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BACKWARD ENGINEERING HISTORICAL MAPS: THE UPDATE OF THE OPEN HYDROGRAPHY DATASET OF NAPOLEONIC CARTOGRAPHY

1. Introduction

This article is the natural continuation of other publications issued in the context of the research activities of the LAD: Laboratory of Digital Archaeology at Sapienza concerning the *Carte topographique de l'Égypte* edited by Pierre Jacotin (Jacotin 1818; Godlewska 1988), in the context of the French Campaign in Egypt and Syria under the command of Napoleon Bonaparte, at the turn of the 18th and 19th centuries. The LAD was established in 2021 at Sapienza University of Rome to collect several research projects sharing a strong interest in the application and development of digital tools and methods to the archaeological domain. A particular attention is paid to the application of network and web technologies to the management, analysis and dissemination of the archaeological data and processes in an open and collaborative way. Following the directions traced by the Open Science directives, LAD fosters the adoption of open software, hardware and methodologies in the daily archaeological practice, the creation and sharing and publication of open archaeological data. Specific software tools have been created and made available to the community to reach this end (Bogdani 2022a) and a continuous effort is spent toward a greater awareness of younger scholars and colleagues through practical laboratories dedicated to Archaeological Information Systems and Databases, GIS platforms and new formats, standards, and technologies for the publication of the archaeological record.

One of the LAD's projects was the digitisation of the Napoleonic map of Egypt, an activity that started in 2019 and that was accelerated by the outbreak of the Covid pandemic that put a harsh stop to the other field activities. The methodological aspects of the georeferencing process have already been published in 2019 (D'Erasmo 2019, 1-9). More recently, the orthorectified map has been published as an open access tiled web map service (Bogdani 2022b) and the same is true for rich vector datasets that have been acquired from the document with a very patient digitising work (Bogdani *et al.* 2022). The resulting data set has been published as open access on the Zenodo repository (Bogdani 2022c), and a demonstrative and interactive version has been made freely available online as vector web tiles (https://lab-archeologia-digitale.github.io/jacotin-1828/).

A special focus has been put on the hydrographic network, an element that has undergone many changes in the last two centuries determining, in

turn, thorough changes in the Egyptian landscape. The Nile and its branches have been the indispensable natural prerequisite for the birth of the Egyptian civilisation and have continued to determine its economic, population, and cultural landscape throughout the millennia. The digital documentation of the pre-modern situation documented in the Napoleonic map is of great interest to specialists of archaeology and history of different chronologies.

Tightly related to the river is the population and the settlement network, that was the second theme under study. Thanks to the renewed interest of scholarly research in historical gazetteers, it was possible to offer a major aperture towards the community by trying, through different methodologies, to link our digitised 18th century Egyptian places to other records of gazetteers, both historical and current. It is not an easy task to deal with anthropic landscapes that have undergone radical changes, and we have tried not to conceal the gaps produced by the missing data but to fully document our difficulties in the hope that others in the future will do better than we did. Finally, this short contribution is aimed at sharing our latest attempt to expand the hydrographic theme by trying to provide outbound links and to reproduce the LOD (Linked Open Data) approach experimented with the settlement network.

J.B.

2. Egypt: an ever-changing landscape

The question about "how can an ancient landscape be reconstructed?" is increasingly being answered by Landscape Archaeology. By means of a wide range of tools such as the study of written sources, historical maps, archaeological evidence, geoarchaeological and paleoenvironmental studies, this branch of the discipline attempts to offer a broad overview of ancient landscapes regardless of their location. Among the various tools mentioned, one of the most widely used to work around the obstacles imposed by the changing landscape in times is the use of historical cartography. As far as Egypt is concerned, a valuable cartographic document that can provide a precious aid to the study of the ancient landscape is the *Carte topographique de l'Égypte*.

From the Prehistory through the Pharaonic era to Hellenistic, Roman, Medieval, and Modern times, the landscape of Egypt has changed a lot determining different topographical organisation of the country and significantly transforming settlement, road, and hydrographic networks (Wilson 2012; Cooper 2014; Ghiringhelli 2017, 2021). New villages and towns were founded from one age to the next which over time expanded, were either abandoned or relocated. The marshy areas that characterised large portions of the landscape were reclaimed, and canals were built or restored either to

Fig. 1 – Satellite images from Google Earth Engine of the Wādī al-Naṭrūn in 1984 (a), in 2004 (b) and in 2020 (c).

improve connections between places or to facilitate agricultural practices. There is little archaeological evidence left of the many interventions, and both written sources and historical cartography provide a fundamental source of information. As far as the country's hydrographic network is concerned, this continuous cycle of transformation peaked with the construction of the Aswān Dams, both the Low Dam, built at the end of 1800s, and the High Dam, active since 1970. This action allowed large portions of desert areas to be irrigated, and inevitably produced a major change in the landscape.

An example is the area of Wādī al-Naṭrūn, a desert depression located 90 km NW of Cairo that was the location of several monastic complexes since 360 CE, the time to which the foundation of the Monastery of St. Macarius dates (https://atlas.paths-erc.eu/places/208). The area is now surrounded by cultivations that effectively alter the understanding of the ancient landscape in which the archaeological evidence of the monastic complexes was framed (Fig. 1). Other examples can be added, originating from the construction of the Aswān Dam, such as coastal erosion and the flooding of the islands located along the course of the Nile (Hillier *et al.* 2006; Graham 2010; Badawy 2021). The case of the island of Philae is emblematic: its temples endangered by the construction of the Lower Dam were dismantled and reassembled on the nearby island of Agilkia. These are only a few famous events that have occurred in Egypt over the centuries and that have played a part in the evolution of an ever-changing landscape, heightening the demand for useful tools to study it.

D.D.E.

3. Towards a LOD infrastructure for the study of ancient Egyptian hydrography

The LAD team has been working on the digitisation of the Napoleonic map by georeferencing it and by vectorising the networks regarding

Fig. 2 – Screenshot showing 3D visualisation of the hydrography dataset of Napoleonic cartography v. 3.5. (from https://lab-archeologia-digitale.github.io/jacotin-1828/).

hydrography and settlements (D'Erasmo 2019; Bogdani *et al.* 2022). However, an 18th century cartography is a static document, even if it has been digitised, and moreover not all the topographical units represented within it are to be considered ancient (Fig. 2). Indeed, several topographic and hydrographic elements represented in the *Carte topographique* existed in different periods of Egyptian history. For these reasons, although the Napoleonic map is a valuable document for observing the landscape of Egypt before the great changes of the modern and contemporary ages, it remains a snapshot. Behind the place names and hydronyms catalogued by French *savants* there are millennia of history bearing witness to geopolitical, commercial, and agricultural dynamics of past times. For these reasons, the LAD team decided to make an upgrade of the original dataset resulting from the digitisation of Napoleonic cartography, starting with the hydrographic network. This update aims to make a quite static dataset, documenting the late 1700s, queryable by linking it to online geographic databases taking a step toward a LOD infrastructure and adding new information that help in the study of the ancient Egyptian landscape.

3.1 *A new dataset: the hydrographic network v. 4*

The fourth version (v. 3.5) of the Napoleonic hydrographic network dataset developed by the LAD contains few attributes (Bogdani *et al.* 2022, 83):

– unique numeric identifier (URI);
– name in French, as reported in the Napoleonic map, when available;

– type of the geographical feature, using the map of values;
– the assigned order of each element.

According to the typology of the watercourse, these attributes are linked to a specific geometry type: lines where rivers and canals are concerned, and polygons with special regard to lakes, marshlands, ponds, the branches of the Nile and the Nile itself. In version 4 of the dataset (v. 4), the aim is to link existing geometries to online databases mentioning the elements present in the Napoleonic map and expand the attribute table with information regarding the chronology of the watercourses and whether they can be navigated.

As regards the linkage of the dataset with existing online databases, it must be emphasised that in recent years, numerous international projects have created open geographical databases for the study of the ancient world. Most of these databases focus on the investigation of ancient toponymy, providing information on the evolution of place names over the centuries. More often, the entries of these databases are linked to geographical coordinates that give the precise or approximate location of places in the world. The coordinates refer to point elements or to areas, especially where the location of the place is uncertain (e.g. https://pleiades.stoa.org/places/727068). Currently, as far as Egypt is concerned, there are no open datasets that provide complex geometries related to ancient hydrography except that of the Ancient World Mapping Centre (http://awmc.unc.edu/wordpress/). However, this dataset focuses only on the Hellenistic and Roman times and is based on the vectorisation of the Barrington Atlas (Talbert 2002; http://awmc.unc.edu/wordpress/map-files/).

V. 4 will mainly be linked to databases that contain information on the toponymy of the single watercourse and not geometries mapping its course. The databases selected are Pleiades (https://pleiades.stoa.org/), Trismegistos (https://www.trismegistos.org/), and ToposText (https://topostext.org/) and they were chosen because of geographical contents about many waterways depicted in Napoleonic cartography. Another fundamental attribute for v. 4 is the chronology. Considering that the final goal of this version is to provide a queryable dataset that also gives information about the existence in times of the digitised elements, it was decided to create two numeric fields, "chrono_from" and "chrono_to", in which the chronological reference range for each vectorised element will be entered, if possible.

The hydrographic network was not only used to supply water to places but also as communication paths, and for this reason it was decided to include a last numerical field in v. 4. This information regarding the possibility of sailing or not sailing a watercourse using a numerical range from "0" to "3" where 0 equals non-navigable and 3 equals navigable. This data can

Fig. 3 – The Alexandria Canal vectorised from Napoleonic cartography.

be found from written sources or from geoarchaeological investigations, as will be seen below in paragraph §3.2 for the case of the Alexandria Canal.

To summarise, the following fields will be added to v. 4:

– the unique numeric identifier of Pleiades, when available;
– the unique numeric identifier of Trismegistos, when available;
– the unique numeric identifier of ToposText, when available;
– the date to which the watercourse is dated, when available;
– the date on which the watercourse stops flowing, when available;
– the navigability level of the waterway, when available.

3.2 *The case of the Alexandria and Suez Canals*

The development of v. 4 is still in progress. Nevertheless, in this paragraph specific reference will be made to two waterways of the Egyptian hydrographic network shown in Napoleonic cartography that have different histories and a different chronology and that can be good examples to describe the structure of the new dataset: the Alexandria Canal and the ancient Suez Canal. Following through the possibilities offered by these two watercourses,

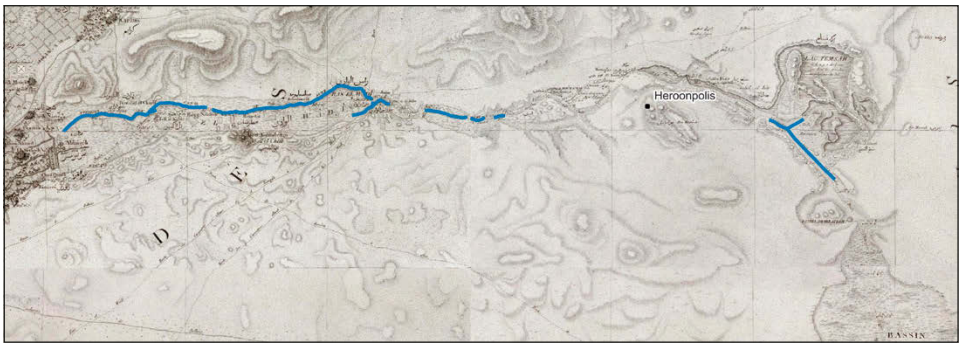

Fig. 4 – The remains of the ancient Suez Canal vectorised from Napoleonic cartography.

the implementation process from v. 3.5 to v. 4 will be outlined. In the v. 3.5, the Alexandria Canal (Fig. 3) has three attributes:

– name: Canal d'Alexandrie;
– typology: canal;
– order: 8.

The Alexandria Canal (today al-Maḥmūdiyya Canal) was built around 331 BCE to supply water to the city of Alexandria and therefore did not exist in the earliest Prehistoric and Pharaonic times. This waterway initially extended as far as the village of al-Nas̲h̲ al-Baḥrī, ancient Schedia, where it connected to the Canopic branch of the Nile. However, the Canopic branch dried up before the Islamic conquest of Egypt (640/641 CE), since at that time the Alexandria Canal was connected to the Bolbitine branch that replaced the Canopic in the canal's supply (Labib 2012). In addition, written sources indicate that travellers often preferred to reach Alexandria through secondary waterways leading to the city by Mareotis Lake because the canal was subject to silting. However, contrary to this, recent geoarchaeological studies suggest that after the dissecation of the Lake Mareotis in 9th century CE the Alexandria Canal was the preferred path to reach the West coast of the Delta (Flaux *et al.* 2017, 678-680).

The goal of v. 4 will be to implement the Alexandria canal geometry record with fields containing the information outlined above and link it to databases that mention it:

– name: Canal d'Alexandrie;
– typology: canal;
– order: 8;
– pleiades_id: 727068;
– trismegistos_id: 60;

– topostext_id: 3073302WAga;
– chrono_from: -331;
– chrono_to: 2023;
– navigable: 2.

The other example is the ancient Suez Canal (Fig. 4). This waterway that connected the Egyptian delta to the Red Sea through the Wādī Ṭumīlāt was probably inaugurated at the end of the 2nd millennium BCE by Sesostris III. At that time, it was named Pharaoh's Canal and continued to be used, despite periods of abandonment and reconstruction, until the mid-eighth century CE (Kramers 2012; Redmount 1995). This channel testifies the existence of a waterway connecting Egypt and the Red Sea since the Pharaonic period. In the v. 3.5 the attributes associated with the ancient Suez Canal were:

– name: Vestiges du Canal de Suez;
– typology: canal;
– order: 11;

The v. 2.0 will report the following attributes:

– name: Vestiges du Canal de Suez;
– typology: canal;
– order: 11;
– pleiades_id: NULL;
– trismegistos_id: 54477;
– topostext_id: NULL;
– chrono_from: -1879;
– chrono_to: 760;
– navigable: 3.

Those of the Alexandria Canal and the Suez Canal are just two examples that testify to the informative potential of version 4 of the hydrographic dataset of Napoleonic cartography. Once completed, v. 4 will be an entirely innovative tool for the study of the ancient Egyptian landscape.

D.D.E.

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ABSTRACT

Since 2019, the LAD team has been working on the digitisation of the Carte topographique de l'Égypte through a GIS platform. The data contained in this historical cartography, published in the early years 1800s, play a key role in research on the ancient Egyptian landscape, yet they show a still image from the late 1700s. Taking a step towards a Linked Open Data (LOD), this paper illustrates the work of updating the already published dataset of the hydrography of Napoleonic cartography by the LAD team, to which new information useful for the study of the Ancient Egyptian landscape will also be added.