysu Erdoğdu	Electrical Engineer	data collection
12.	BAH	Baha Dinçel	Physicist	data collection
13.	BAB	Barış Bekdik	Civil Engineer	data collection
14.	BAC	Başak Çallıoğlu	Underwater Videographer	data collection
15.	BLK	Tevfik Belek Öztürkcan	Diving Instructor	data collection/database/analysis
16.	BEL	Belma Namlı	Diving Instructor	data collection
17.	BEN	Bengiz Özdereli	Underwater Videographer	data collection
18.	BOZ	Berker Özsarı	Diver	data collection
19.	BIL	Billur Tekkök	Archaeologist, PhD	database/analysis
20.	BDE	Birol Demirci	History Teacher	data collection
21.	BUK	Buket Oğuz	Computer Engineer	data collection
22.	BKK	Burak Karacık	Naval Architect	data collection
23.	BRK	Burak Özkırlı	Biologist	data collection/database/analysis
24.	CAK	Çağrı Kundak	Mechanical Engineer	data collection
25.	CNT	Cantekin Çimen	Computer Programmer	data collection/database/analysis
26.	CBE	Cengiz Bektaş	Diving Instructor	data collection
27.	CIC	Çiğdem Cihangir	Industrial Engineer	data collection/database
28.	CIK	Çiğdem Külekçioğlu	Archaeologist	data collection/database/analysis
29.	CTS	Çiğdem Toskay	Archaeologist, Ph.D	data collection/database/analysis
30.	CIY	Cihan Yapa	Diving Guide	data collection
31.	COS	Coşkun Teziç	Underwater Photographer	data collection
32.	DAA	Damla Atalay	Civil Engineer	data collection/database/analysis
33.	DRY	Derya Lökçü	Archaeologist	data collection

34.	DHC	Doğan Haluk Camuşcuoğlu	Architect	data collection/database
35.	DOD	Doruk Dündar	Mechanical Engineer	data collection
36.	EJR	Ejder Varol	Electrical Engineer	data collection
37.	ETU	Ekin Tuncalı	Mechanical Engineer	data collection
38.	ELD	Elif Denel	Archaeologist, Ph.D	data collection/database/analysis
39.	ECT	Emrah Cantekin	Diving Instructor	data collection
40.	FEK	Emrah Koşgeroğlu	Architect	data collection/database/analysis
41.	EMG	Emre Gürdal	Diver	data collection
42.	EMT	Emre Tuksal	Mechanical Engineer	data collection
43.	ECP	Emrecan Polat	Diver	data collection
44.	ERA	Ersin Aydın	Diving Instructor	data collection
45.	EDK	Esra Demirkol	Sociologist	data collection/database/analysis
46.	EVR	Evren Koban	Biologist, PhD	data collection
47.	ETU	Evren Türkmenoğlu	Archaeologist	database/analysis
48.	EZG	Ezgi Kırış	Engineer	data collection
49.	FZG	Fazıl Selçuk Gömeç	Diver	data collection
50.	FTC	Filiz Tütüncü	Archaeologist	data collection/database/analysis
51.	FUN	Funda Atun	City Planner, PhD	data collection/database/analysis
52.	GER	Gerd Knepel	Architect	data collection
53.	GUY	Gülfem Uysal	Anthropologist, PhD	data collection/database/analysis
54.	GAP	Girayhan Alpdoğan	Underwater Videographer	data collection
55.	GOK	Gökçe Durusoy	Underwater Videographer	data collection
56.	GKF	Gökçen Fidan	Medical Doctor	data collection
57.	GXG	Göksu Gürer	Metallurgical Engineer	data collection
58.	GUR	Gürkan Balkan	Diving Guide	data collection
59.	GUZ	Güzden Varinlioğlu	Architect, PhD	data collection/database/analysis
60.	HLD	Haldun Ülkenli	Diving Instructor	data collection
61.	HAC	Hande Ceylan	Architect	data collection/database/analysis
62.	HUY	Hülya Yalçınsoy	Archaeologist, MoCT	analysis
63.	JOH	Johann Müller	Wood Expert	data collection
64.	KEA	Kemal Engin Aygün	Underwater Videographer	data collection
65.	KGT	Kemal Gökhan Türe	Metallurgical Engineer	database/analysis
66.	KMC	Kemalcan Acarı	Veterinarian Doctor	data collection
67.	KBA	Kerem Bayrı	Diving Instructor	data collection
68.	KAL	Koray Alper	Archaeologist	data collection
69.	KBB	Korhan Bircan	Ceramic Artist	data collection
70.	LEY	Levent Yüksel	Sociologist, PhD	data collection
71.	MAH	Mahmut Duruş	Diving Guide	data collection
72.	MAR	Marianne Hilke	Diving Instructor	data collection
73.	MMT	Mehmet Aytuğ	Diving Guide	data collection
74.	MEY	Meryem Yavuz	Videographer	data collection
75.	MIC	Michaela Reinfeld	Archaeologist	data collection/database/analysis
76.	MUG	Müge Bulu	Archaeologist	data collection
77.	MSY	Muhibe Suna Yılmaz	Computer Programmer	data collection

78.	MBB	Murat Bircan	Ceramic Artist	data collection
79.	MDR	Murat Draman	Industrial Engineer, PhD	data collection
80.	MUS	Mustafa Dilaver	Diving Guide	data collection
81.	TME	Mustafa Ergün	Archaeologist	data collection/database/analysis
82.	NEK	Nermin Karagöz	Archaeologist	data collection/database/analysis
83.	OGL	Oğulcan Şahin	Cultural Preservationist	data collection/database
84.	OHA	Okan Halaçoğlu	Captain	data collection
85.	OCA	Oktay Çağlar	Computer Programmer	data collection/database
86.	ÖMA	Ömer Akman	Diving Guide	data collection
87.	OYO	Ömer Yolaç	Underwater Photographer	data collection
88.	OAK	Onur Akbay	Diver	data collection
89.	ONR	Onur Emir	Coast Guard	data collection
90.	ORA	Orhan Aytür	Underwater Photographer	data collection
91.	ORH	Orhan Serdar	Archaeometrist, Ph.D	data collection
92.	OTI	Orhan Timuçin	Diving Instructor	data collection
93.	OZY	Ozan Yazgan	Diver	data collection
94.	ODE	Özge Demirci	Archaeologist	data collection/database/analysis
95.	OZG	Özgür Liman	Underwater Photographer	data collection
96.	PAY	Pelin Aksungur Aydın	Diver	data collection
97.	RSW	Reuben Shipway	Biologist, Ph.D	data collection
98.	SCH	Samet Celil Harmandar	Archaeologist	data collection/database/analysis
99.	SAO	Şefik Altay Özaygen	Computer Programmer	database
100.	SAK	Selçuk Akın	Diver	data collection
101.	SEE	Selen Esen	Diver	data collection
102.	SGU	Serdar Gülsöken	Diving Guide	data collection
103.	SKG	Serkan Girgin	Computer Programmer	database
104.	SEV	Sevil Gürel Peker	Archaeologist	data collection/database/analysis
105.	SIN	Sinem Güldal	Archaeologist	data collection
106.	SPL	Soner Pilge	Ceramic Artist	data collection/database/analysis
107.	STE	Stefan Frank	Diving Guide	data collection
108.	SOZ	Süha Özgeçen	Mechanical Engineer	data collection
109.	TCZ	Tahsin Ceylan	Underwater Photographer	data collection
110.	TTK	Tutku TANDIR	Archaeologist	data collection
111.	UMA	Umut Aksu	Mechanical Engineer	data collection/database/analysis
112.	UAY	Umut Aydın	Pharmacist	data collection
113.	UMT	Umut Görgülü	Archaeologist, MoCT	data collection/analysis
114.	UKK	Umut Kahramankaptan	Computer Engineer	data collection
115.	VLK	Volkan Ertürk	Computer Programmer	data collection
116.	WOL	Wolfgang Platen	Diving Guide	data collection
117.	YUN	Yunus Altun	Diving Guide	data collection
118.	YSB	Yusuf Şafak Bayram	Computer Programmer	database
119.	ZET	Zehra Tatlıcı	Chemist	data collection/database/analysis
120.	ZAD	Zeynep Aslı Dülgeroğlu	Environmental Engineer	data collection/database/analysis

Appendix F

Literature Review



Historical American Building Survey (HABS) web page (http://memory.loc.gov/ammem/collections/habs_haer/).

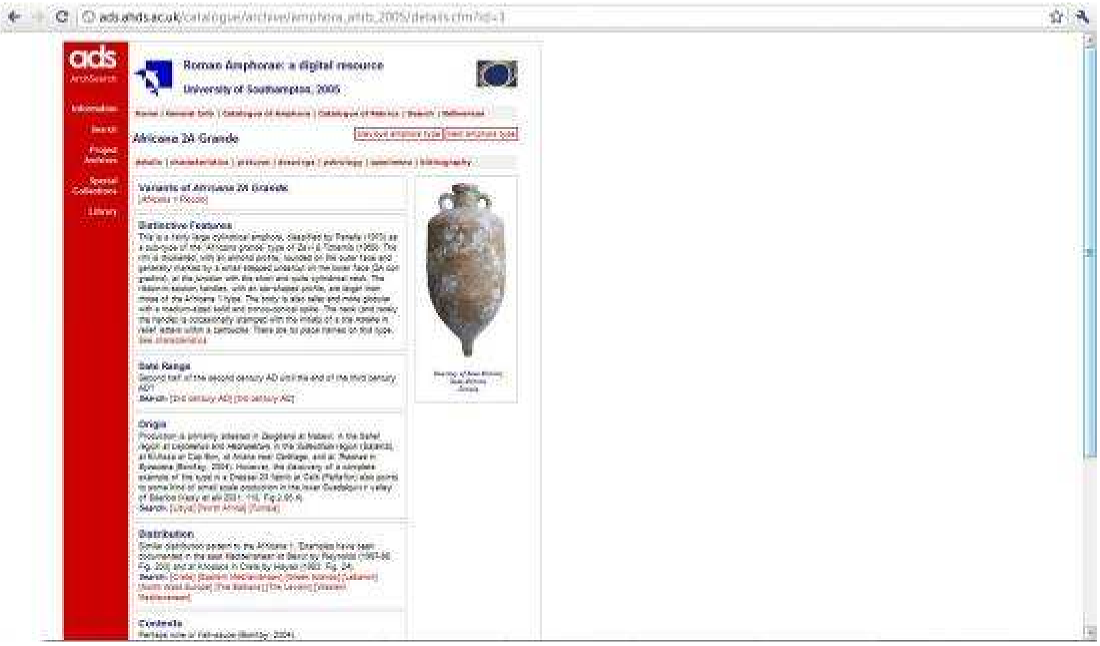
Turkish Archaeological Settlements (TAY) web page (http://tayproject.org/).

Nautical Archaeology Digital Library (NADL) web page (http://nadl.tamu.edu/).

The Institute for the Visualization History (VIZIN) web page (http://www.vizin.org/).

Virtual Museum of Canada (VCM) web page (http://www.museevirtuel-virtualmuseum.ca/index-eng.jsp).

Big Anchor Project web page (http://www.biganchorproject.com).



Roman Amphorae: a digital resource web page (http://ads.ahds.ac.uk/catalogue/archive/amphora_ahrb_2005/details.cfm?id=3).

Virtual Exploration of Underwater Sites (VENUS) web page (http://sudek.esil.univmed.fr/venus/).