

# Dissemination in archaeology: a GIS-based StoryMap for Chan Chan

500

Received 11 July 2018  
Revised 26 November 2018  
4 March 2019  
Accepted 21 May 2019

Eva Savina Malinverni and Roberto Pierdicca  
*Dipartimento di Ingegneria Civile, Edile e dell' Architettura,  
Universita Politecnica delle Marche,  
Ancona, Italy, and*

Francesca Colosi and Roberto Orazi  
*ITABC, Consiglio Nazionale delle Ricerche, Rome, Italy*

## Abstract

**Purpose** – The purpose of this paper is to demonstrate the importance of exploiting a geographic information system (GIS)-based data management, designed and implemented for an important monumental site. In particular, data collected during the years have been used to create a storytelling experience to disseminate the tangible and intangible heritage of Chan Chan (Peru), the wider site in mud bricks of Latin America.

**Design/methodology/approach** – The paper discusses the steps that have been performed to use the data stored in a GIS, arguing over the importance of sharing the knowledge through web-based tools, and in particular by the implementation of a storytelling. In this context, the data were structured in interoperable forms in order to preserve the universal value of the archaeological site. The exploitation in an all-in-one solution of the archival research, field surveys and planning represents a step forward for let known ancient testimonies to the whole mankind.

**Findings** – The GIS-based inventories represent the backbone for an affordable management of heritage resources. The novelty of the proposed approach lies on the creation of an integrated, accessible and updatable data system sharable on web.

**Originality/value** – The GIS of Chan Chan is an example of documentation of a wide archaeological area (14 km<sup>2</sup>) with complex and heterogeneous data. The developed web tool makes use of these data which can be queried even by non-expert users. The pipeline of this paper can act as useful guidelines to practitioners and researchers who want to disseminate cultural information.

**Keywords** Data management, Environment, GIS, Dissemination, Archaeology, StoryMap

**Paper type** Research paper

## 1. Introduction

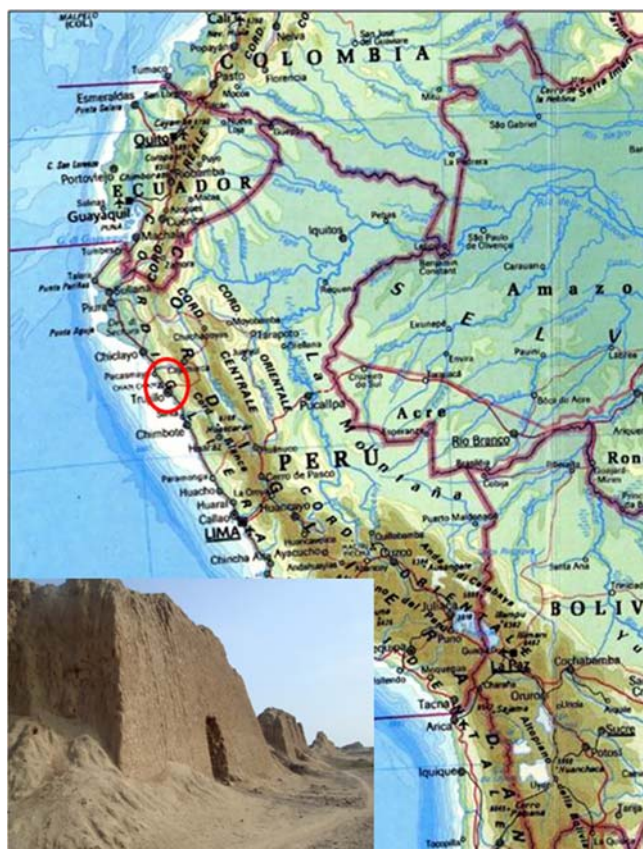
Chan Chan is situated about 550 km north of Lima along the northern coast of Peru. The town represents the largest settlement of Latin America build in adobe and for many centuries was the capital of the Chimú civilization, which extended on the greatest part of the northern coast of Peru between the 8th and 14th sec. AD (Figure 1).

Since it is inscribed in the UNESCO World Heritage List since 1986, Chan Chan is managed through a specific plan, prepared by the Ministerio de Cultura of Peru in the year 2000. The Plan Maestro de conservación y manejo del Complejo Arqueológico Chan Chan (Plan Maestro) is organized in 7 programs and 153 projects related with the investigation, conservation, valorization, protection and promotion of the site and its territory with the aim of supporting the socio-economic development of the local population.

Within this framework, the environmental, economic and socio-cultural sustainability represents a key challenge that can be faced only whether historic cities undertake effective management policies (Shah, 2016).

World heritage organizations claim for promoting this kind of activities; UNESCO for instance treats this argument stating that “the future of humanity hinges on the effective





**Figure 1.**  
The geographical  
localization of the  
archaeological site  
with a frame of the  
ruins of an ancient  
structure

planning and management of resources” (Meskell, 2012). As well, ICOMOS introduced the Outstanding Universal Value for Cultural Heritage goods that shall be pursued by considering the following aspect:

- Documentation prior to damages. Early recording of damage and surveying image capture is a first essential step.
- Measurement for capturing and retain such data for further actions toward recovery and reconstruction.
- Data need to be managed and transmitted in interoperable forms.

The Italian Mission in Peru (MIPE) of the CNR-Institute for Technologies Applied to Cultural Heritage (ITABC) has been operating in Chan Chan since 2002 in collaboration with the Università Politecnica delle Marche and the Ministerio de Cultura of Peru and with the financial support of Italian Ministry of Foreign Affairs. The aim is to help the accomplishment of the Plan Maestro by documenting the architectural typologies and by preserving the site and the natural landscape through the realization of an archaeological park (Colosi *et al.*, 2013; Colosi and Orazi, 2015).

At this stage, it is mandatory to launch initiatives aimed at publicizing internationally the site and providing visitors with a wider touristic offer. In fact, despite its exceptional

beauty, Chan Chan is not sufficiently known outside of Peru and is therefore excluded from the main international touristic circuits.

Over the years, the MIPE has built a geographic information system (GIS) of Chan Chan (Colosi *et al.*, 2009) which contains territorial, archaeological and architectural information for management and conservation activities and the main planning elements of the Archaeological Park. Mapping on the GIS a virtual tour of the site, constructed by panoramic photos, has been realized.

On the base of such conspicuous database, the challenge is represented by the following research question:

*RQ1.* How heritage inventories, managed with the aid of a GIS, can be exploited to be presented and shared with the mankind?

Starting from such a premise, this work deals with the design, creation and implementation of a storytelling of Chan Chan that, telling a tangible and intangible heritage of extraordinary value through different graphic, descriptive and multimedia tools, aims to be not only a scientific product of data storage, but also an instrument for the promotion of the site at an international level.

In fact, managing and sharing heterogeneous data collected over more than 15 years of activities could not be impossible without the aid of a tool that enables one to interact with; without an effective solution for manipulating this information, the risk is that the precious knowledge hold within the GIS could remain unexploited (Wheatley and Gillings, 2002). Consequently, the organization of data becomes paramount in different scenario like restoration, public administration, analysis by experts and also for sharing at different levels of detail.

Since the storytelling is based on the georeferenced data collected through geomatics techniques by the MIPE over many years of work in Chan Chan, it can be more properly defined as a StoryMap, where the spatial information system is organized in virtual touristic topics that help to know about different topics the site.

In this paper, the StoryMap of Chan Chan is presented, empathizing the priceless value of involving the local communities with different kinds of courses (described in the realized web-site), besides enabling them to be independent in implementing the StoryMap by themselves. This was possible thanks to the new skills gained with new data, organized in the GIS, and the courses held among the years. These pages present a methodology for exploiting data that, up to now, are available just for the insiders and that permit to manage a complex tool (the GIS) in an easy way (WEB). The merit lies on sharing, with the research community a pipeline of work (the general schema in Figure 2) that should become a best practice for every kind of archaeological site.

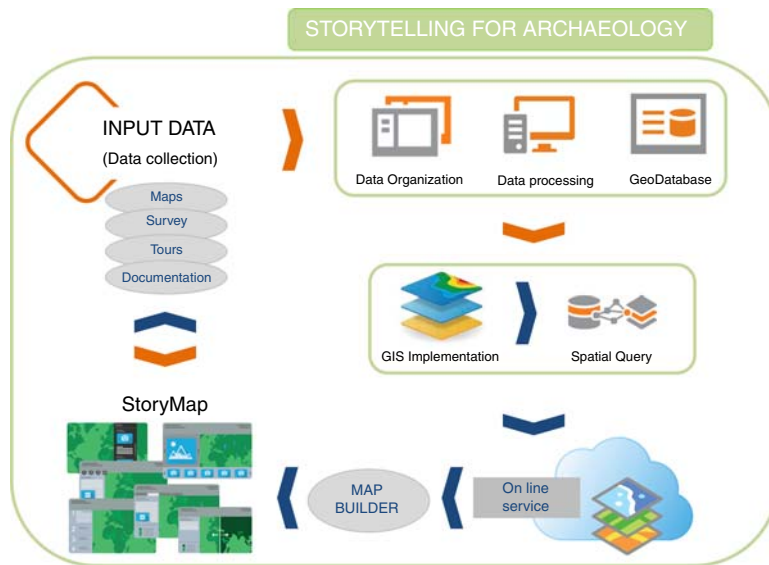
Starting from a short synthesis about the state of art, the archaeological complex and its culture is described. Therefore, methodology and results are exposed, showing some contents and the possibility of future developments. The paper closes with some general conclusions and future perspectives.

## 2. Background

### 2.1 *The storytelling: state of art*

“Narratives are ubiquitous in human experience. We use them to educate, communicate, convince, explain, and entertain. As far as we know, every society in the world has narratives, which suggests that they are rooted in our psychology and serve as an important cognitive function” (Finlayson *et al.*, 2010).

Although the methods have changed, the desire to tell and hear stories remains, and still impacts our perception (Brouillard *et al.*, 2015; Poulot, 2015). Nowadays, thanks to the internet, information and communication are becoming faster and more concise. For this



**Note:** Orange arrows represents the work previously performed among the duration of the project, while blue arrows are the steps required to achieve the creation of the Storymap

**Figure 2.**  
The general schema describing the pipeline of work. After the initial phase of heterogeneous data collection, the procedure enable to create the Storymap for sharing such data

reason, new technologies and new ways of exchanging information and messages among people are being developed (Pierdicca *et al.*, 2016a; Malinverni *et al.*, 2017).

The term “Digital storytelling” refers to the use of digital tools to tell stories combining multimedia features (Silvaggi and Braga, 2013, p. 51). It emerged as a practice in the early 1990s with the birth of the hypertexts. As the web grew, storytelling approaches combined hypertext with rich media and user-generated content (Bruner, 1991). Digital storytelling is rapidly evolving, fostering innovation and creativity, while revealing new directions for narratives to flow.

In the realization of a digital storytelling, it is important to distinguish between history and its chronology and the way of telling the story, which foresees totally different times and patterns (Hazel, 2008). This type of approach is particularly effective when it intends to present the cultural heritage in a captivating and comprehensible way to the different categories of users (children, young people, uninformed adults and informed adults).

In this framework, the digitalization of the cultural object and the creation of digital archives are fundamental not only to solve problems of cataloging, storage and conservation, but also to allow interoperability among databases and different levels of access according to the needs of users. Through the creation of database at different scales (territory, sites, monuments and objects) connected to each other, the storytelling of a site or an historical landscape is constructed by presenting captivating scientific and continuously updated contents.

Moreover, new instruments like computers, smartphones and tablets have become part of material culture with great forcefulness, changing the access to digital space. The new set of virtual reality and augmented reality devices are seen as an additional disruptive chance within our grasp (Caspani *et al.*, 2017; Pierdicca, Frontoni, Zingaretti, Malinverni, Colosi and Orazi, 2015; Pierdicca, Malinverni, Clini, Mancini, Bozzi and Nespeca, 2015).

The digital storytelling uses the modern multimedia tools and in this way “allows to increase a monumental or museographic space, and to enrich the visitors’ experience cycle by offering them new action and participation capacities” (Brouillard *et al.*, 2015).

Storytelling offers more opportunities for knowledge, it allows sensory and immersive experiences that lead the visitor to a more intimate relationship with the good and it creates a narrative heritage that can be made available to the entire community (Paolini and Di Blas, 2014). Moreover, digital storytelling offers the possibility to know a place and its history even when, for economic, safety and health reasons it is not possible to visit it directly. Through multimedia tools, the user gets in touch with the spirit of the site, having a first, intimate knowledge of it.

For what is regarding the IT tools for the implementation of digital storytelling, various synthesis and critical contributions are available (among the more recent, Caspani *et al.*, 2017). The European report Athena Plus, for instance, lists the main digital steps toward the storytelling and all the main tools for collecting and organizing digital data (Brouillard *et al.*, 2015).

### 2.2 *The storytelling with maps: the StoryMap*

The possibility to “read-and-write” online maps has given rise to the geospatial web. Maps have become common in everyday life, people are accustomed to use web services such as Google Maps© in order to add and share cartographic contents (Giaccardi and Fogli, 2008). In the storytelling “world,” the maps provide a context and can help to better understand the information that the public is reading (Caquard, 2013; Caspani *et al.*, 2017).

The digital era has given new value to maps and narration. Now maps are interactive and “queryable,” enriched by multimedia contents and links. The interactive maps, with the support of the GIS, geolocalizing every place and related contents, allow the creation of storytelling that transmits information and messages in a concise and complete way, involving the readers in the interactive stories, geolocalizing every point of interest and their related contents.

Realizing storytelling with maps (StoryMaps) is a practice suitable for immediate communication, in a world where data are always wider and technology is keeping up with the times: the information is provided and collected in the most simplified way, the message arrives directly to the reader and the understanding of the topics is made more engaging. The StoryMap “may disclose the richness hidden behind the cultural heritage becoming the key for reading the past” (Caspani *et al.*, 2017).

There are various apps and softwares for the realization of StoryMaps, among which:

- StoryMap ArcGis by Esri© is one of the most featured tool. It offers six semi-structured models (sequential, series and comparative) suitable for likewise.
- StoryMap JS© is a map editor synchronized with Google Drive Editor. It supports the use of maps, slides, headers, multimedia links and explanatory text.
- Odyssey© provides models for the planning of StoryMaps and allows the creation of three different types of maps: in slide format; the one based on scrolling the page; an animated display.
- TimeMapper supports the description of a point, date and explanatory text that must be inserted in a Google spreadsheet.
- Google Earth Tour Builder realizes Tour 3D in Google Earth.

In conclusion, the stories based on maps and narrated through different descriptive and multimedia tools.

### 2.3 GIS and StoryMaps

If the data can be processed and organized by GIS tools, thanks to the features and extensions of the GIS online it is possible to proceed with the creation of a StoryMap.

Starting from the GIS data, the narration of a territory through a StoryMap reaches the public, educate it and involve it. StoryMaps are extremely useful for showing simplify GIS information, they are interactive and easy to read. They represent a new way of communicating. This is a free tool to help one to tell stories on the web, highlighting the locations of a series of events and also, if the stories are based on a GIS implementation, it results a different way to share and to use the data with respect to web-based solutions (Brovelli and Magni, 2003). In fact, as stated by Prinz *et al.* (2014), geospatial information services are able to facilitate web-based data visualization strategies in archaeology to match with the new frontiers of the Web 2.0. WEB GIS in fact has been used for years in archaeology to visualize GIS data (von Schwerin *et al.*, 2013), even if they were used more like a data collector, rather than a narration of a site. Notwithstanding, a WEB-GIS acts as solution to migrate GIS information from desktop toward the web, where the user can make spatial queries. In the case of StoryMap instead, the web acts as an exploration tool, whilst spatial query is done on the existing GIS to narrate, on the WEB, structured data. A StoryMap can be intended as is an integrated set of map(s), related content (legend, text, photos, video, etc.) and functionalities (pan/zoom, pop-ups, swipe, time slider, etc.) that make it a fully functioning information product. In other words, it helps to inspire users to tell their own stories. Our StoryMaps also serve as a sort of public testbed for a variety of map-based functionalities and user experiences.

The words of Allen Carrol, Programmer of Esri, express clearly the main objectives the StoryMaps: “[...] ArcGIS has been widely embraced as a tool for management, analysis, decision support, modeling, and situational awareness. ArcGIS has huge promise in another arena: communication. Thanks to continuing changes in the internet, cloud computing, mobile and tablet platforms, and to constant improvements in the software itself, we can now put the power of GIS into the hands of managers, CEOs, reporters, school kids – everyone. The goal of the StoryMaps effort is to enable thousands of GIS users to tell their own stories[1].”

## 3. The archeological park of Chan Chan

### 3.1 Chan Chan, the earth town

The most populated part of Chan Chan covers approximately 14 km<sup>2</sup>, but the whole urbanized territory spreads over more than 20 km<sup>2</sup>, producing an extremely complex and articulated urban structure that reflects a high level of social and economic organization (Figure 2).

The central area presents nine monumental enclosures named palaces or *ciudadelas* and five *huacas* or stepped pyramids. Inside of the *ciudadelas* were placed wide ceremonial squares, small courtyards decorated with niches (*audiencias*), a great number of warehouses and the tomb of the sovereign (*Plataforma de Entierro*). The *ciudadelas* perimeter walls exceed, in some cases, 10 m in height and 700 m in length. They are always aligned in a N/S direction, with an entrance door on the northern side (Kolata, 1982).

The *huacas* were constructed with mud bricks and stones and normally located inside fenced areas. Within the urban area, the biggest is the one of Obispo and Toledo; the second one has been affected by an important excavation project, carried out by Ministerio de Cultura in the years 2016–2018. For what is regarding their function, the discovery of rich grave goods within their structure has suggested that they might be elitist *plataformas de entierro* or monumental religious buildings. Numerous small *huacas* are widespread in the eastern part of the territory, being probably connected with the cultivated fields. Among them, the *huacas* Arco Iris and Esmeralda stand out, which, although quite distant from the archaeological site, were part of the dense network of sacred monuments linked to the landscape and were decorated with rich bas-reliefs, today completely restored (Plate 1).



**Plate 1.**  
Aerial overview of the  
archaeological site.  
From the top is visible  
the urban  
organization of  
Chimu's civilization

---



The population of Chan Chan lived in different residential accommodations which revealed their social status. The aristocracy occupied some big complexes and defined elite compounds, which are today much degraded (Klymyshyn Uliana, 1982, pp. 119-120), while the common people lived in popular quarters constructed with *quincha*, a building technique made of a mixture of mud on a structure of reeds and wooden posts (Topic, 1982). The different elements that constitute Chan Chan and enrich its territory are interconnected through a dense network of pathways, often elevated, that crossed the cultivated fields in order to reach some strategic points which were particularly important from a practical or ceremonial point of view (Campana Delgrado, 2006). The routes directed to the North (Camino Viejo y Camino Ceremonial) jointed the town with the large channels of irrigation, whilst several paths connected the town with the cultivated fields.

Therefore, the monumental complex of Chan Chan is characterized not only by an extraordinary extension, but also by an internal organization and a richness of architectonic and decorative elements that make it one of the most important archaeological sites of the Latin America.

### *3.2 The Chimu and the water: culture and survival*

The agriculture was the main source of sustenance of Chan Chan and its diffusion was assured by a highly developed irrigation system. A series of channels transversely connected the various rivers that from the mountains flow into the Pacific Sea, distributing the water to the fields, overcoming the desert's asperity. This complex water network has allowed to define the Chimor State as "the most powerful hydraulic state that ancient Peru has ever known" (Lavallée and Lumbreras, 1986).

Some scholars hypothesize that in these lands the Chimu cultivated the cotton through a form of large-scale agriculture. This type of extensive exploitation is compared to the traditional method of cultivation in *huachagues* (Campana Delgrado, 2006).

The *huachaques* are cultivated areas near the sea fed directly by the humidity of the subsoil thanks to the presence of a rather superficial water table. They were grown by *campesinos* with vegetable gardens or with the *tatora*, a typical reed used for the manufacture of mats, baskets and small boats (*caballitos de totora*) riding on which the Chimú were able to sail the long waves of the Pacific and throw fishing nets. In fact, in addition to agriculture, fishing represented an important source of sustenance for the population of Chan Chan; the fresh Humboldt currents made the sea very rich in fish, crustaceans, mollusks and edible seaweed.

The flora and fauna of Chan Chan are widely illustrated on the bas-reliefs that decorate the walls of the *ciudadelas*. Fishing scenes are often depicted, where nets full of fish are collected by men riding *caballitos de totora* (Plate 2). In other cases, the terrestrial world prevails, with the representation of squirrels, ducks and various types of birds.

### 3.3 The intangible heritage of Chan Chan

The cultivation of the *tatora*, linked to traditional fishing with the *caballito de totora*, is still practiced today along the northern coast of Peru and therefore it represents a precious intangible heritage that must be preserved.

In Huanchaco district, near Trujillo, there are two areas of great historical importance for the cultivation of the *tatora*. One of them consists of natural depressions found in the southern boundary of the archaeological complex of Chan Chan. The other is the *Balsar of Huanchaco*, near the little sea village, that is a complex of artificial basins for the cultivation, the drying and the processing of the *tatora*. This is a Regional Protected Area since 1992 and has been recognized by the Ramsar Convention as “Wetlands Built by Man” ([www.ramsar.org](http://www.ramsar.org)). To the *Balsar of Huanchaco* is strictly connected a minority of fishermen who still use to practice the traditional form of fishing, constructing and riding the typical *caballito de totora* (Plate 3).

Unfortunately, in the *huachaques* of Chan Chan the cultivation of the reed has been abandoned and in the *Balsar of Huanchaco* it has been strongly reduced. The main cause of this situation lies in the fact that today artisanal fisheries have been reduced to subsistence



**Plate 2.**  
The topics illustrated  
by means of bas  
relieves. This picture  
represents an example  
of decoration



**Plate 3.**  
The typical boats  
used for fishing called  
*caballito de totora*



level, altered by giant industrial fisheries made with modern and most cost effective means. The MIPE aims to provide support for the economic development of the fishermen minority, creating an “Eco-museum of the totora” and revitalizing the huachaques of Chan Chan and the *Balsar of Huanchaco*.

The handicraft, especially the production of ceramics, constitutes an important source of sustenance for the local population. The ceramists reproduce the ancient iconographies by continuing to use traditional modeling and cooking techniques. In the same way of the ancient Chimu, in fact, the artisans of the Valle del Moche do not use the potter’s wheel and they bake their pieces in wood-fired ovens built in bricks.

In order to support and improve the local handicraft, the MIPE, in collaboration with the Instituto Italo Latino Americano, carried on the program “Support to the socio-economic development of the region of Chan Chan (Peru) – training courses for ceramists.” The program has produced stages in Italy and two theoretical and practical training courses for the ceramists of the region (Plate 4). The meaning of rehabilitating the traditional ceramic activities is in connection with the needs of the local population which wants to preserve and enhance ancestral practices that are threatened with disappearing (Colosi and Orazi, 2011a, b).

#### **4. Building the StoryMap by means of GIS data**

##### *4.1 The GIS of the Chan Chan archaeological park*

A specific GIS has been implemented to study the wide area of Chan Chan and to provide a plan for the site maintenance. Year after year many surveying campaigns collected a lot of information by means of different surveying techniques: remote sensing, photogrammetry, laser scanning, GPS and other integrated technologies. The interaction between the collected data and the geographic information tools in a multidisciplinary approach has been useful for the study and management of the archaeological complex and its territory. The aerial photogrammetric surveying by Harvard University and the updated Quickbird image has been an important aid to guide the surveying on field and to recognize some archaeological emergencies. The different feature elements have been organized in GIS layers with



**Plate 4.**  
Picture shot at the end  
of the course with the  
participants

---

dedicated attributes. First of all the buffer and the core zones define the boundaries of the archaeological site. The *Caminos* localizes, when it is possible, the ancient paths that connected the town with its territory. The reconstruction of the main and secondary routes is useful to analyze and understand the dynamic of growth of the ancient town. The hard work has been the surveying, by a mobile DGPS, of many archaeological structures characterized by different uses. The list includes: *Huachaques*, *Cementerios* (cemeteries), *Barrios Populares* (popular quarters), *Plataformas* (graves of the sovereign), *Palacios* (palaces), *Residencias Elite* (elite compounds) and *Huacas* (Figure 3). Another opportunity it is the possibility to map on the GIS the site to explore it in virtual way. Some virtual tours were built and showed by hyperlinks too. Them, collected as panoramic images from different strategic point of views and geolocalized have been organized expressly for a pre-visit of the site. The virtual tours have been enhanced adding descriptive report sheets, exploiting the GIS data and displayed selecting the related hotspot (Plate 5). The product has been located in the *Museo de Sitio* giving the better solution for a preview knowledge of the site for the visitors.

#### 4.2 Technical implementation

Even if it is not the main focus of the paper, it is, however, useful for the reader to understand the data structure that stands behind the GIS implementation. Among the years, we set up a workflow ranging from data gathering toward a tidy management system with the aim of providing information for different kind of users (Gabrielli and Malinverni, 2007). To this extent, our efforts have been aimed at:

- (1) defining the database structure and defining the archaeological entities;
- (2) developing a spatial database management system for the collected archaeological data (Geo-DBMS); and
- (3) handling and mapping spatial data into GIS environment.

**Figure 3.**  
General plan of the  
archaeological park  
where the structures  
and their use are  
depicted



**Plate 5.**  
Users experiencing  
the virtual tour  
installed inside the  
museum of the  
archaeological site



For its implementation, a standard ontology model has been followed, as described in Felicetti *et al.* (2013). The model well fits with the Chan Chan case setting and gives a structure to all its entities.

Interested reader can be found more details about this approach even in Pierdicca, Frontoni, Zingaretti, Malinverni, Colosi and Orazi (2015) and Pierdicca, Malinverni, Clini, Mancini, Bozzi and Nespeca (2015). In Figure 4, the RDBS is reported.

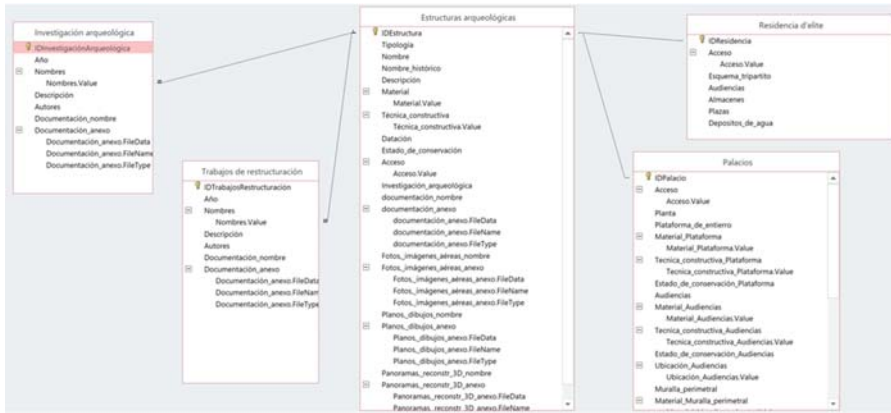


Inside the GIS, the Park planning elements are managed, as the points of control, the green and recreational areas, the cultural routes, the signage and billboards, and the entrances to the monuments.

By means of ArcMap, the geographical data have been managed over time, by exploiting the editing and geoprocessing features of the software.

In order to exploit the metadata, geometries and attributes related to the layers composing the GIS (Figure 5), the standard shape file was used, preserving the following complementary files:

- shx: preserving the geometries indexes.
- shp: preserving the geometries.
- dbf: preserving the attributes database.



**Figure 4.**  
Schematic representation of the conceptual models adopted for the implementation of the RDBS, which represent the backbone of the GIS



**Figure 5.**  
Definition of different layers within the GIS. The data management allows to define the main layers composing the system, organized according to the conceptual model previously described

More data have been exported like the.sbn and.sbx: for spatial indexes and the.prj: for preserving the coordinate systems.

For the implementation of the base map for the Chan Chan StoryMap, we retrieved the folders containing the different layers belonging to the GIS (Figure 6). This work of retrieval of the layers and creation of a new folder is essential to add every layer on the new Web Map, avoiding any loss of information. After this phase, the GIS data can be used for the online platform, as explained in the following.

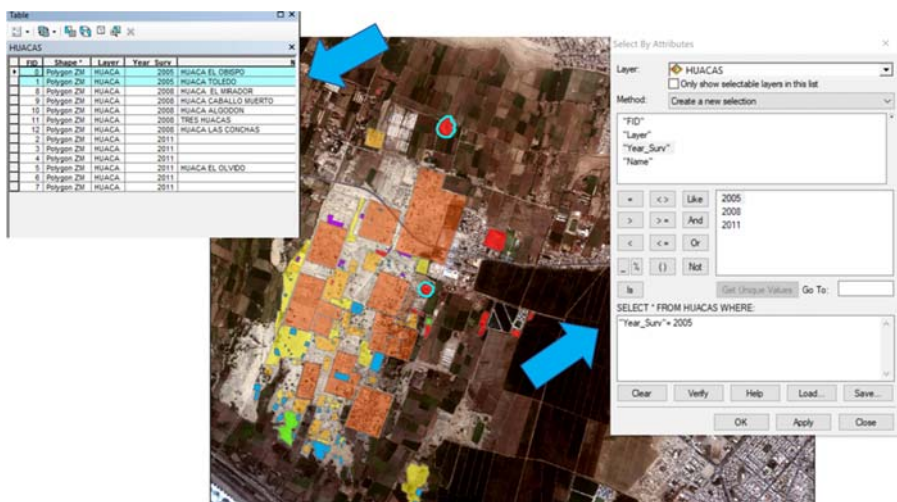
*4.2.1 Creation of the basic web map online.* As partially described above, for what is regarding the local dissemination of the results, MIPE has implemented new communication tools (panoramic tours, AR) within the Museo de Sitio that, going beyond the traditional communication techniques, allow the tourist to obtain a sort of pre-visit the site (Pierdicca *et al.*, 2016a).

In order to reach the international public, a web map that constitutes the base for the StoryMap of Chan Chan has been realized by using ArcGIS Online. The latter is an online web-based platform which allows the users to create, use and share maps, apps, scenes, layers, reports and data.

A GIS-based web map is an interactive graphical representation of a GIS displayed online that can be used to show data and answer queries. The web maps can be used not only to create a StoryMap, but also to be shared via links or embedded in websites. For this purpose, the user should create a public profile in order to share the implemented web solution.

To realize the basic map for the StoryMap of Chan Chan, the Quickbird satellite image has been chosen, which already was the basis of the GIS. The GIS shape files were converted into a readable and quickly web viewable format by Map Viewer of ArcGIS online. In this way, it is possible to visualize the layers of interest in a single screen, according to the needs of the moment (study, elaboration, design, assessment and so on) and to add symbols on the map indicating the position of a structure, an area or any element of interest. By using the potential of the GIS and its features, we can also create visit routes related to the various topics of a StoryMap. In the case of Chan Chan, for example, specific itineraries for sacred structures, palaces, roads, bas-reliefs, etc., could be realized.

For the sake of completeness, it is worth to describe this step. In fact, the original shape file needs to be converted in a specific file format, suitable to be managed online. This



**Figure 6.**  
Query data selection,  
essential phase to  
build the StoryMap

procedure is completely automatic and it is just necessary to upload the single folder, created in advance with the GIS information coming from the source project file (the same used for the implementation of the GIS).

**4.2.2 Map series builder.** Once the basic web map was completed with all the layers coming from the GIS and the notes added on the map, it was possible to proceed with the realization of the StoryMap by using the StoryMap Series Builder of Esri[2].

For building the story, the logical organization follows the various topics related to Chan Chan and the Chimú civilization, showing them through the presentation of the data collected on site and elaborated over time. The projects realized from the MIPE and the archaeological and conservative actions carried on by Ministerio de Cultura have also been described.

By using the software, it was possible to enrich the geographic and scientific data coming from the GIS with text, images, videos and hyperlinks.

## 5. Dissemination of results: some contents of the StoryMap

As stated in the introduction section, the value of the workflow lies on exploiting multi-source and multi-temporal data for dissemination purposes. The GIS developed during the years acts as the backbone of the web-based StoryMap. Given the huge amount of data and the multiple interpretation that one might give to develop narratives about Chan Chan, for the present study the following arguments were included in the platform, chosen in order to disseminate both tangible and intangible heritage information: urban planning, the importance of the sea and religion. This main thread is of paramount importance, since it comes from the knowledge of the bas-reliefs that have been studied and documented from many years.

A first sight of the developed platform is depicted in Figure 7.

### 5.1 The importance of the sea

The city was detached from the sea by damp zones (called *totorales* or *huachaques*) where a typical tilling was cultivated (namely *tatora*) which was (and is still) used to produce fishing boats (par. 2.2). Moreover, Chimú was a population of fisherman, as demonstrated by the representation of the bas-reliefs. Most of these latter cannot be seen by the visitors since they are not visible, lost or not included in the visit path allowed for the archaeological park. The adoption of the developed StoryMap becomes thus paramount to share the information about Chimú's practices and habits. The page related to this topic can be seen in Figure 8.



**Figure 7.**  
The image shows a general overview of the developed platform with all the main sections



5.2 The urban structures and the archaeological park planning

Thanks to the organization of data within the GIS, comprising shape files, entities and attributes georeferenced in a unique reference system, it has been possible to highlight the key aspects of the urban structure (par. 2.1) and take them into account to prepare a plan to preserve and to visit the archaeological park. The inclusion of structured geometric data in the GIS has now the twofold purpose of facilitating the study by experts and, at the same time, to communicate the topic to the interested public.

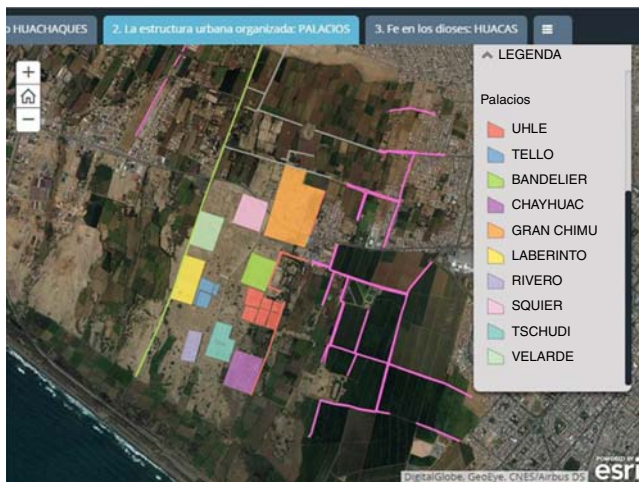
In fact, the possibility to visualize the various features and the related information provides a clearer and more complete view of the archaeological area that, for its vastness and the state of conservation of the structures, is not easy to understand through the touristic visit.

Furthermore, in this way the StoryMap can be useful to illustrate and narrate the development of the Chimu society in space and time. A focus of this aspects is reported in Figure 9.

**Figure 8.**  
In this section the topic of the importance of the sea is treated, with particular focus on the urban areas devoted to the production of totora and the fishing boats



**Figure 9.**  
The visualization of the GIS data in the interactive map and the related contents is here fundamental to understand the urban structure of the archaeological park



### 5.3 *Huacas: faith and gods*

The last topic was the typology of building that Chimú used to celebrate the divinity, the *huacas*. During the years, some of these priceless buildings have been surveyed and virtually reconstructed by the MIPE. However, given the complexity of the models and/or other infrastructural limitations, they have not been exploited for communication purposes. On the StoryMap of Chan Chan, two points have been added referring to huaca Arco Iris and huaca Esmeralda that are located outside of the archaeological area. For these two monuments, the respective monographs have been created, in simple and synthetic description, such as to be included in an international database. A URL link has been created to connect the cards to the points in the web map. The StoryMap includes these reconstructions and all the information related to the *huacas*, as briefly showed in Figure 10 (Pierdicca *et al.*, 2016b; Pierdicca, Malinverni, Frontoni, Colosi and Orazi, 2016).

The presented data are the result of scientific purposes and 3D models that, through the StoryMap, tell the *huacas* in their spatial and decorative evolution, so that the user can perceive the sacred nature of these buildings.

## 6. Conclusions and future perspectives

The research work described in this paper represents another important milestone for the enhancement of Chan Chan and for the population historically and culturally depending on it. The adoption of management and communication strategies related to wide archaeological areas represents the best solution for a sustainable safeguard of cultural resources. This has been proved by several studies related to the digitization of Cultural Heritage sites that their conservation is entrusted on innovative and cost effective tools for a systematic data collection, management and updating.

The recent literature stresses the concept of open access and open data as the main driven to overcome the problem of accessibility in archaeology (Kansa and Kansa, 2014). However, as stated in Kansa (2012), movements do not gloss over sustainability, quality and professional incentive concerns. Rather, these reform movements offer much needed and trenchant critiques of the academy's many dysfunctions. These dysfunctions, ranging from the expectations of tenure and review committees to the structure of the academic publishing industry, go largely unknown and unremarked by most archaeologists.

The answer to this challenging process is represented by an innovative use of the GIS since it can be used to manage large data sets for developing sustainable management plans and to undertake decision-making strategies. Whether some works move toward this direction (Previtali and Valente, 2019), applications in archaeology are very limited (Pica *et al.*, 2019).

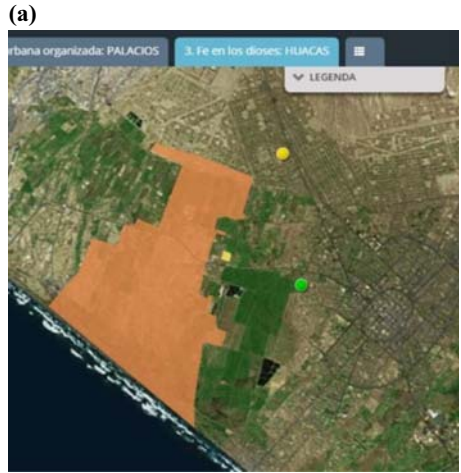
Although this process requires costly and time consuming procedures, especially for large areas, using GIS allows, as showed by the StoryMap tool developed[3], to preserve the information and, at the same time, to disseminate it. In fact, digital StoryMap has the advantage of being quick to be implemented (even by non-expert users), easy to maintain and perfect for explaining a project, though very complex in terms of dimension and data heterogeneity.

Adding new features will be easy as well, since the backbone of the system is structured starting from a well-established data management system.

The StoryMap, therefore, is an effective tool to spread the knowledge of a wide archaeological complex which presents many features of authenticity and integrity of universal value. In the StoryMap, data of different nature are collected in a single reference system and can be viewed at different scales of representation and analysis.

Moreover, within the StoryMap there is not only space for the material cultural heritage, but also for the rich intangible heritage that, in the case of Chan Chan, is still alive in the economy and culture of the population.

Albeit the proposed methodology is promising, it is even fair to highlight some drawbacks that we foresee to overcome in the future development of the MIPE project.



**Figure 10.**  
Geolocalization of the main religious buildings. 15a depicts the GIS data overlapped to the map; 15b reports a descriptive sheet with detailed information

First of all, the solution offered by ESRI is a commercial one; this means that is user friendly, at the expenses of costs, which are quite high and not affordable for a possible generalization of the method for archaeological areas, where the low budget is a common issue. The only way

to personalize the platform is to buy a professional license and get the source code of the web solution; this might allow one to create multi-user access (for instance common user and expert). Up to now, this possibility has not been explored.

Moreover, multimedia data like images, sheets and/or virtual tours have been added as external link, since the restrictions of the trial version do not allow to manipulate the source code. This is another aspect that will be investigated in the future, in order to merge GIS data with other resources. Finally, the site was developed by using the local language; future implementations will consider to develop a multilanguage solution (which is nowadays a state of art possibility offered by the web), for making the platform sharable at a world-wide scale.

In conclusion, the StoryMap becomes a proper instrument for the enhancement of the immaterial heritage and a possible process to keep alive its memory. Moreover, this instrument can be an useful didactic tool to spread through children and young students the consciousness of their cultural heritage. In this way, the StoryMap is a further help for the management of the Park, for the monitoring of the monuments, for the dissemination of knowledge. The long-term goal is that Chan Chan and its intangible heritage could become elements of development, creation of work and cultural liveliness for the territory.

### Acknowledgments

On the occasion of this paper which contributes decisively to the knowledge of Chan Chan and to the diffusion of the work of the Italian Mission in Peru, it is obligatory to thank the institutions and the people who have made this work possible. Therefore, the authors would like to thank the Ministerio de Cultura and in particular Dr ra Ana Maria Hoyle Montalva, the ITABC and the colleagues who took part in the studies and the Università Politecnica delle Marche. A special thanks goes to Simone Mazzieri who carried out the data organization work as part of his thesis. The work was made possible thanks to the contribution of the MAECI.

### Notes

1. <https://blogs.esri.com/esri/esri-insider/2011/12/16/telling-stories-with-maps/>
2. <https://storymaps.arcgis.com/en/app-list/>
3. [www.arcgis.com/apps/MapSeries/index.html?appid=b626dd2e372d4db291ac91e82b248584](http://www.arcgis.com/apps/MapSeries/index.html?appid=b626dd2e372d4db291ac91e82b248584)

### References

- Brouillard, J., Loucopoulos, C. and Dierickx, B. (2015), "Digital storytelling and cultural heritage: stakes and opportunities", Report of AthenaPlus WP5 "Creative applications for the reuse of cultural resources", Officine grafiche Tiburtine, Roma, available at: [www.athenaplus.eu/index.php?en/169/publications](http://www.athenaplus.eu/index.php?en/169/publications)
- Brovelli, M.A. and Magni, D. (2003), "An archaeological web GIS application based on mapserver and PostGIS", *International Archives of Photogrammetry Remote Sensing and Spatial Information Sciences*, Vol. 34 Nos 5/W12, pp. 89-94.
- Bruner, J. (1991), "The narrative construction of reality", *Critical Inquiry*, Vol. 18 No. 1, pp. 1-21.
- Campana Delgrado, C. (2006), *Estudio de la ciudad de adobe mas grande de America latina*, Editorial Orus, Lima.
- Caquard, S. (2013), "Mapping narrative cartography", *Progress in Human Geography*, Vol. 37 No. 1, pp. 135-144.
- Caspani, S., Brumana, R., Oreni, D. and Previtali, M. (2017), "Virtual Museums as digital storytellers for dissemination of built environment: possible narratives and outlooks for appealing and rich encounters with the past", *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 2017 (26th International CIPA Symposium, Vol. XLII-2/W5, August 28-September 1, Ottawa)*, Vol. 42 Nos 2W/5, pp. 113-119.

- Colosi, F. and Orazi, R. (2011a), "Studi e progetti per la creazione del Parco Archeologico di Chan Chan", *Thule. Rivista italiana di studi americanistici*, Nos 30/31, aprile-ottobre 2010-2011, a cura di Carolina Orsini e Sofia Venturoli, Centro Studi Americanistici "Circolo Amerindiano" Onlus, Perugia, pp. 139-172.
- Colosi, F. and Orazi, R. (2011b), *Valorización del Complejo Arqueológico de Chan Chan y desarrollo socioeconómico de su territorio*, (Cuadernos IILA, Serie Cooperación 47), Stampa3, Roma.
- Colosi, F. and Orazi, R. (2015), "Project for the archaeological park of Chan Chan, Peru", in Gabardella, C. (Ed.), *Heritage and Technology. Mind, Knowledge, Experience, Le vie dei Mercanti. XIII Forum Internazionale di Studi*, Capri, Aversa, pp. 2031-2040.
- Colosi, F., Gabrielli, R., Malinverni, E.S. and Orazi, R. (2013), "Discovering Chan Chan: modern technologies for urban and architectural analysis", *Archeologia e calcolatori*, Vol. 24, pp. 187-207.
- Colosi, F., Fangi, G., Gabrielli, R., Orazi, R., Angelini, A. and Bozzi, C.A. (2009), "Planning the archaeological park of Chan Chan (Peru) by means of satellite images, GIS and photogrammetry", *Journal of Cultural Heritage*, Vol. 10 No. S1, pp. e27-e34.
- Felicetti, A., Scarselli, T., Mancinelli, M. and Niccolucci, F. (2013), "Mapping ICCD archaeological data to CIDOC-CRM: the RA schema", *Proceedings of the 17th International Conference on Theory and Practice of Digital Libraries (TPDL 2013)*, Valetta, Malta, 26 September.
- Finlayson, M.A., Gervas, P., Mueller, E., Narayanan, S. and Winston, P.H. (2010), "Preface: computational models of narrative", in Finlayson, M. (Ed.), *Papers from the AAAI Fall Symposium*, AAAI Press, Menlo Park, CA, pp. 7-8.
- Gabrielli, M. and Malinverni, E.S. (2007), "Multimedia database for the heritage information system of the Ancyra project", XXI CIPA International Symposium "Anticipating the Future of the Cultural Past", Athens, October 1-6, pp. 323-417.
- Giaccardi, E. and Fogli, D. (2008), "Affective geographies: toward a richer cartographic semantics for the geospatial web", *Proceedings of the Working Conference on Advanced Visual Interfaces, Napoli*, pp. 173-180.
- Hazel, P. (2008), "Narrative and new media", *Proceeding of the 5th International Narrative in Interactive Learning Environments Conference, Heriot Watt University, Edinburgh, August 6-8*, p. 40.
- Kansa, E. (2012), "Openness and archaeology's information ecosystem", *World Archaeology*, Vol. 44 No. 4, pp. 498-520.
- Kansa, S.W. and Kansa, E. (2014), "Data publishing and archaeology's information ecosystem", *Near Eastern Archaeology*, Vol. 77 No. 3, pp. 223-227.
- Klymyshyn Uliana, A.M. (1982), "Elite compounds in Chan Chan", in Mosely, M. and Day, K.C. (Eds), *Chan Chan, Andean Desert City*, University of New Mexico Press, Albuquerque, NM, pp. 119-143.
- Kolata, A.L. (1982), "Chronology and settlement growth at Chan Chan", in Mosely, M. and Day, K.C. (Eds), *Chan Chan, Andean Desert City*, University of New Mexico Press, Albuquerque, NM, pp. 67-84.
- Lavallée, D. and Lumbreras, L.G. (1986), *L'america precolombiana, le Ande, dalla preistoria agli Incas*, Rizzoli Editore, Milano.
- Malinverni, E.S., Pierdicca, R., Colosi, F. and Orazi, R. (2017), "Web tool as a virtual museum of ancient archaeological Ruins in Peru", in De Paolis, L., Bourdot, P. and Mongelli, A. (Eds), *Augmented Reality, Virtual Reality, and Computer Graphics*, Lecture Notes in Computer Science, Vol. 10325, Springer, Cham, pp. 282-296.
- Meskill, L. (2012), "The rush to inscribe: reflections on the 35th session of the world heritage committee, UNESCO Paris, 2011", *Journal of Field Archaeology*, Vol. 37 No. 2, pp. 145-151.
- Paolini, P. and Di Blas, N. (2014), "Storytelling for cultural heritage", in Contin, A., Paolini, P. and Salerno, R. (Eds), *Innovative Technologies in Urban Mapping*, Springer, Cham, pp. 33-45.
- Pica, V., Cecili, A., Annicchiarico, S. and Volkova, E. (2019), "The historical small smart city protocol (HISMACITY): toward an intelligent tool using geo big data for the sustainable management of minor historical assets", *Data*, Vol. 4 No. 1, available at: <https://mdpi.com/2306-5729/4/1/30>

- Pierdicca, R., Frontoni, E., Malinverni, E.S., Colosi, F. and Orazi, R. (2016a), "Esquina multimedia: museum exhibition for the visualization of Chan Chan archaeological site", in Lerma, J.L. and Cabrelles, L. (Eds), *Arqueológica 2.0. Proceedings of 8th International Congress on Archeology, Computer Graphics, Cultural Heritage and Innovation*, València, pp. 274-277.
- Pierdicca, R., Frontoni, E., Malinverni, E.S., Colosi, F. and Orazi, R. (2016b), "Virtual reconstruction of archaeological heritage using a combination of photogrammetric techniques: Huaca Arco Iris, Chan Chan, Peru", *Digital Applications in Archaeology and Cultural Heritage*, Vol. 3 No. 3, pp. 80-90.
- Pierdicca, R., Malinverni, E.S., Frontoni, E., Colosi, F. and Orazi, R. (2016), "3D visualization tools to explore ancient architecture in South America", *Virtual Archeology Review*, Vol. 7 No. 15, pp. 44-53.
- Pierdicca, R., Frontoni, E., Zingaretti, P., Malinverni, E.S., Colosi, F. and Orazi, R. (2015), "Making visible the invisible: augmented reality visualization for 3D reconstructions of archaeological sites", in De Paolis, L.M. and Mongelli, A. (Eds), *Augmented and Virtual Reality*, Lecture Notes in Computer Science, Vol. 9254, Springer, Berlin, pp. 25-37.
- Pierdicca, R., Malinverni, E.S., Clini, P., Mancini, A., Bozzi, C.A. and Nespeca, R. (2015), "Development of a GIS environment for archaeological multipurpose applications: the Fano historic centre", *XIII International Forum Le Vie dei Mercanti*, pp. 588-597.
- Poulot, D. (2015), "Is the invention of memories necessary to identities?", Report of CulturalBase project for AXIS 1, Cultural memory, TF2, Memory and identities, available at: <http://culturalbase.eu/documents/2>
- Previtali, M. and Valente, R. (2019), "Archaeological documentation and data sharing: digital surveying and open data approach applied to archaeological fieldworks", *Virtual Archaeology Review*, Vol. 10 No. 20, pp. 17-27.
- Prinz, T., Walter, S., Wieghardt, A., Karberg, T. and Schreiber, T. (2014), "GeoArchaeology Web 2.0: geospatial information services facilitate new concepts of web-based data visualization strategies in archaeology – two case studies from surveys in Sudan (Wadi) and Turkey (Doliche)", *Archaeological Discovery*, Vol. 2 No. 4, pp. 91-106.
- Shah, K. (2016), "Creation of cultural heritage inventories: case of the historic city of Ahmadabad", *Journal of Cultural Heritage Management and Sustainable Development*, Vol. 6 No. 2, pp. 166-194.
- Silvaggi, A. and Braga, P. (2013), "Description of a digital Storytelling workshop in a museum context", in Da Milano, C. and Falchetti, E. (Eds), *Digital Storytelling an Inclusive Scientific Museum: A European Project*, Vetrani Editore, Nepi, pp. 49-55.
- Topic, J.R. (1982), "Lower-class social and economic organization at Chan Chan", in Mosely, M. and Day, K.C. (Eds), *Chan Chan, Andean Desert City*, University of New Mexico Press, Albuquerque, NM, pp. 146-175.
- von Schwerin, J., Richards-Rissetto, H., Remondino, F., Agugiaro, G. and Girardi, G. (2013), "The MayaArch3D project: a 3D WebGIS for analyzing ancient architecture and landscapes", *Literary and Linguistic Computing*, Vol. 28 No. 4, pp. 736-753.
- Wheatley, D. and Gillings, M. (2002), *Spatial Technology and Archaeology*, Taylor & Francis, New York, NY.

### Further reading

- Çakici Alp, S. and Şahin Güçhan, N. (2017), "Challenges in use of geographical information systems (GIS) in a research for understanding conservation of cultural heritage in Bursa", *Journal of Cultural Heritage Management and Sustainable Development*, Vol. 7 No. 3, pp. 328-344.

### Corresponding author

Roberto Pierdicca can be contacted at: [r.pierdicca@staff.univpm.it](mailto:r.pierdicca@staff.univpm.it)

For instructions on how to order reprints of this article, please visit our website:

[www.emeraldgrouppublishing.com/licensing/reprints.htm](http://www.emeraldgrouppublishing.com/licensing/reprints.htm)

Or contact us for further details: [permissions@emeraldinsight.com](mailto:permissions@emeraldinsight.com)