Archeologia e Calcolatori
28.2, 2017, 539-548

OPEN HISTORY MAP

1. What is OHM

OpenHistoryMap is a web mapping tool (http://www.openhistorymap.org). The management is done by a non-profit association (Italian APS) set up in Bologna by the authors.

The project started gaining traction in 2015 with a first public presentation at DH15 in Granada, Spain (Montanari *et al.* 2015).

Technically, OHM is a web-GIS platform containing spatial archeological and historical data.

In the general trend of sharing data[1] in the web the GIS technology is a well-known practice. Public administrations are already arranging data in GIS to satisfy certain requirements (e.g. the Italian experience of Raptor and Sitar: Frassine, Naponiello 2012; Serlorenzi *et al.* 2012); on the other hand, scholars and research groups store and share data through variously-licensed data in web-GIS (e.g. Cirelli 2016), although EU-level regulations would require the sharing to happen in an Open Access manner (Mooney *et al.* in press). However, this is still an exception among the common uses of geolocalized data.

Most of the people look for and share online geolocalized information to accomplish common tasks, as anyone of us do whenever using platforms like GoogleMaps. As GoogleMaps, or any kind of similar web based service, provides for a topographical representation of the present, OHM is thought to display the topography of ancient times. To achieve this ambitious goal, we think that a global approach is the most indicated. Therefore, we are setting up a flexible and adaptable platform in order to collect data from all different kinds of archaeologies.

OHM's experience strictly depends on its community. This community is going to be composed of specialists, of course, but also of common users. These two categories will have both the possibility to implement data on the system as the OpenStreetMap (OSM) reality has shown as best practice (Haklay, Weber 2008).

The main and possibly most radical difference from OSM is the fact that the stored information will be classified based on its reliability and it will be possible to filter it according to the user's needs.

[1] The potential scale of the data collection process requires the definition of the dataset to be strict and well thought in order to elaborate data in a sensed and most importantly coherent manner.

OHM aims at the enhancement of data usability, dissemination and education in a complex world, as the one of archaeological research.

OHM is a open source project that uses open source tools and enhances the standard OSM infrastructure pipeline.

Currently, the project has grown, but it is still at its evolutional stages so it could possibly change, get better and be integrated.

2. Inputs

The OHM Project starts from a very specific set of assumptions regarding the complexity of academic archaeological research.

These assumptions start from the definition of physical evidence (anthropic or not) in the territory. These physical elements have to be interpreted in a structured manner through research driven interpretations. These interpretations are bound to the complex structure of academic research or of any kind of research or documentation. This research has to be, in the end, traceable.

These are the basic assumptions that generate the complex structure of the ontology defined in OHM. And these assumptions rely on the two-faced aspects of the historic and archaeological world, one of physical evidence and one of speculation. This latter part is the basis for the definition of the research ontology, while the physical evidence is the part covered with the OHM infrastructure.

In OHM, the data loading process is delegated to the user community, but can easily done by the administrators. This opportunity is granted in order to manage big datasets published in common geospatial formats by organizations, associations, researchers. The data can be inserted directly by the user through an on-line editor (a modified ID Editor adapted from the OSM platform).

With the digitization of the plan, the user will be able to complete the data with information about the added objects, such as the dating or the materials, using the extremely flexible OSM tagging system. The user will need to indicate the source the object has been digitized from, choosing from a predefined set of choices (oral, topographic, archival, bibliographic).

2.1 *Digitizing data*

Users can digitize data using polygons, lines and points. Everything physical, that occupies a space, needs to be represented as a polygon. Lines and points, instead, serve to indicate logical information. The difference between a polygon and a line or a point represents the differentiation between archaeological and historical documentation. The first one refers to excavated or physical documented evidence, whereas the second ones represent context interpretation, connections, events, not visible on the ground. To exemplify, we can say that street's stones must be digitized as polygons, the road as a whole as a polygon, while the viary route itself (e.g. the ones drawn in *Itineraria* like the *Tabula Peutingeriana*) must be represented by a line.

As by assumptions, the first and possibly most important aspect is the physical one. On this aspect, we are relying on the ID Editor (https://github.com/openstreetmap/iD), giving us enormous freedom on the practical digitization aspects, and on the Mapnik (http://mapnik.org/) tile renderer, giving us freedom on the rendering aspect.

The data collected and digitized can be of any level of detail, from an ancient city block to the single stone composing a wall or a road.

This detail level becomes relevant in the moment we are rendering, because specific zoom levels will hide or show detail levels giving the user a better and faster overview of the part of world he is looking at.

In the following table, there are some examples of geometric features:

POINT	Historical event	Es. Battle of Salamis
	Historical node	Es. Commercial port in a commercial network, production site, etc.
LINE	Routing graph	Es. Commercial routes, canalization, waterways, migration routes, battle maneuver, etc.
POLYGON	Archaeological data	Es. Buildings, roads, artifacts, etc.
	Landscape archaeology data	Es. Ancient land uses, paleotopography, etc.

Tab. 1 – OHM geometric feature classes with examples.

2.2 *Filling in attributes*

OHM collects any kind of information, helping in the structuring operation by giving simple templates to start with (the OSM base enables the addition of any kind of attribute, even if not standard for a template).

An example template of an event can be defined as follows:

Type	Content
Event	Battle
name:it	Battaglia di Salamina
wiki:it	https://it.wikipedia.org/wiki/Battaglia_di_Salamina
name:en	Battle of Salamis
wiki:en	https://en.wikipedia.org/wiki/Battle_of_Salamis

Tab. 2 – Example template of an event.

As pointed before, it's not possible to add an element without specifying the source. Before the finalization of a digitization, every drawn element must be correlated to a "relation" feature. In an OSM environment this is typically used, for example, to describe a bus line where every element of the route (timetable, stops, itinerary) is bound to one another by the relation tagged with type=route and route=bus and, finally name=<route_name>.

In the same way in OHM, the relation feature is needed to, first of all, validate the data as well as to specify the source, which naturally contains interpretation and chronological context.

The validity of the element depends on the meta-ontology aspects giving an interpretation of an element and an interpretative framework for the single event or element. Specifically, the contextualization is built creating a relation with the following elements:

Type	Content
research	Temporal
valid:start	-480/09/23
valid:end	-480/09/23
reliability	bibliographic:educational
source	https://en.wikipedia.org/wiki/Battle_of_Salamis

Tab. 3 – Example of a bibliographical relation feature.

Fig. 1 – Render of structures represented only by their perimeter in the case study of Marzabotto: House 1, *Regio* IV, *insula* 2 and its surroundings (after Govi 2010).

The templates are built in a different way depending on the element. As for the polygons, the differentiation is based on the detail level of the drawing.

When digitizing structures represented only by their perimeter (e.g. a topographical map of a region), the user can take advantage of a standard template as seen before for the event example; in this case the inserted data will be shown from zoom level 17 and beyond (Fig. 1).

Fig. 2 – Schematic render of structures of Marzabotto's House 1, *Regio* IV, *insula* 2 (after Govi 2010).

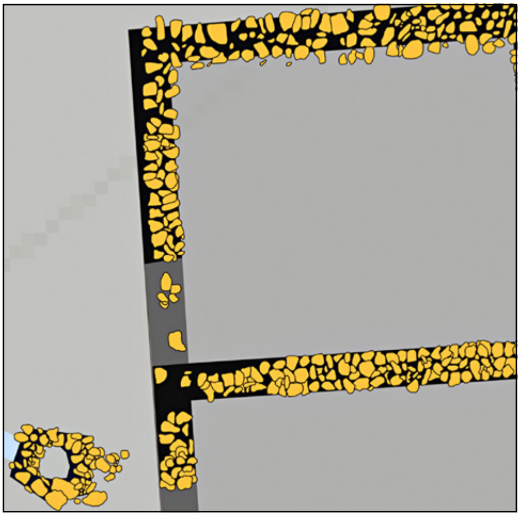

Fig. 3 – Render at detailed level of zoom showing the well and a portion of walls of Marzabotto's House 1, Building 2, Sectors X-XI (after Govi 2010).

When dealing with a schematic archeological map (e.g. a map showing wall's outline and other architectural details), a more detailed template can be used and it could possibly contain the specific elements as shown below:

STRUCTURAL ELEMENTS	INFRASTRUCTURAL ELEMENTS	NON STRUCTURAL ELEMENTS
wall	road	door
column	drainage	well
roof	aqueduct	kiln
…	…	…

Tab. 4 – Some templates describing schematic data.

All this kind of data will be rendered from zoom level 18 to 19 (Fig. 2).

A detailed archaeological map can be used to draw specifical items, from wall bricks/stones to mosaic tiles. In this case the template content will include detail on material:

STRUCTURAL MATERIALS	BINDING/ISOLATING MATERIALS	NON STRUCTURAL MATERIALS
Stone	bitumen	stone
Brick	cement	earth
Timber	clay	clay
Metal	plaster	metal
…	…	…

Tab. 5 – Some templates describing detailed data.

These data will be rendered from zoom level 20 to 25 (Fig. 3).

2.3 *Source reliability*

Sources reliability concerns planimetric and positioning accuracy of data. Sources are classified according to their verifiability, defining four main types (*Direct sources; Survey sources; Archival sources; Bibliographical sources*), each divided into two sub-categories (a, b).

1. *Direct Sources*. Direct sources include inserted objects without any bibliographic reference. They have the lowest degree of reliability and are divided into:
   - 1a. Oral sources: they refer to everything digitized in the system starting from information known only by hearsay;
   - 1b. Mnemonic sources: they concern everything that is drawn by memory without referring to any specific source. For example, the user is entering data just because he remembers to have seen it somewhere.

2. *Survey Sources*. Survey sources include graphical representations detected directly by the user. They are more reliable than *Direct Sources* and are divided into:
   - 2a. Direct drawing sources: they comprise scale objects drawn through the trilateration/triangulation or using a Cartesian system;
   - 2b. Instrumental mapping sources: they comprise objects mapped through land survey with instruments like total station, GPS, laser scanner or through photogrammetry, etc.

3. *Archival sources*. Archival sources include objects extracted from digital or paper archives, that are not yet published in a critical edition. Epigraphs and the cadastre also belong to this category. For example, the latter can inform on the plan of a medieval castle in the architectural phase of current conservation.

3a. Catalogue sources: they come from paper archives;

3b. Digital archives: they comprise digital data.

4. *Bibliographical Sources*. Bibliographical sources include monographs, articles and all that is published. This type of source has been differentiated according to the kind of users it addresses to:

4a. Educational sources: they consist in texts concerning history or archaeology written for an audience of connoisseurs or for not expert people;

4b. Academic sources: they include texts written by academics to share their studies with the scientific community. This is the source with the highest degree of reliability.

Although sources reliability also concerns positioning accuracy of data, the classification criteria of the sources do not guarantee that the positioning taken by a superior source is more correct than another taken from another one of lower level. For example, a land survey through Global Navigation Satellite System (GNSS) survey has many chances of being more correct than a drawing made in the field in the 1920s. If the GNSS plan would be published somewhere, then the data can be moved from level 2 to level 4 (in the right subcategory), otherwise it will remain between the survey sources. Higher levels of reliability mean a better critical review of the data and the opportunity of reviewing them, increasing the accuracy.

However, the feature visibility in the map is controlled by users, who can independently decide what to display to suit their needs. For example, a scholar would only toggle visibility on *Bibliographical Sources* to academic purposes; on the contrary, a common user would like to have a more general, maybe not specialistic, point of view.

3. Tools

3.1 *Technology*

From a technological point of view, the platform is based on the OSM technological stack, redefining the elements that are characteristic for OHM. Specifically, the elements that required customization are the following: ID Editor, from the OSM stack (Jacob, Winstanley 2010); the tile render; and navigation in general from the general-purpose GIS stack. This customization is required by the structure of the information to be managed, that is no longer directly "defined" but more "interpreted", i.e. we are no longer talking strictly about the street graph and "highways", but about "street surface" (as areas that can be used as streets) and "road networks" to define the graph between the elements to get from a point to another on the map. This distinction, very important for OHM, is one of the main distinguishers between the OHM Ontology and the OSM Ontology.

The answer to this distinction is evident in all the elements before mentioned. The advantage of the usage of a stable OSM Application Programming Interface (API) is incredible, enabling users to interact with complex historical data in a simple manner and most importantly to interact with such data with established and well documented community tools, such as Nominatim, Overpass API, JOSM, OSMOSIS.

The impact is on the origin communities as well, considering we are returning generalizations of the code and of the tools in code. Specifically, for ID Editor, for example, we are defining a set of tools and APIs to generate personalized and easily customizable presets for specific space/time configurations, in order to help users, edit data in a contextually sound manner.

1. *ID Editor:* the Editor needs to be redefined according to time-driven ontologies coherent with the meta-level definition of infrastructures that enable the harmonization of them according to the timeframe analyzed or described. Additionally, the ID Editor adds the cross-timeframe definitions for sub-research level detailed meta-information. Both png and vector tiles are usually bound to pure cartographic and attribute filters. The addition of timeline elements (validity start and end attributes for single elements) are crucial in the filtering and generation. The co-location on different time periods is not easily managed in the default rendering pipeline. For an easier navigation, the choice needs to go towards either transparent pngs or vector tiles with high alpha backgrounds. The first solution is defined *a priori* while the second one can be re-defined at runtime.
2. *Mapnik:* for Mapnik, on the other hand, we are defining rendering setups for the time aspect of the datasets in order to enable a 4-dimensional render of the datasets.

In addition to these tools we try to contribute to, there are new elements that should help us define our specific information pipeline: Tiler, ARDb and Time Traveler Toolbar.

1. *Tiler:* Tiler is a Tile server and Tile map server generator to digitize raster maps and easily transform GeoTIFF into usable geographic TelePresence Management Suite (TMS) endpoints with an intelligent URL-generation algorithm and a resolution-based zoom-management system. The tiles are pre-generated and stored in an easily manageable folder to be backed up and managed. The system integrates with a configurable ID Editor endpoint and generates a usable URL to start digitizing immediately. It also analyzes a set of feature of the tiff file.

2. *ARDr.info:* ARDb (Archaeological Research Database) is an archaeological and historical source database, to which OHM platform relates when digitizing an element that requires bibliographical (4b. Academic) source. When a relation feature is built in OHM, the system refers to ARDb to gain bibliographical reference. If the source the users are looking for is not already present, it's possible to create a new bibliographical record directly from OHM in ARDb. ARDb is a platform to reach into the OHM database, extract and expose data about the researchers and the digitized maps and information related to the maps and researches. Therefore, the correlation between OHM and ARDb gives the possibility to visualize and query a detailed map of the Research itself.
3. *Time Travel Toolbar:* as with rendering, the issue with navigation is the kind of navigation required. The classic navigation has a very simple two-dimensional approach. Adding time dimension points out to another issue. How can time be represented, beside a specific timepoint? The first possibility is to focus on a specific time lapse, and then navigate through time, being able to loose at the changes that a choosen area went through (diachronic mode). Alternatively, you can visualize the area and different time phases all at once in a synchronic mode, using specific renderings to define the phases. TimeTravelToolbar is a JavaScript control built around LeafletJS to enable time dimension movement, considering the many interpretative groupings around a specific time/space crossing.

4. Conclusions and future work

Carrying on this project, there are some difficulties to face. Possibly, the most important is the lack of data standardization; "schools of archaeology" have different ways of managing and storing data. The flat OSM tagging system has proven very suitable to receive different input from very different sources, using the relations to create meta-level information connections. The definition of new tags, heritage of the OSM platform, is easy and becomes a core element in an always changing re-interpretation of the past, enabling researchers to enhance the expressiveness of the whole system.

This same flexibility generates an additional set of opportunities, giving the research groups the ability to prepare and define straight-to-digital documentation instead of paper-driven documentation.

Of course, in order to achieve a systematic data cover, OHM would benefit the collaboration of as many research groups as possible, sharing their digital data for mapping and their interpretation for historical research.

OHM team's purpose is therefore to work on this two perspectives: the further developing of the OHM platform and the dissemination of the system towards different kinds of research groups, different kinds of archaeological approaches, different kinds of scientific traditions. In other words, to build a community.

Acknowledgements
The OpenHistoryMap team would like to thank the Organization Committee of *KAINUA* 2017 International Conference, in particular Prof. Elisabetta Govi, Dr. Andrea Gaucci, and all Marzabotto's research team for kindly giving us the possibility to test our platform with Marzabotto digital data. A special thanks to Dr. Alice Costantino for the editing support.

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REFERENCES

Cirelli E. 2016, *Applicazioni GIS all'archeologia urbana: il caso di Ravenna*, «Archeologia e Calcolatori», 27, 209-226.

Frassine M., Naponiello G. 2012, *RAPTOR: archeologia e tutela. Verso la pubblica amministrazione digitale*, «Archeologia e Calcolatori», 23, 81-99.

Govi E. 2010, *L'analisi planimetrica e la ricostruzione delle fasi edilizie*, in E. Govi, G. Sassatelli (eds.), *Marzabotto. La Casa 1 della* Regio *IV,* Insula 2, 1. *Lo scavo*, Bologna, Ante Quem, 179-203.

Haklay M., Weber P. 2008, *OpenStreetMap: User-Generated Street Maps*, «IEEE Pervasive Computing», 7, 12-18.

Jacob R., Winstanley A.C. 2010, *My town, my map*, «Milieu 2010: Maynooth Geography Society Journal», 33rd Edition, 42-44.

Montanari M., Trojanis R., Bernardoni S., Tepedino L. 2015, *Open History Map - A New approach to open access for archaeology and cultural heritage*, in G. Guidi, R. Scopigno, J.C. Torres, H. Graf (eds.), *2015 Digital Heritage. Proceedings of the 2015 Digital Heritage International Congress (Granada 2015)*, 2, IEEE, 479-480.

Mooney P., Ciepluch P., Jacob R., Corcoran P. in press, *Open research: Working with open software and open data in academic-based gis research*, in *Proceedings of the 3rd Open Source GIS Conference (OSGIS) (Nottingham 2011)* (Abstract: http://www.cs.nuim.ie/~pmooney/websitePapers/OSGIS2011_ABSTRACT-Mooney-et-al-Submitted-April2011.pdf; accessed: 31/03/2017).

Serlorenzi M., Lamonaca F., Picciola S., Cordone C. 2012, *Il sistema informativo territoriale archeologico di Roma: SITAR*, «Archeologia e Calcolatori», 23, 31-50.

ABSTRACT

OpenHistoryMap aspires to become the open source geographical system for archaeological information, both from an academic and an educational point of view. There are many fragmented online web-GIS experiences targeted at very specific projects, but no tool enables a broader overview of both research and studies. For these reasons, in order to create an Open Access platform, one of the most important aspects is the creation of tools that can facilitate both the sharing of archaeological spatial and temporal information as well as the easy reuse of the generated data. OpenHistoryMap is supposed to create a tool that is both a map of the archaeological world as well as a repository for the connected data within structured research papers. The project finds its roots first of all within the collective experience of "archaeology" that refers to non-expert users, and in the second place within the academic scientific experience of research centres and universities. While the first approach gives an integrated and reliable picture of the cultural item, the second provides consistent and solid datasets with a perspective on the mixture of specific types of information.