



SEASONAL WATERCOURSES AS A SOURCE OF WEALTH AND A CAUSE OF DESTRUCTION: THE WATER MANAGEMENT IN ADULIS (ERITREA) IN ANTIQUITY AND TODAY

LES COURS D'EAU SAISONNIERS COMME SOURCE DE RICHESSE ET CAUSE DE DESTRUCTION : LA GESTION DE L'EAU À ADULIS (ERYTHRÉE) DANS L'ANTIQUITÉ ET AUJOURD'HUI

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ABSTRACT

In 2011 an Eritrean-Italian archaeological mission started a research and excavation activities in the area of ancient Adulis, an emporium town along the coast of the Horn of Africa on the Red Sea, in current Eritrea, documented by the sources in the 1st century AD and disappeared between 7th and 8th.

The geographical context of Adulis certainly contributed to its splendour in ancient times, and invites us to broaden the research field outside the excavation area to address the ancient commercial networks, without neglecting the intermediate scale, that would explain relations of the settlement to its territorial context and resources.

Adulis was settled by the bed of Haddas, a seasonal watercourse, and water was certainly a crucial natural resource for the development of the town. A violent overflow of Haddas was probably the cause of Adulis' sudden destruction between the 7th and 8th centuries. Today, this watercourse is at the same time one of the main resources and one of the major vulnerability factors of this portion of the Eritrean coast, where the communities of Zula, Afta and Foro live a fragile balance, seasonally endangered by its floods. The protection of the site of Adulis today, depends on this same balance.

Keywords: Archaeological site, irrigation system, spate irrigation, dam, cultural site management.

RESUME

En 2011, une mission archéologique érythréenne-italienne a commencé des activités de recherche et de fouille dans la région de l'ancienne Adulis, une ville-*emporium* le long de la côte de la Corne de l'Afrique sur la mer Rouge, dans l'Érythrée actuelle, documentée par les sources au premier siècle après JC et disparue entre le VIIe et le VIIIe siècle.

Le contexte géographique d'Adulis a certainement contribué à sa splendeur dans les temps anciens, et nous invite à élargir le champ de recherche en dehors de la zone de fouille pour aborder les réseaux commerciaux anciens, sans négliger l'échelle intermédiaire, qui expliquerait les relations de la colonie avec son contexte territorial et ses ressources.

Adulis a été fondée le long du lit de l'Haddas, un cours d'eau saisonnier, et l'eau était certainement une ressource naturelle cruciale pour le développement de la ville. Un violent débordement de l'Haddas fut probablement la cause de la destruction soudaine d'Adulis entre le VIIe et le VIIIe siècle. Aujourd'hui, ce cours d'eau est à la fois l'une des principales ressources et l'un des principaux facteurs de vulnérabilité de cette partie de la côte érythréenne, où les communautés de Zula, Afta et Foro vivent un équilibre fragile, en péril saisonnier par ses inondations. La protection du site d'Adulis aujourd'hui, dépend de ce même équilibre.

Mots clés : Site archéologique, système d'irrigation, irrigation par naissains, barrage, gestion du site culturel.

INTRODUCTION

The site of Adulis, on the south-western coast of the Red Sea, represents one of the most complete complexes of material and chronological evidence in the Horn of Africa: a town-emporium of over forty hectares which is preserved, almost intact, under a few meters of silt and sand, accumulated following the violent flooding, perhaps also accompanied by seismic tremors, which caused its destruction between the end of the seventh and the eighth century of our era.

The Italian-Eritrean international mission has been operational since 2011, started after the request of the Eritrean Authorities, who have entrusted the Alfredo and Angelo Castiglioni's Research Center on the Eastern Desert (Ce.R.D.O.) with the task of bringing to light the ancient port settlement, also with the aim of creating the first national archaeological park in Sub Saharan Africa (Castiglioni et al. 2013; Bortolotto et al. 2013; Castiglioni et al. 2018). The project involves, alongside the National Museum of Eritrea and the Regional Museum of the Northern Red Sea in Massawa, the Università Cattolica di Milano, Università Orientale di Napoli, Politecnico di Milano, Università dell'Insubria. The mission, financed by Eritrea, by Ce.R.D.O. and by Piccini Group, has received MAECI (Ministero degli Affari Esteri e della Cooperazione Internazionale) contributions

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since 2012, AICS, project VITAE in 2020, and is supported by ISMEO (Associazione Internazionale di Studi sul Mediterraneo e l'Oriente).

The town of Adulis, one of the main ports of the Horn of Africa in ancient times, has been known from Western sources since the 1st century AD (*Periplus Maris Erythraei*, 4, 2.6; Plinius, *Naturalis Historia*, VI, 34) and archaeologically documented by limited field researches of the late nineteenth and first half of the twentieth century, which brought to light evidence mainly relating to the last phases of life of the town (Lefebvre 1845; Sundström 1907; Paribeni 1907; Munro-Hay 1989; Anfray 2016).

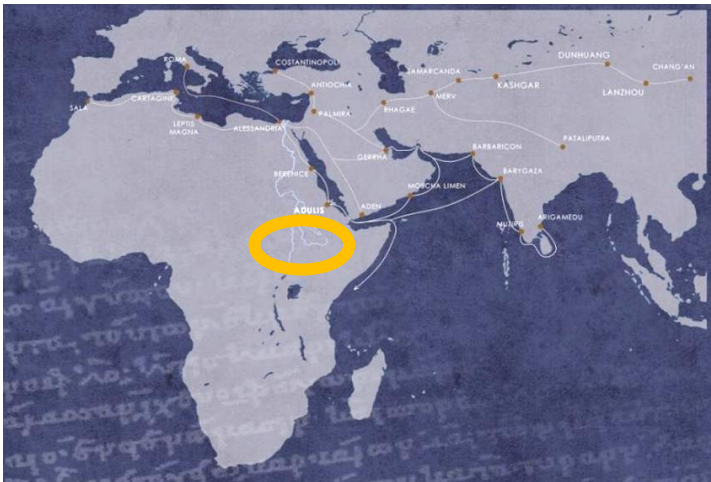


Figure 1: The position of Adulis in relation to the ancient trade routes (image by A. Mazzieri, G. Sottocornola, A. Todeschini).



Figure 2: An example of the ancient buildings now visible in the archaeological area.

Adulis represents an extraordinary opportunity to investigate the origins and development of the urban civilization of the Horn of Africa, which also means broadening the knowledge of a geographical and cultural space that constitutes the link between the Mediterranean and the Indian Ocean, that is, between the West and Orient. The optimal state of conservation of the archaeological deposits, due to the destruction by natural causes, which buried - and therefore preserved - the town under silt and sand, allows to appreciate the quality, variety and abundance of stone architecture, a characteristic that, outside the Roman Provinces of Africa, in ancient times is found only in this region of the continent, elsewhere characterized above all by buildings in wood and clay. This supports the hypothesis of a well-structured and organized urban centre, which had the constructive and technical skills to extend its spatial organization around and control its natural resources.

The extension of the site, over forty hectares of settlement surrounded by a vast alluvial plain, crossed by the seasonal watercourse currently called Haddas, also raises the question of the supply of food resources, in particular during the months of inactivity of the port, and therefore of the water organization of the place, that has developed over almost a millennium.

Other scholars, such as Jean François Breton, have also observed that a town of similar size and importance, although dedicated to dense commercial exchanges, could not delegate the satisfaction of its food needs to imports alone.

The huge amount of amphoral fragments found on the site, not only from the excavations but also and above all on the surface, consists almost entirely of the type of so-called Ayla / Aksum amphora, whose content, not entirely certain (dates/date-wine, fish sauce?), could not make up for the entire diet.

Recent archaeobotanical investigations on the remains of seeds found in some stratigraphic deposits and incorporated in the ceramic body of bricks, confirm the cultivation of barley and emmer in the Adulitan territory between the 5th and 6th centuries AD (Delle Donne, 2021). This dating, provided by the contexts of discovery, obviously does not exclude that the practice of agriculture was also present in previous centuries, at least from the 3rd century BC, when the settlement was already of such importance to possess monumentalized spaces, as documented by the famous *Monumentum Adulitanum* described by Cosma Indicopleuste (Bowersock, 2013, pp. 34-39; 44-62).

If it is true that, in more recent times (19th century) a port and commercial city like Massawa depended for food on villeges like Arkiko, Emberemi and Monkullo in the range of 15 km ca. (Folchi, 1898), it should nevertheless be noted that, unlike Massawa, built on a madreporic island with no fresh water, Adulis was lapped by the abundant seasonal waters of the Haddas river, a resource so important in the context of the coastal lowland, as to suggest not only the development of activities that would benefit from it, but also the main reasons for this settlement choice.

Compared to Breton's thesis, which forces the identification of traces of ancient hydraulic arrangements in the physiognomy of the current landscape, at the present state of research

it is only possible to order a series of information and observations, none of which is sufficient to define the ancient agricultural landscape and any hydraulic works, but all equally useful in orienting the ongoing research.

There are many questions that still await an answer and the future research of the Adulis mission will aim at investigating the origin and evolution of the settlement in relation to all the interconnected elements that have created the historical landscape that is preserved today: natural factors, infrastructures, resources, the potential for agriculture, artisanal and commercial activities. This will make it possible to fill the gap in knowledge concerning the relationship between the town and its territorial context, opening new perspectives to explain its origins, the connection between urban architecture and the landscape, the agricultural strategies prior to and/or subsequent to urbanization. Landscape transformations must be considered in relation to the complex interaction between anthropic initiatives, environmental opportunities and limits, climate, crops, as well as hydraulic, architectural and agronomic knowledge, to define the potential of the area in terms of subsistence. This necessarily multidisciplinary approach would allow archaeology to provide a strategic contribution to planning the sustainable development of this area. All this must contribute to protecting the territorial fragility of this archaeological context, as local inhabitants themselves ask: the communities of the nearby villages of Afta and Zula, and of the main centre of Foro have pointed out the need to prepare security measures for the protection of the site, in particular related to the management of hydrogeological risk.

In fact, the separation between archaeological excavation and conservation cannot be conceived: this, in order to be effective, cannot ignore the involvement of the owners of the places, the first custodians of their memory. The archaeological mission has the task of adequately communicating the aims and results of scientific research - as well as the development of a multidisciplinary methodology that ensures on site specific skills in the field of conservation and restoration.

RICHNESS AND VULNERABILITY OF ADULIS ACROSS THE CENTURIES

For the Archaeological site of Adulis and its surroundings, which include the area between the villages of Foro, Zula and Afta and the coast, water is the natural resource representing at the same time the main richness and the main vulnerability. This double nature of the hydrologic asset is witnessed by the history itself of Adulis: according to oral sources collected between the 19th and the 20th century, first by British and French explorers and later by Italian colonial officers, water was the cause of the destruction of this emporium town. To provide a short list of European explorers who documented the Eritrean territory: the British James Bruce (1769) and Henry Salt (1805-1809), the French D'Abbadie brothers (1837-1848), G. Lejan (1864), the Italians Giuseppe Sapeto (1837-1880), Orazio Antinori and Arturo Issel (1870). During the so-called "scramble for Africa" carried out by European Imperialist countries, the Italian Army occupied

Massawa in 1885 and conquered the inland in 1890, when the Eritrean Colony was founded. The Italian colonial occupation ended in 1941.

The British explorer Henry Salt (1789-1827), travelling in the Horn of Africa around 1809-1810, wrote: “*on my return to Massowa [Massawa], in May, [...] Shum Hummar [...] told me, ‘that great remains of an old town could still be traced near Zulla, which had been called ‘Azoole;’ that the houses appeared to have been larger and more numerous than those at Massowa; immense masses of square stones, four or five feet in breadth, lying heaped confusedly together in the bed of a ‘gorf’ or ‘torrent’; by the sudden overflowing of which, it was traditionally reported, the town had been destroyed’*”. SALT H. (1814). *A Voyage to Abyssinia and Travels in the Interior of the Country, Executed under the Orders of the British Government in the Years 1809 and 1810*, London p. 350.

Not very different was the content of oral sources collected during the Italian Colonial period, as demonstrated by the touristic guide issued by the Italian Touring Club in 1929, where, along with the description of the ruins in Adulis, it is written «*Verso la fine del VII secolo o al principio dell’VIII, la città scompare, probabilmente in seguito a un’inondazione prodotta dall’improvviso svuotarsi per terremoto di un lago a monte nella regione Forù (secondo la leggenda abissina, il rumore fu udito fino ad Acsum)*». Bertarelli L.V. (1929). *Guida d’Italia del Touring Club Italiano. Possedimenti e Colonie*, Milano, p. 684: “*at the end of the VII century or in the early VIII, the city disappeared, probably as a consequence of a flood caused by the sudden emptying of a lake upstream in the Forù area.*

Upstream of Forù, a locality likely coinciding with the current village of Foro, it therefore seems that a lake was formerly present, and it would not be surprising that it was an artificial reservoir, since along the important road that connected Adulis to Aksum, there were two ancient dams, still *in situ*. In Aksum, economically and culturally linked to Adulis, there was the Mai Shum dam. Near the archaeological site of Qohaito, attributable to the same building culture of Adulis and contemporary to it, there was the Sahira dam (Littmann et al. 1913). Similarly in the Arabian peninsula, with which in ancient times trade and migrations were very frequent, dams creating artificial reservoirs had been the basis of agricultural development: the great Ma’rib dam, in present-day Yemen, dating back to the 1st millennium BC, is testimony to the fact that, although the wealth of the Kingdom of Sheba was linked to the Incense Route, nevertheless irrigated agriculture was a pillar of the local economy, to the point of promoting the construction of a hydraulic work of such grandeur (Pietsch et al., 2010).

In the Arabic peninsula the irrigation techniques seem to have passed on along the centuries maintaining their main characteristics, as demonstrated by the stratigraphic investigation in the surroundings of the ancient Ma’rib dam (Pietsch et al., 2010); it is not the same in the coastal lowlands facing the Zula bay, once admitted that complex irrigation systems were in use in antiquity. It has still to be defined if the abandonment of agricultural activities was a side effect of the destructive flood mentioned by Salt, or if it was a long term process; nevertheless no farming activity in the plain of Zula was mentioned in the explorers’ reports dating back to the early 19th century, neither in the

extremely detailed descriptions by the British officers Holland and Hozier, directing the settlement of a military camp around Zula in 1868. The British military campaign aimed at defeating the Ethiopian Emperor Theodor, based in Magdala on the Ethiopian plateau: from the British camp, set in the Zula plain, the army followed the Komayle valley to reach Magdala.

On the contrary they describe the extremely basic techniques locally in use to collect water, that is through simple potholes in the ground, and the richness in vegetation only during the rainy season (Holland and Hozier, 1870, p. 278). The British overview is confirmed by the Italian Colonial reports from the late 19th - early 20th century (Folchi, 1898), which describe the local population as nomadic or seminomadic, therefore dedicated to pastoralism and subsistence farming instead of agriculture.

According to archival sources and bibliography, the return to a complex irrigation system in this area dates back to 1917, when an Italian colonial company led by the entrepreneur Ernesto Beltrame, carried out the works to turn the plain of Zula into a tobacco and cotton plantation (From PUGLISI G. (1952). *Chi è? dell'Eritrea*. Edition: Agenzia Regina, Asmara). Such works included a stone and soil barrier to collect the water from Haddas, and diverting canals simply dug in the earth, according to a technique introduced in Eritrea in the early 20th century through the employment of Yemeni labour, engaged by the Italian Colonial Government, to start cotton plantation in Wekiro and Emberemi, at the north of Massawa, in a context similar to the one of Adulis-Zula. It is noteworthy that the employment of Yemeni workers was due to their expertise in traditional irrigation systems (Martini, 1913).

THE CURRENT HYDROGRAPHIC SYSTEM IN THE ZULA PLAIN

The water that is possible to use for irrigation in the plain of Zula, is the one derived from Haddas, a seasonal watercourse starting on the highlands, not far from Qohaito, and flowing into the bay facing Adulis; before arriving in Foro, that is 3 kilometers upstream the archaeological site, Haddas collects also the water from Komayle and Alighede watercourses. The last is the most important of the region for the extension of its catchment area, its flow rate and frequency of floods. According to the reports of Hydraulic Engineer Paolo Reviglio (Paolo Reviglio (Turin 1884 – Asmara 1967) worked all over Eritrea as Hydraulic Engineer; the gratitude goes to his grand-daughter Paola Matteoda, who shared the documents of her grandfather, collected in the Archivio Privato Matteoda-Reviglio), active in Eritrea from 1912 to 1965 ca., the total catchment area of the three watercourses would cover a surface of more than 2.000 square kilometers, where summer rains generate an annual flow rate of 100 million cubic meters. Adulis is therefore located in the alluvial plain formed by the annual deposits left by the seasonal watercourses.

The depth (thickness) of the annual deposits, which varies within the plain, has dramatically changed the morphology of the area along the centuries, so that it is not

possible, at the present state of the research, to define exactly the ancient morphology of the area, now smoothed and flattened. Nevertheless it might be helpful to observe the elevation data from the map named “*Carta della Colonia Eritrea – foglio Zula*” issued at scale 1:50.000 by the Istituto Geografico Militare Italiano in 1889-90 and updated in 1909 (The proper mapping of the newly conquered territories was crucial for the Italian Colonial Army, therefore the collection of maps of Eritrea issued by the Italian Military Geographic Institute is very consistent). The orthometric elevation marked where the ruins of Adulis are mapped, is 33 meters: today Adulis and the nearby village of Afta are at the same elevation, while from the map from 1909, it is clearly remarkable that the ruins were located on the highest spot of the plain between Foro (where the dam is, at 48 m.a.s.l.) and the sea, suggesting that the ancient town was built in that specific place because of its altitude, the highest downstream Foro, in a safe position from seasonal water.

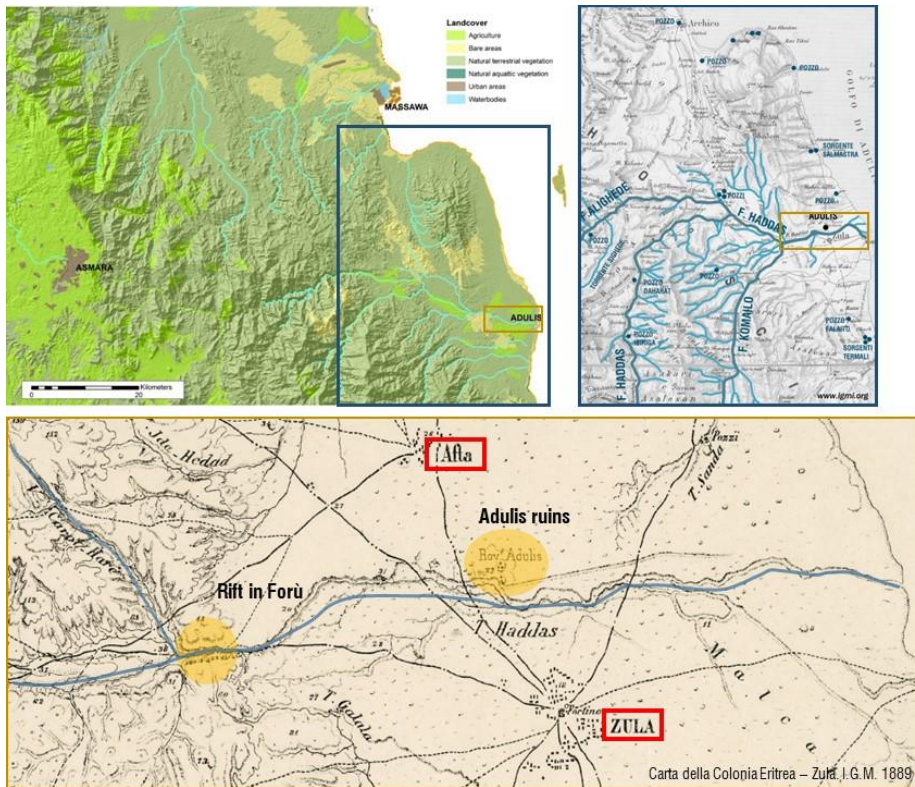


Figure 3: the watercourse network at territorial and local scale

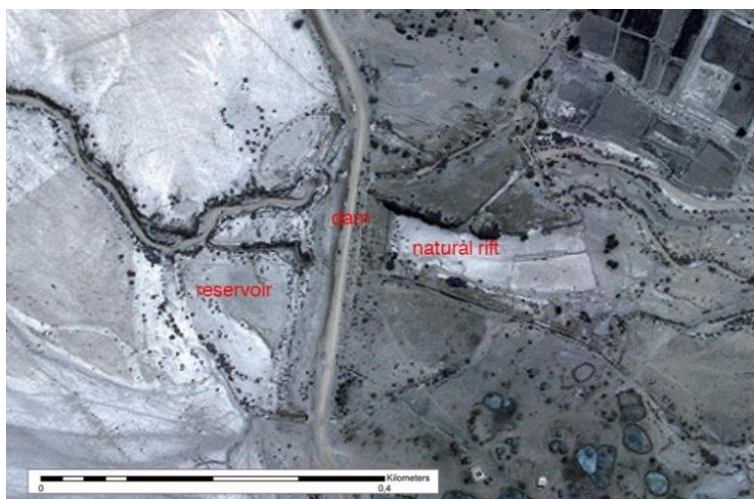


Figure 4: satellite view of the dam in Foro (DigitalGlobe 2012), it is visible that the reservoir (on the left side of the barrier) is silted up.

Near Foro there is a natural rift, constituted by a sudden, vertical break in the basaltic rock terrace: the break is 50 meters wide and 14 meters high, and is likely the natural waterbed of Haddas. The cliffs of the break and the general layout of the rift might have perfectly supported the construction of a barrier to create an artificial lake or reservoir, able to store seasonal water in order to use it along the year for agricultural purpose mainly, and at the same time able to mitigate the effects of sudden, violent and destructive floods. In addition to the event occurred around the 7th-8th century AD, recalled by the oral sources mentioned above, which probably caused the destruction of Adulis, also in the 20th century and more recently, episodes demonstrating the disruptive effects of Haddas floods occurred: in 1924 the soil and stone barrier built few years before by Ernesto Beltramo was broken down, destroying the plantations downstream, and similar events must have been common in the past centuries.

Between 1954 and 1960 a new dam was built, with a reservoir of over 20 million cubic metres capacity, which demonstrated to be extremely resistant, so that the structure is still in place; however, at present the dam is no longer in condition to mitigate the effects of floods downstream, because the reservoir is silted up and the water can easily overcome the dam itself. The current elevation of the silt in the former reservoir is actually higher than the dam spillway.

Also recently, in winter 2015, a violent flood seriously damaged the village of Foro and the area downstream. Besides these occasional episodes, the inefficiency of the dam originates a phenomenon which is seriously affecting the agricultural and farming activities of the area in the long term, thus structurally deteriorating the local economy, mainly based on farming and small breeding. As it is no longer possible to store the Haddas water in the reservoir to use it all along the year, the farmed surface is constantly

decreasing and from the originally 10.000 hectares, now only 1.000 hectares ca. are still cultivated. Part of the farming activity is currently only rain-fed (Cattaneo and Massa, 2020). The irrigation technique on which the fields are shaped and organized, is the spate irrigation, which is in fact based on the presence of a reservoir or a lake, and was in use in antiquity in different areas worldwide, not only in the Arabic peninsula (e.g. in the Ma'rib dam area), but also in Latin America and Asia, in particular in the present-day Pakistan. The system is based on a simple principle: seasonal water is collected by a barrier, whence a fan of primary canals, simply dug in the soil, divert the water downstream into secondary canals, which lead it into the fields. The fields are from one to three hectares wide and surrounded by soil embankments high up to 2 meters, so that each field can be flooded and store water in the soil; by breaking the embankment separating two different fields, it is possible to fill with water also the fields not directly reached by the canals. In case the water is not enough, the first fields to be abandoned are the ones located further from the canals. Without the reservoir, the canals would have water only during the floods, a time too short to manage the proper diversion into each field; moreover, in this case, the embankments of the fields nearby the canals have also to work as barriers in opposition to sudden and violent water, which is a purpose they are not built for (Bortolotto and Cattaneo, 2015).

In addition to the damages to villages and fields, and to the reduction of the cultivable fields, also the archaeological area is remarkably affected by the impossibility to control sudden and violent floods. This problem, which is more and more serious as a consequence of the reduced efficiency of the dam in Foro, was clearly remarked before its construction, around 1907, when Roberto Paribeni brought to light several artifacts in Adulis, considered of great interest (Martini, 1913) but endangered by Haddas floods, as written by the Italian archaeologist to the Italian Colonial Governor of the time (A letter by Roberto Paribeni dated 1907 to the Colonial Government, warning about the preservation problems of Adulis in relation to Haddas floods, is in the Archivio Centrale dello Stato in Rome, fondo Martini). The hydrographic issue is of paramount importance today, when the subsistence of three villages and the preservation of a cultural site of paramount importance depend on it and, if well managed, could rely on it to boost the economy of this area, which in ancient times was not marginal at all.

Seasonal watercourses as a source of wealth and a cause of destruction: The water management in Adulis (Eritrea) in antiquity and today



Figure 5: the view of the dam (photo 2014).



Figure 6: from above – the natural morphology of the area around Adulis; the cultivated fields, abandoned fields (photos 2015).

The management of water has been identified as a priority at the territorial scale for the safeguard of Adulis site, also by the Politecnico di Milano research team which has been working for the preservation of the site since 2012, on invitation by Ce.R.D.O., taking part to the annual excavation fieldworks, in order to work with archaeologists in the understanding of the artifacts from the construction point of view and to design a preservation strategy along with the excavations. Since 2020, with the starting of the VITAE project, the research activity includes hydrogeological risk assessment. In Adulis the link between water and preservation is very strict, as the walls of the buildings are constituted by stone blocks tied with clay mortar: the rainwater damages the edges of the walls, while the flooding water collected in the excavation trenches at the wall feet, causes the gradual detachment of the lower stones, with irreversible structural consequences affecting the entire artifact.

The local community is the main stakeholder directly involved in the maintenance of the site and in its future development. The farming system based on spate irrigation has, as a side effect and as a necessary condition at the same time, an extremely cohesive community: during the floods the entire villages are engaged in the activities needed to control and divert the water, and after the floods they all work to reset and restore the embankments intentionally broken and damaged. A spate irrigation system is based on a remarkable supply of manpower, both for the amount of work necessary and for its compressed timing. The organization of the works and the cohesion of the communities are so crucial and determinant for the functioning of the entire system, that the tree structure of the irrigation scheme has a strict correspondence in the hierarchy of the community involved in the works (AEAS/ESAPP/SLM report 2005). The agricultural system and the community reflect each other, and the future of Adulis strictly relies on the future of the agricultural villages of Zula and Afta, and therefore necessarily on the efficiency of the hydrographic system as a whole.

CONCLUSIONS

When developing a research on an archaeological site, a multiscale and multidisciplinary approach is crucial both for better understanding the past landscape and for designing a sustainable future for its cultural heritage. Investigating water, in its multifaceted aspects, is a key issue in this process. In the case of Adulis, approaching the current irrigation system and hydrographic asset, along with archaeological investigation and bibliographical research, provided important hints to pose the proper research questions about the ancient landscape, that includes not only its physical features, but also its cultural and intangible aspects, and has still to be fully defined. The strategies in water management that resulted to be successful of vulnerable in the past, can be still important teachings to shape a better future.

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