



HERITAGE
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IMPACT OF FLOODING ON THE LIBYAN HERITAGE

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IMPACT OF FLOODING ON THE
LIBYAN HERITAGE

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with the support of



INTRODUCTION

In the wake of the devastating floods that struck Libya on September 10th, 2023, this preliminary Damage Assessment Report has been compiled with the aim of providing vital information to local authorities, stakeholders and scientific committees. The document presents an indicative analysis of the aftermath of the floods, focusing on the urban area of Derna, as well as two significant archaeological sites: Apollonia and Cyrene.

It comprises indicative analyses on the urban area of Derna as well as the archaeological sites of Apollonia and Cyrene. The methodology used for this report consists of investigative work through satellite imagery to assess the extent of flooding and subsequent damage in the affected areas, archival research, historical records and geological data to provide context and perspective on the floods, open source data & social media which are essential to obtain real time information during disaster events.

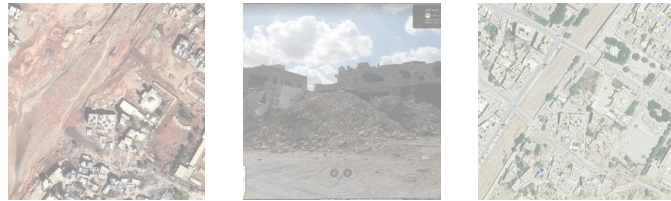
For the Apollonia site, we initiated the process by analyzing satellite images and conducting a preliminary assessment. Photos taken post-floods by our local operators in Libya enabled us to compare them with previously acquired drone and on-site data (from 2017-2019) This previous mission was carried out in collaboration with the Libyan Department of Antiquities (DoA) and the French Archaeological Mission in Libya (MAFL).

This comparative study was undertaken to identify on-site degradation and deterioration.

As for the Cyrene site, our local operator visited Cyrene to document the site and assess the damages. This proved invaluable as satellite imagery provided limited information on the state of the site post-floods. Nevertheless, we compiled enough data and compared it with previous acquisitions to formulate well-informed recommendations.

This project was funded by ALIPH.

URBAN AREAS



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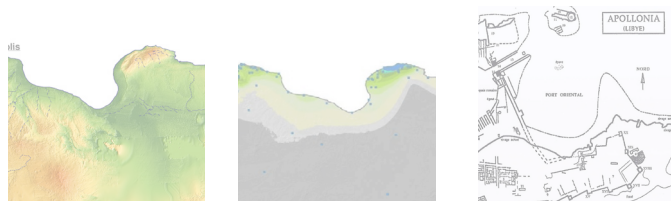
ARCHAEOLOGICAL SITES



APOLLONIA

CYRENE

GLOBAL SYNTHESIS



CYRENAIC COASTAL RISKS

DERNA



Derna - 06.2023, Maxar

DERNA



Derna - 13.09.2023, Maxar

- ① Al Atiq mosque
- ② Souk al Zalam
- ③ Piazza al Hamra
- ④ Al Rachid mosque
- ⑤ Al Senussia/ Al Zawiya mosque
- ⑥ Al Sahaba mosque
- ⑦ Shrine of Sahabi
- ⑧ Al Jaraba mosque
- ⑨ Al Fath mosque
- ⑩ Star café
- ⑪ King Idris Library
- ⑫ Darnis sports club
- ⑬ Derna Cultural centre
- ⑭ Mausoleum of Sidi Ali Al-Washish
- ⑮ Zawiya al Rifaiya
- ⓧ unidentified sites



DERNA AL ATIQ MOSQUE

Date of construction 1670
 Current state 100% Destroyed
 Function Mosque



The Al Atiq mosque was built in 1670 during the Ottoman rule. The roof is typical of Ottoman architecture with 42 domes - the mosque is also called the mosque of a hundred domes -. Its interior is composed of 30 marble columns of approximately 5 meters with slightly different capitals from other buildings. The plan is divided into seven corridors and six vertical naves. The minaret is 15 meters high and is also typical of the Ottoman style with a square pulpit, an octagonal shaft, and a conical spire. The Al Atiq mosque had just been renovated after it was damaged during the Libyan war. It has been completely wiped by the floods.



Google maps, Zaki Banoon, uploaded in 09.2023

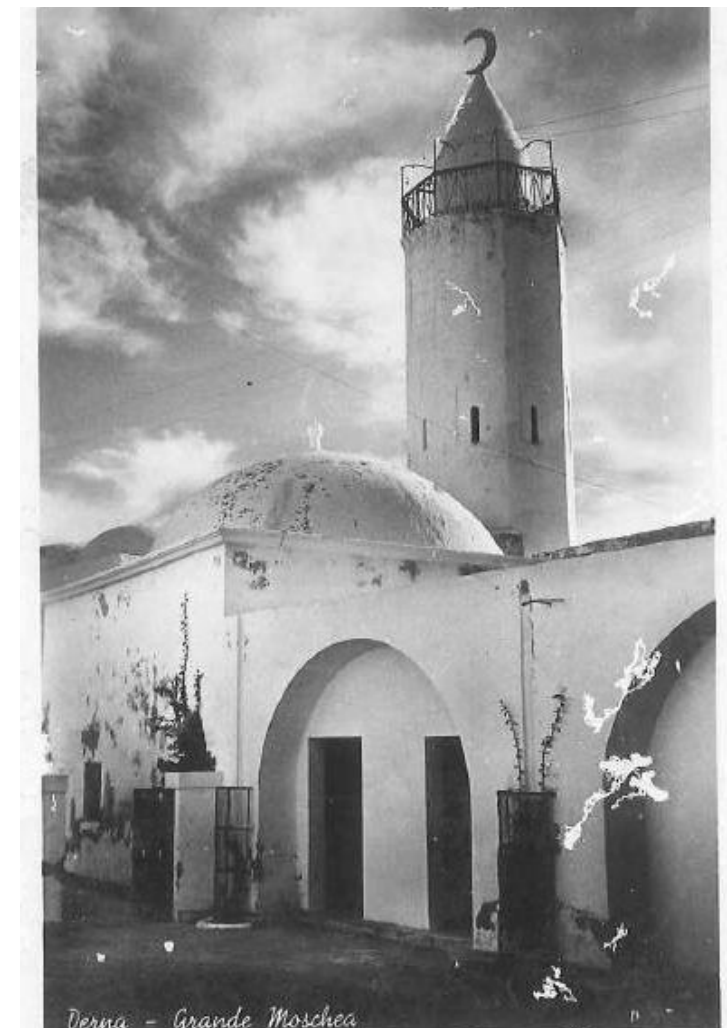
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Archivio centrale dello stato, circa 1920



Kazimierz Nowak/ National Digital Archives



Derna - Grande Moschea, View of the east side, Archivio centrale dello stato, 1938



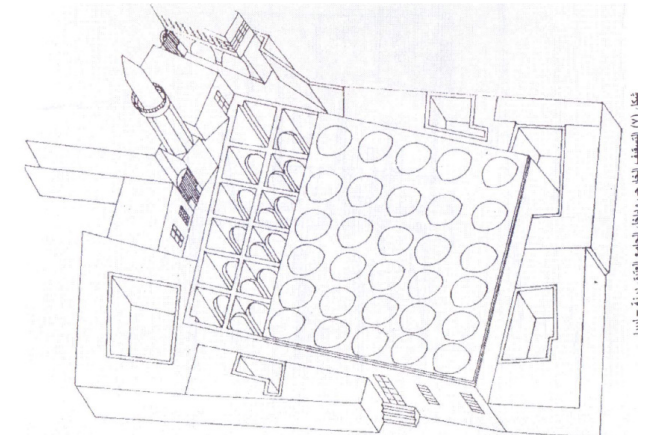
Startimes, 2008



View of the mosque circa 1940, Fathi Al-Selini



Fawzia Tarban Gabrni Gaber, journal of architecture, arts, and humanistic sciences, volume 5, issue 19, Jan-Feb 2020



Fawzia Tarban Jabrni Jaber, journal of architecture, arts, and humanistic sciences, volume 5, issue 19, Jan-Feb 2020

DERNA SOUK AL ZALAM

Date of construction XVII Century
 Current state 100% Destroyed
 Function Market



Souk Al Zalam is one of the oldest souks of Derna, the entrance is situated next to the Al Attiq mosque, one of the oldest souks in Derna dating back to the Ottoman rule, constructed in Andalusian style. It represented the artery of the city's economic and social life. Contained about 90 shops, and different branches and courtyards such as the trabelsi piazza. In 2022 began a restoration project for the souk which had been destroyed during the Libyan war.



Archivio centrale dello stato, circa 1920

DERNA



National Library of Australia, 1940-46



National Library of Australia, 1940-46



Libyan Antiquities Authority, circa 1990

DERNA

PIAZZA AL BAIDA AL HAMRA

Date of construction	1670
Current state	100% Destroyed
Function	Public Square



Derna Zoom, 03.2020

Al Baida al hamra, previously known as Piazza Regina Elena, was one of the courtyards adjacent to the city's souk. It was considered as the "rendez-vous" point for Derna's intellectuals and artists.

The piazza was severely impacted during the Libyan war, the central fountain and the archways were completely destroyed. In 2021, began a project of rehabilitation which was completed shortly before the floods.



Archivio centrale dello stato, 1942

DERNA



Archivio centrale dello stato, 1942



Archivio centrale dello stato, 1941



Archivio centrale dello stato, 1942

DERNA

AL RACHID MOSQUE

Date of construction	XVII century
Current state	20% Destroyed
Function	Mosque



Wikimapia, 2005



The Al Rachid mosque was originally called Bu Gharara mosque. it dates back 400 years but was rebuilt in 1887 under Ottoman rule. It was also one of the landmarks destroyed in the war in 2014. A restoration project was completed just a few weeks before the devastating floods, where the outer shape of the mosque was transformed. The mosque suffered water damage inside and degradation to its wooden components.



Google maps, 07.2023

DERNA



Derna Zoom, 21.07.2018



Derna Zoom, 23.07.2018



Department of Antiquity, 17.08.2021



Department of Antiquity, 17.08.2021



Office of Endowments and Islamic Affairs, Derna 11.06.2023



Office of Endowments and Islamic Affairs, Derna 11.06.2023

DERNA

AL SENUSSIA/ AL ZAWIYA MOSQUE

Date of construction	1844
Current state	Unknown
Function	Mosque



The Senussia mosque was established in 1844 on the site of a roman well. It was built inside a cave. It is also called the 'kahf' mosque, the Zawya mosque or the Rock mosque. It is located on a plateau, south of the Sahaba mosque. The mosque is rectangular in shape and consists of five corridors. It is characteristic of Moroccan architecture with Corinthian capitals.



Libyan Antiquities Authority, 2020

DERNA



Libyan Antiquities Authority, 2020



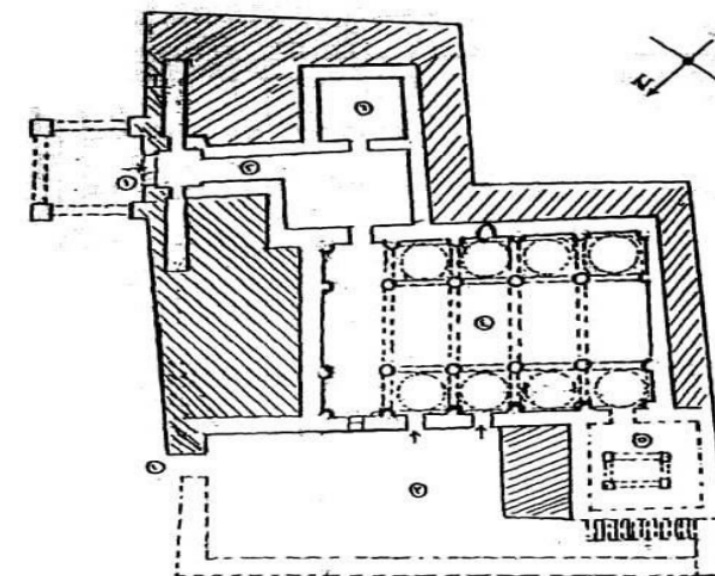
Libyan Antiquities Authority, 2020



Libyan Antiquities Authority, 2020



Libyan Antiquities Authority, 2020



Fawzia Tarban Jabrni Jaber, Journal of the Faculty of Arts, Cairo University
 Volume 80, Issue 1, January 2020

DERNA

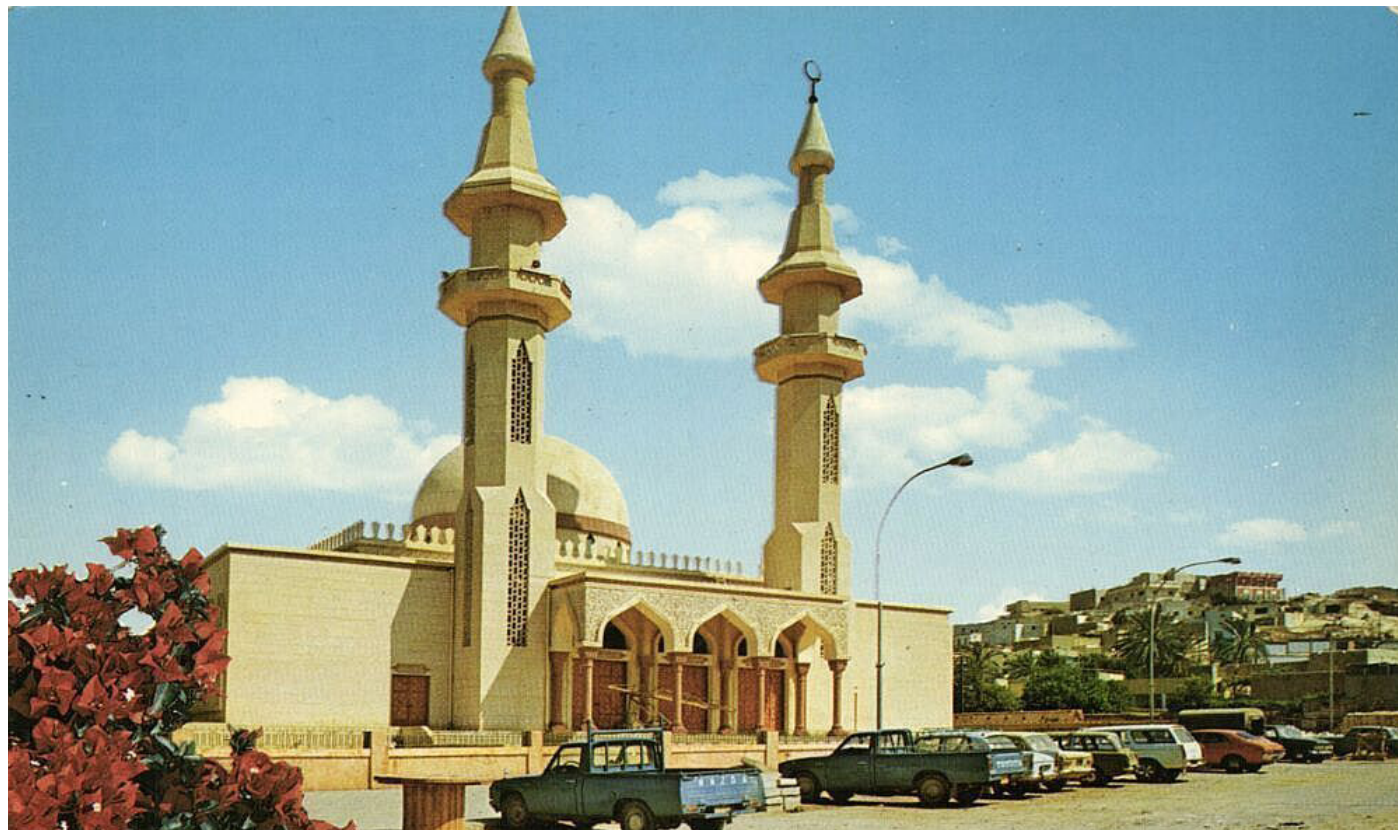
AL SAHABA MOSQUE

Date of construction	1975	
Current state	50%	Destroyed
Function	mosque and cemetery	



Al Sahaba mosque was inaugurated in 1975 with a cemetery containing 70 of the prophet's companions. In addition to its religious role, the mosque is considered a meeting place for the people of the city on most national and social occasions.

The floods of September 10 caused major destruction to the surroundings of the building including its peristyle archway. The cemetery, which was a prominent historical landmark of the city, has been lost. There were also damages inside of the mosque.



Postcard view of the Sahaba mosque circa 1970

DERNA



AFP/Getty, 2016



Reuters, 21.09.2023



Mahmud Turkia/AFP 19.09.2023

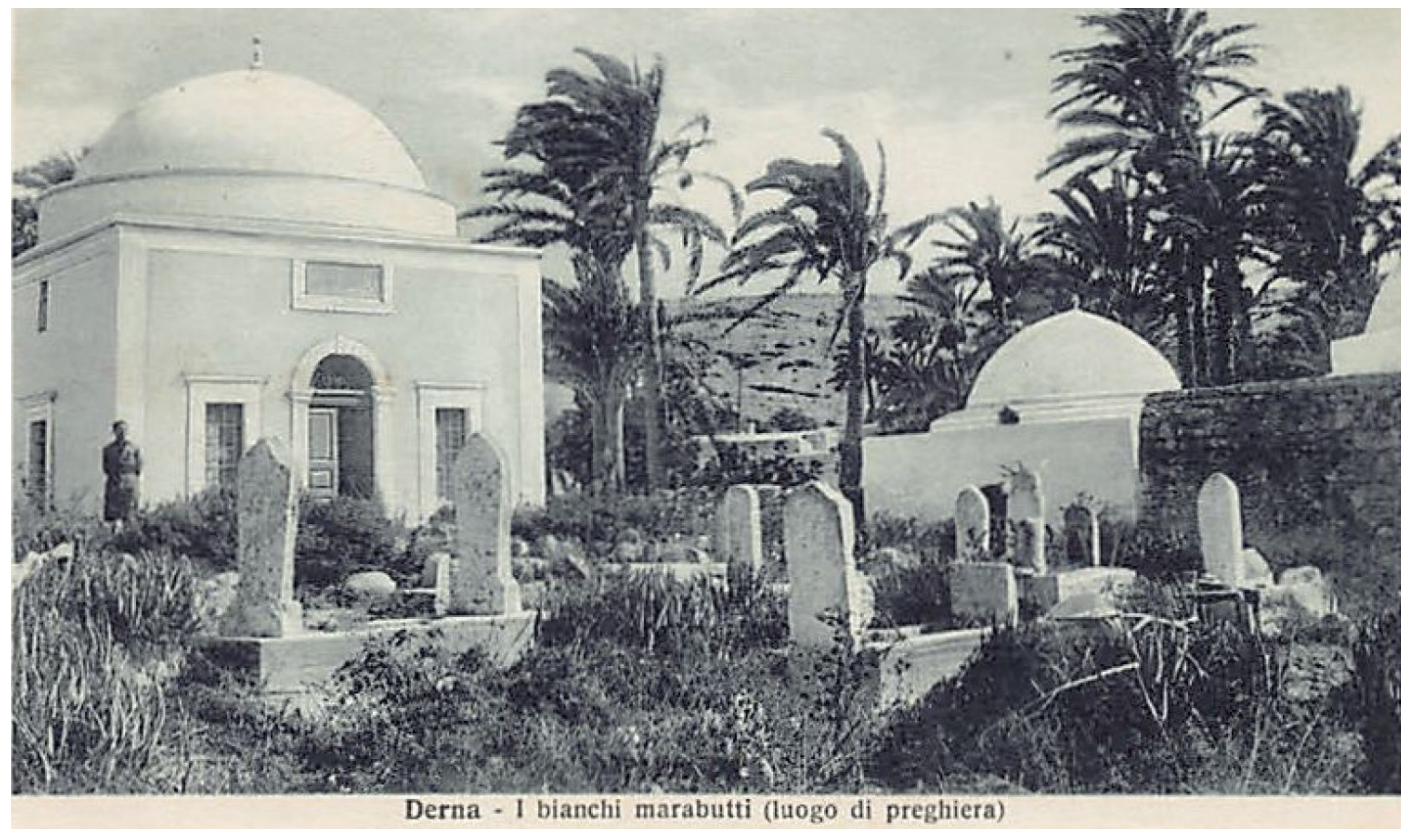
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SHRINE OF ZUHAYR IBN QAYS

Date of construction	XVII
Current state	20% Damaged
Function	Shrine



The shrine of Zuhayr ibn Qays was built in the early XVII century on the south eastern side of the Al Sahaba mosque. It holds the body of the noble companion Zuhayr Ibn Qays and was destroyed during the Libyan war in 2012. The flood severely damaged the shrine and wiped away the cemetery which dates to the 17th century



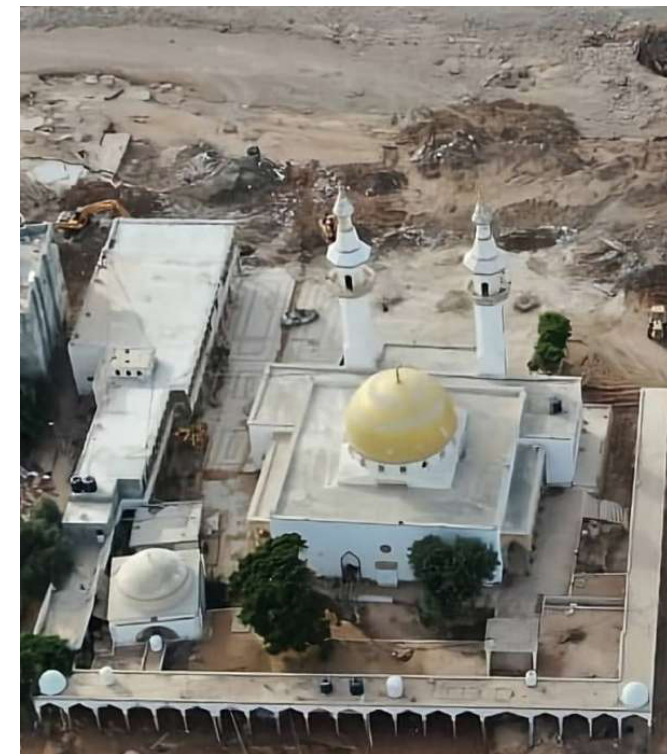
Derna - I bianchi marabutti (luogo di preghiera)

Archivio centrale dello stato, 1937

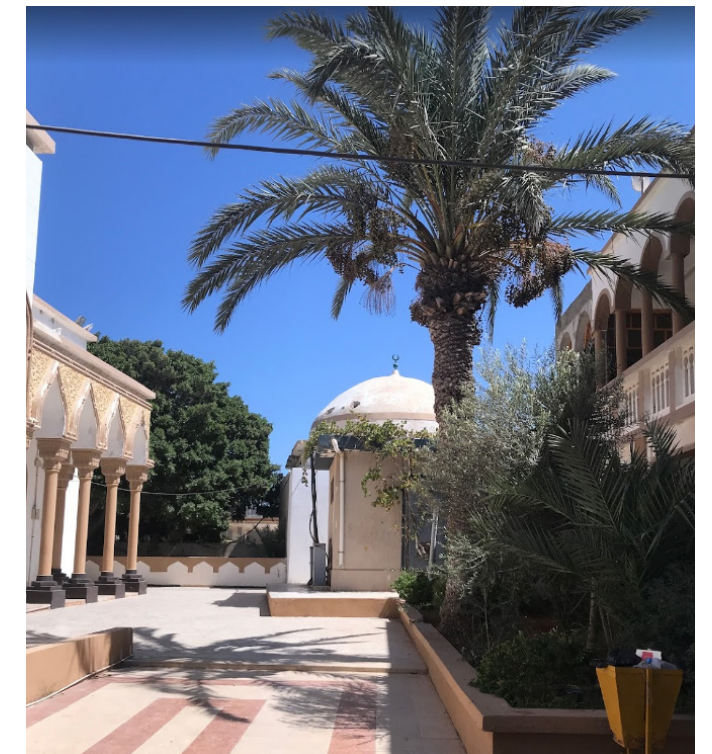
DERNA



Al Ain, 20.09.2023



El Watan news, 23.09.2023



Google maps, uploaded by M. Ebdawi, 08.2023

DERNA
AL JARABA MOSQUE

Date of construction 1558
 Current state 50% Destroyed
 50% Demolished
 Function Mosque



The Jaraba mosque is situated in the Maghar neighborhood, and was built in 1558 in the first Ottoman era by a family from Djerba. It was not built in Ottoman style but is characteristic of local architecture with horseshoe arches and short columns. The plan is irregular to fit in the urban context. Even before the floods, the structure was in a bad state of conservation, but the storm led to its partial destruction before it was torn down for safety measures.



Libyan Antiquities Authority, 08.2021

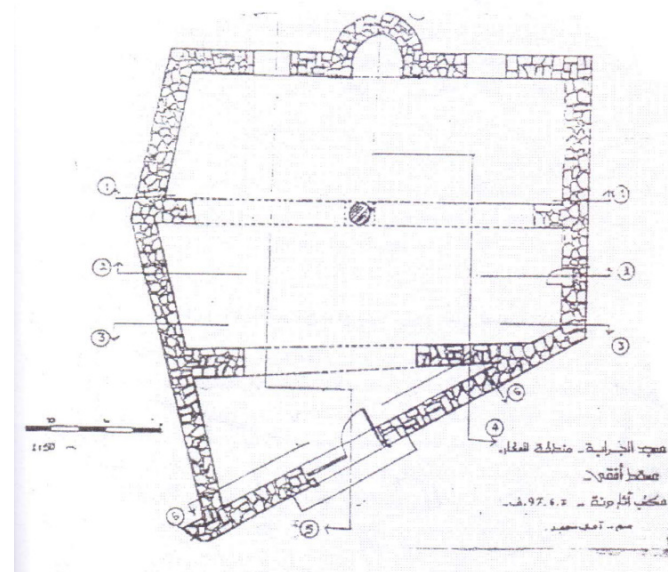


Libyan Antiquities Authority, 08.2021

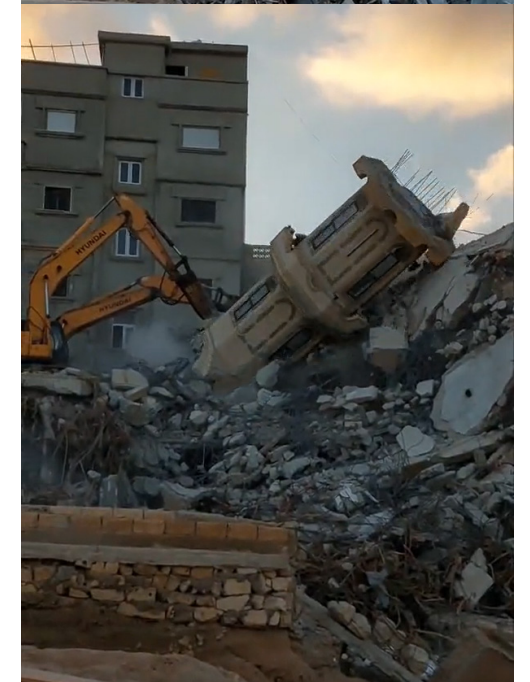
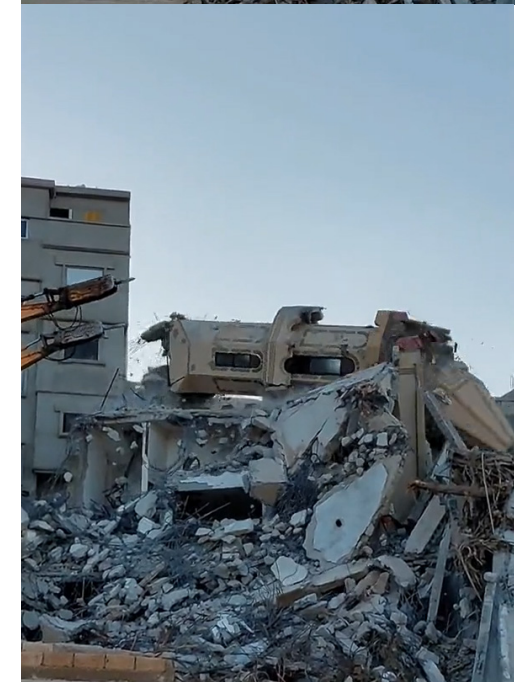
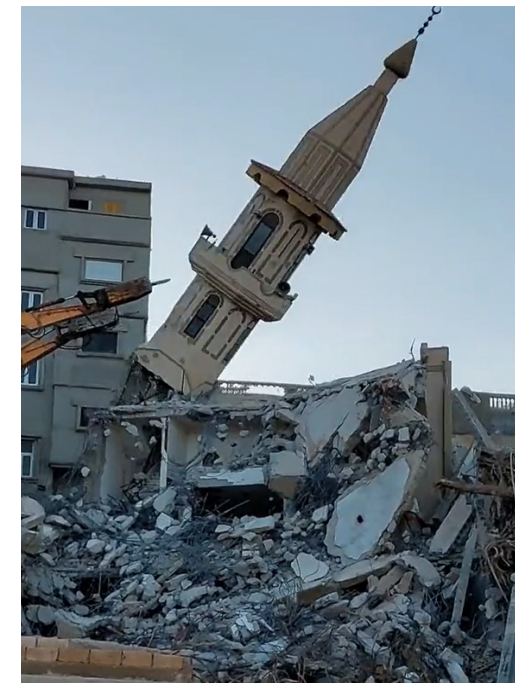
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Libyan Red Crescent Society, 09.10.2023



Fawzia Tarban Jabrni Jaber, Journal of the Faculty of Arts, Cairo University, Volume 80, Issue 1, January 2020



Ayman Said Balha, Facebook October 13, 2023

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AL FATH MOSQUE

Date of construction	XX century
Current state	40% Destroyed
Function	Mosque



Al Fath mosque is situated on the western side of the river, at 500 meters from the beach. The floods have severely damaged the facades of the mosque, destroying its columns, posing a structural threat to the building. Inside, the damages appear to be minor with no apparent structural damage.



15.09.2023, corriere della sera

DERNA



Al Fath mosque Derna, Facebook, 18.07.2018



Al Fath mosque Derna, Facebook, 05.10.2023



Al Fath mosque Derna, Facebook, 05.10.2023



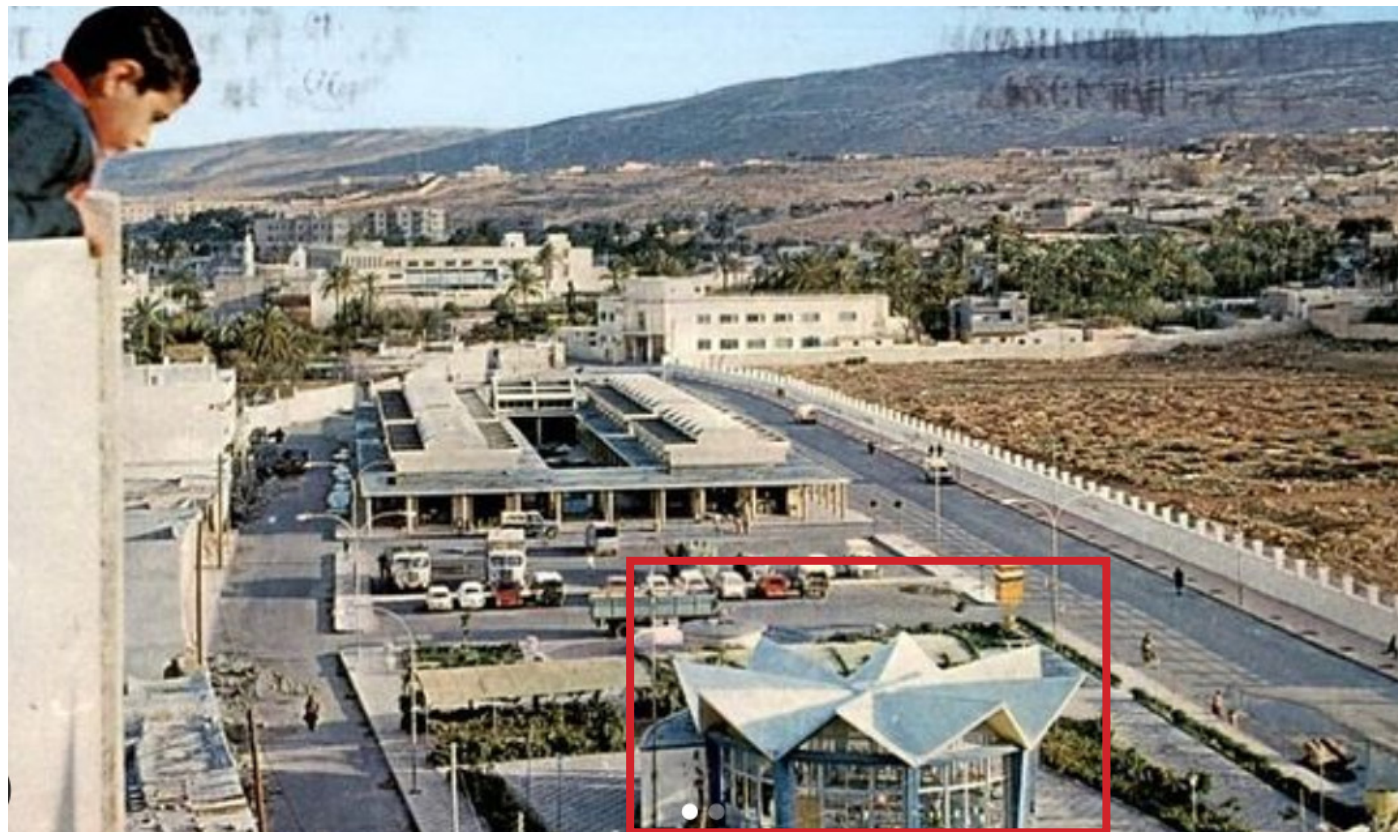
Al Fath mosque Derna, Facebook, 05.10.2023

DERNA
STAR CAFÉ

Date of construction Circa 1920
Current state 100% Destroyed
Function café



Star Café is a rationalist structure probably dating back to the 1930's when Derna was under Italian rule. It is located next to the Sahaba mosque and the city's main vegetable market. The structure is made of concrete, glass and metal. It was a "rendez-vous" point for locals. It has been completely wiped by the floods.



Postcard featuring Star Café circa 1940, before the construction of Al Sahaba mosque

DERNA



Google maps, uploaded by M. Ebdawi, 08.2023



Derna Zoom, unknown date



Google maps, uploaded by M. Elhassadi, 09.2017



Google maps, uploaded by M. Shaheen, 06.2020

DERNA
KING IDRIS LIBRARY

Date of construction 1920
 Current state 40% Destroyed
 Function Public Library



Archives of Prof. S. Shennib, unknown date

DERNA

King Idris Library, also known as Al Zuhur Palace was built in 1920 to be the headquarters of the Italian ruler. In 1956, after the liberation, it was turned into a royal palace, then into the city's Education directorate in 1964. In 2011, during the Libyan revolution, the building was damaged and became a private residence for armed forces and their families. It was finally transformed into a public library, set to open in December 2023.

The floods caused significant damage to the ground floor, in addition to complete damage to all garden works, piazza arches, fences, gates, external floors, air conditioning works, carpentry, electricity, painting...



24.01.2012, king idris the first library, Facebook



09.2023, Facebook



04.10.2023, king idris the first library, Facebook



12.09.2023, Jamal Alkomaty/AP



04.10.2023, king idris the first library, Facebook,



04.10.2023, king idris the first library, Facebook

DERNA
DARNES SPORTS CLUB

Date of construction XX Century
 Current state 50% Destroyed
 Function Sports and cultural complex



The Darnes Sports, Culture and Socials Club was founded in 1958 and named after the ancient name of the city of Derna.

The floods caused devastating damages to the stadiums, facilities, administrative building as well as the shops, restaurants and hotel surrounding the complex. The costs of building a new stadium are valued at 10 million dollars.



Reuters, 12.09.2023

DERNA



Anadolu Agency, 11.09.2023



Ibrahim Ellembi, google maps, 10.2023



Office of the Ministry of Sports - Eastern Province, 22.09.2023



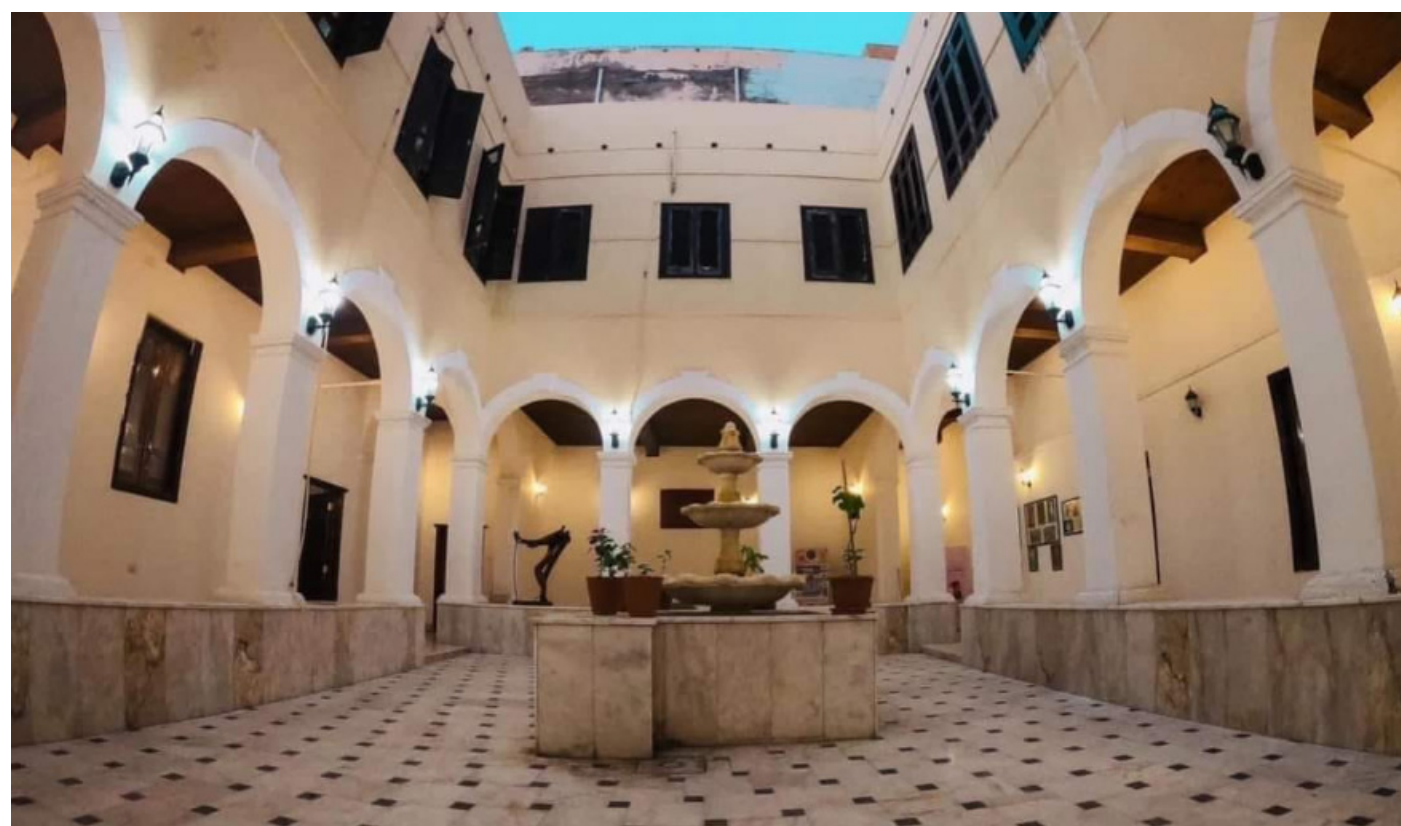
Office of the Ministry of Sports - Eastern Province, 22.09.2023

DERNA DERNA CULTURAL CENTER

Date of construction Unknown
 Current state 90% Destroyed
 Function Cultural center

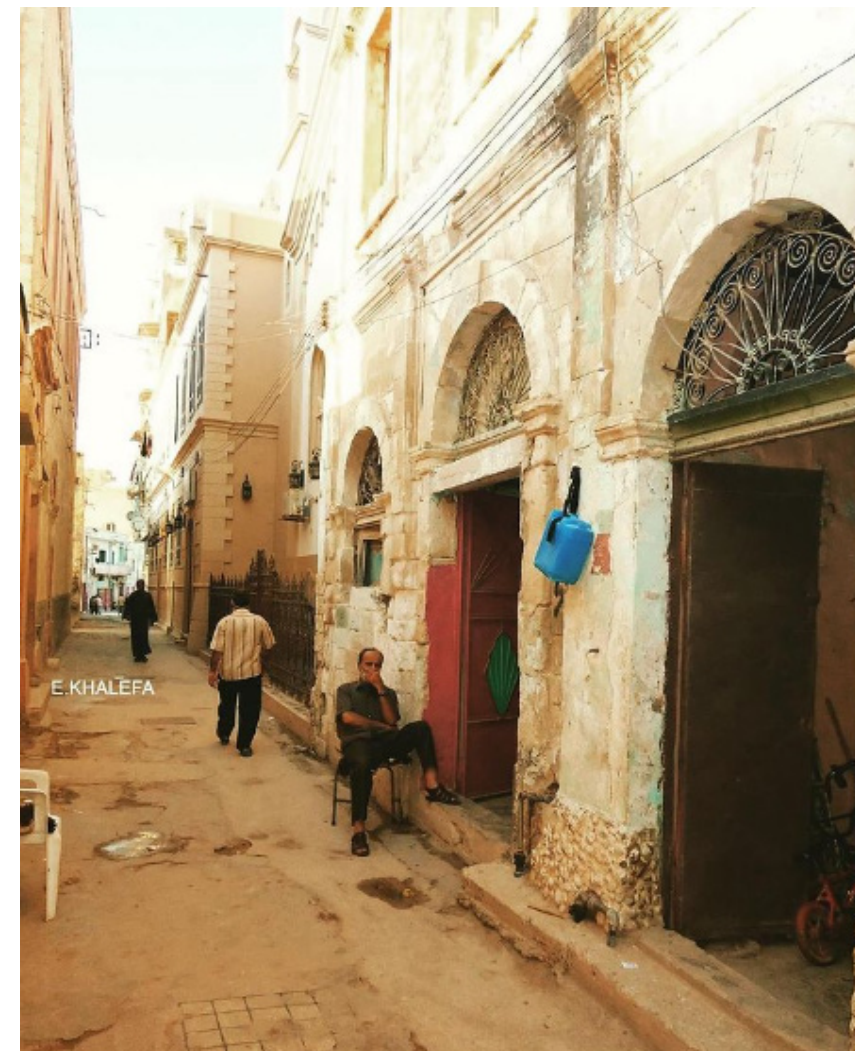


The Derna Cultural center was founded in 1977 in a former church. It welcomed literary and artistic fairs, as well as local film and music festivals. The church was destroyed during the Libyan war but was restored and brought to its former glory. The floods completely wiped the structure which was renovated in 2021.



Sbenkes Zorqane, 2021

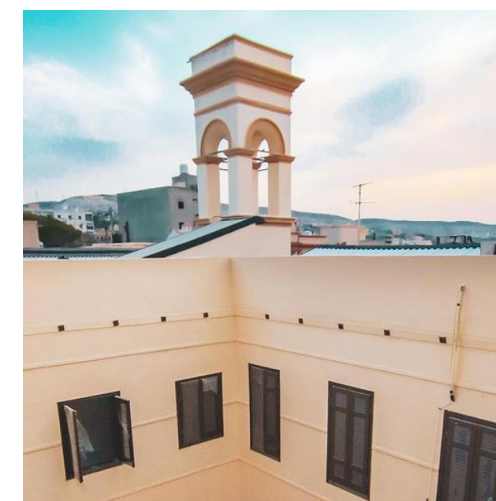
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E. Khalefa, 2019



M Eckream, 2021



H. Elmstiry, 2021



Sbenkes Zorqane, 2023

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MAUSOLEUM OF SIDI ALI AL-WASHISH

Date of construction

Past state

Current state

Function

Destroyed in 2014

Unknown

Shrine



The Mausoleum of Sidi Ali Al Washish was one of the oldest shrines in the city. In May 2014, the shrine was blown up and leveled to the ground. The floods wiped all traces that remained of this shrine.



Archivio centrale dello stato, 1938

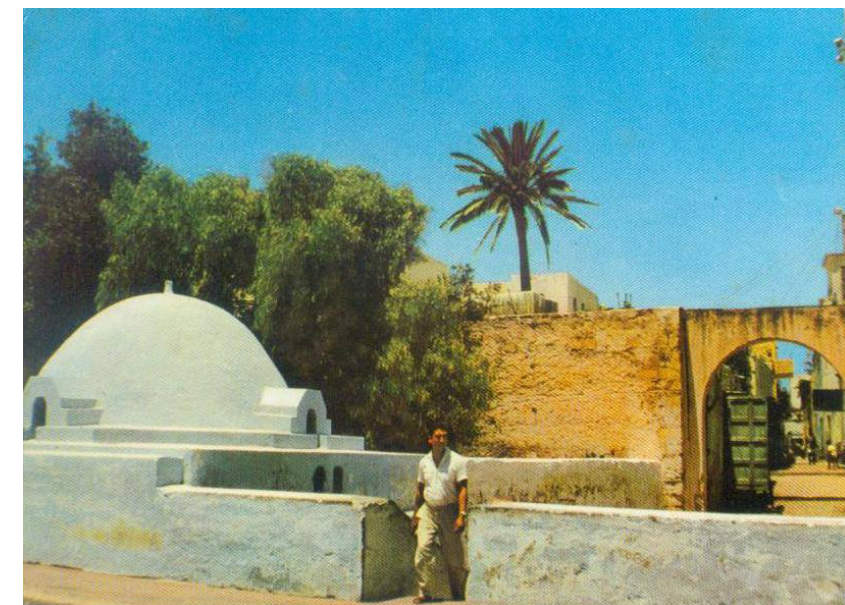
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Archivio centrale dello stato, circa 1920



View of the mausoleum in 1936, unknown source



View of the mausoleum in 1970, unknown source

DERNA

ZAWIYA AL RIFAIYA

Date of construction	Unknown
Current state	Undamaged
Function	Mosque



The Zawiya Al Rifiya is located on the western bank of the Derna river. The decorative elements are characteristic of local architecture with horseshoe arches and limestone wash facade. From the satellite imagery, the site does not seem impacted from the flood.



Archivio centrale dello stato, 1938

DERNA



Derna Archives, 2013



Archivio centrale dello stato, unknown date



Archivio centrale dello stato, 1951

APOLLONIA



Satellite imagery - Apollonia , 04-2018 GoogleEarthPro

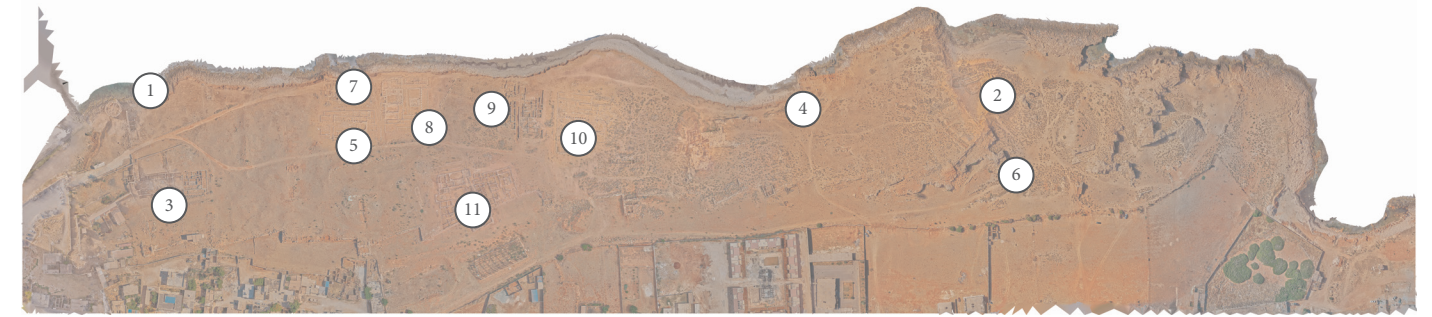


Satellite imagery - Apollonia , 12-2021 GoogleEarthPro



Satellite imagery - Apollonia , 10-2023 PlanetMonthly

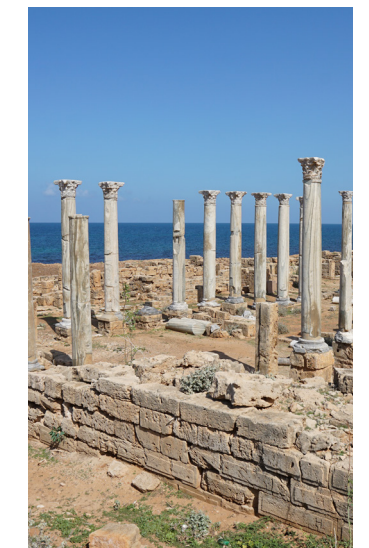
APOLLONIA



Apollonia ,Orthomosaic 07-2017 Iconem

The mission conducted in 2017 was carried out in collaboration with the Libyan Department of Antiquities (DoA) and the French Archaeological Mission in Libya (MAFL).

- ① Historical Port
- ② Amphitheater
- ③ West Church
- ④ Warehouse
- ⑤ Central Church
- ⑥ Eastern Necropolis
- ⑦ Industrial Installation
- ⑧ Roman Baths
- ⑨ Residential Insula
- ⑩ Eastern Church
- ⑪ Palace of the Dux



Drone Images - Apollonia , 09-10-2023 Iconem

APOLLONIA

DAMAGE ASSESSMENT

SOAKED SOIL AND CAPILLARY RISE

The ancient site of Apollonia in Libya, nestled by the seaside, is under intensified threat not only from the persistent dangers of capillary action but also from a recent flood that struck just two months ago.

This coastal location inherently draws saline water from the sea into its subterranean layers due to capillary forces.

As this saline moisture permeates the porous structures of Apollonia's historic relics, salts can crystallize within, leading to potential expansion and fracturing of invaluable artifacts and remnants of ancient architecture.

Moreover, the continuous moisture, intensified by the recent flood, exacerbates the soil's anoxic conditions. Such conditions are conducive to the proliferation of microorganisms which may precipitate the degradation of organic archaeological materials. The flooding, by saturating the site even more extensively, has potentially expedited the already existing threats, making imme-



Amphitheatre - Apollonia , 09-10-2023 Iconem

APOLLONIA

diate preservation actions even more imperative. In the face of these challenges, it's crucial to take swift measures to safeguard the rich cultural legacy of Apollonia.

Capillary rise in concrete joints poses a distinct issue. Unlike stone, these joints have different characteristics. They trap water, which in turn undermines the very equipment they are meant to strengthen.



Apollonia , 09-10-2023 Iconem



Apollonia , 09-10-2023 Iconem



Apollonia , 09-10-2023 Iconem



Apollonia , 09-10-2023 Iconem



APOLLONIA

DAMAGE ASSESSMENT

LANDSLIDE

The site of Apollonia in Libya, perched near the coastline, faces not only the challenges associated with its seaside location but also the looming threat of landslides. While coastal factors like capillary action expose the archaeological treasures to moisture and salt intrusion, the recent flood two months ago has brought an added risk: destabilizing the soil structure and making the site more vulnerable to landslides.

These sudden and downward movements of a mass of rock, earth, or debris can be catastrophic, potentially burying or displacing invaluable artifacts and remnants of Apollonia's storied past.

Such landslides can irreparably damage the site's structural integrity and the delicate stratigraphy that archaeologists rely upon for their research. The combination of saturated soil from the recent flood and the inherent instability



Apollonia , 09-10-2023 Iconem

APOLLONIA

of the coastal terrain makes Apollonia particularly susceptible. To ensure the preservation of this invaluable heritage site, proactive measures against landslide risks are important.

While the traces of the landslide are not significant at the moment (compared to the 2019 orthomosaic), it is crucial to monitor them closely.



Apollonia , 09-10-2023 Iconem



Apollonia , 09-10-2023 Iconem



Apollonia , 09-10-2023 Iconem



Apollonia , 09-10-2023 Iconem



APOLLONIA

DAMAGE ASSESSMENT

WATER STAGNATION

The site confronts a pressing conservation challenge in the form of water stagnation. While factors like its seaside location and recent flooding events contribute to heightened moisture levels, the retention of water within the site's buildings and substructures poses a threat.

Stagnant water can lead to the degradation of ancient masonry, eroding the very foundations of these historical edifices. Moreover, pools of stagnant water become breeding grounds for harmful microorganisms and pests, which can further deteriorate both organic and inorganic archaeological materials.

The humidity created by trapped water can also promote the growth of molds on organic relics. For Apollonia, where each structure holds invaluable insights



Apollonia , 09-10-2023 Iconem

APOLLONIA

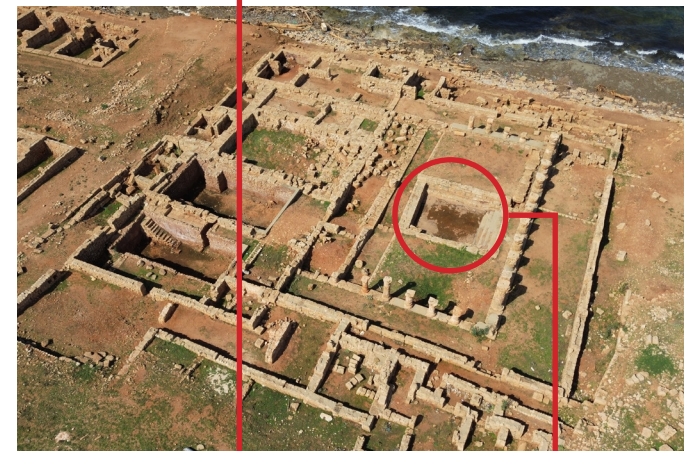
into civilizations past, addressing water stagnation is crucial to ensure the longevity of its archaeological legacy.



Apollonia , 09-10-2023 Iconem



Apollonia , 09-10-2023 Iconem



Apollonia , 09-10-2023 Iconem



Apollonia , 09-10-2023 Iconem

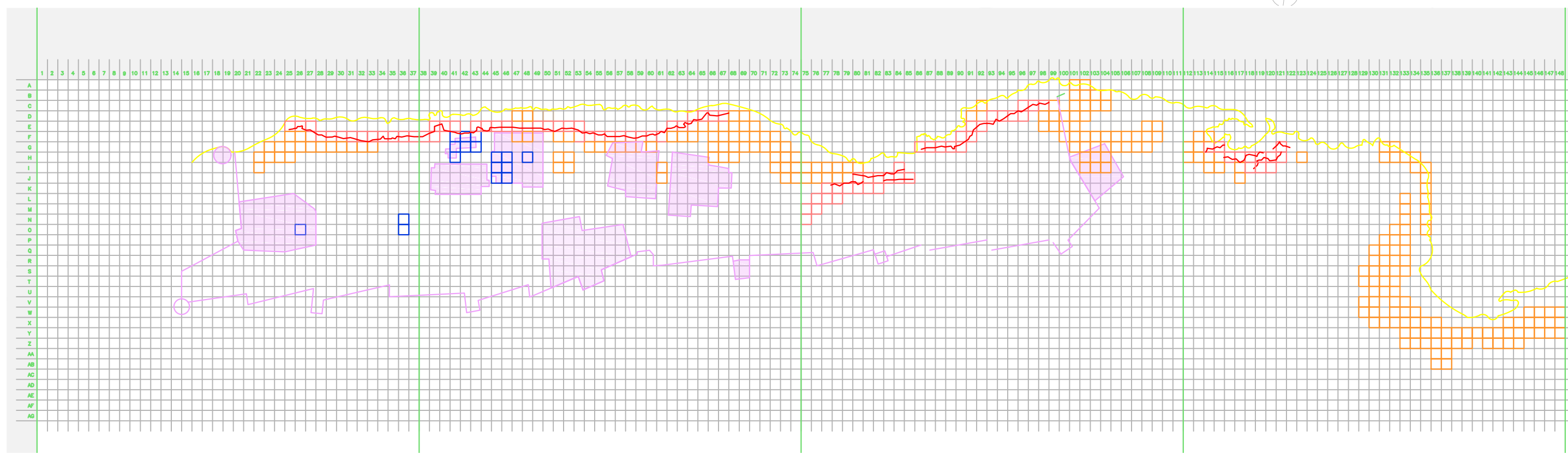
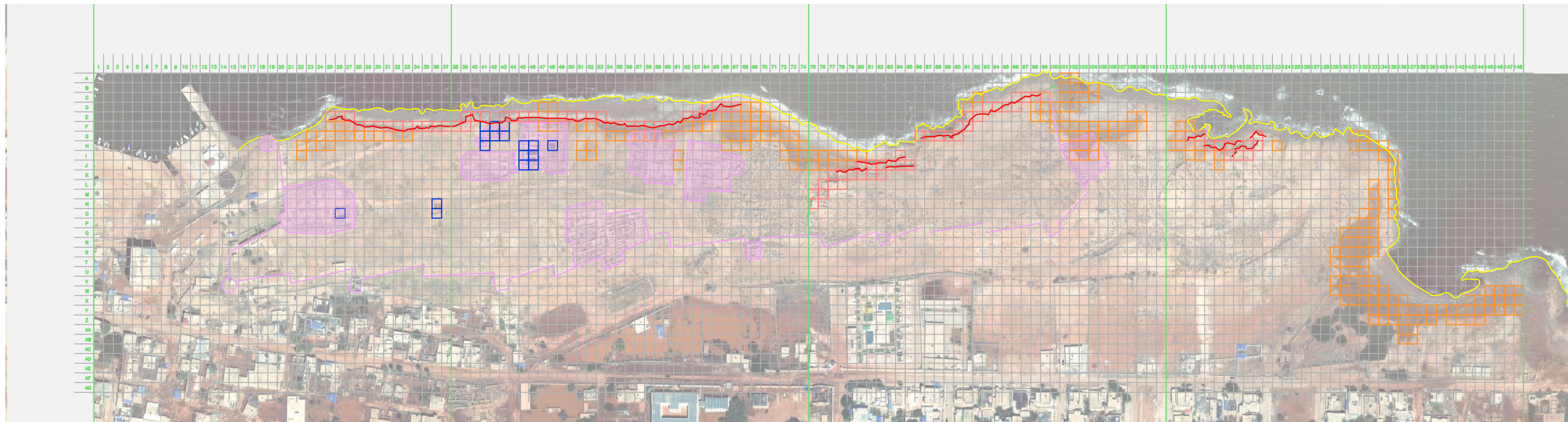


SEQUENCE 1

SEQUENCE 2

SEQUENCE 3

SEQUENCE 4



- Soaked soil
- Water Stagnation
- Landslide impact
- Coast-line
- Landslide path
- Archaeological structures
- 10m x 10m location grid

APOLLONIA

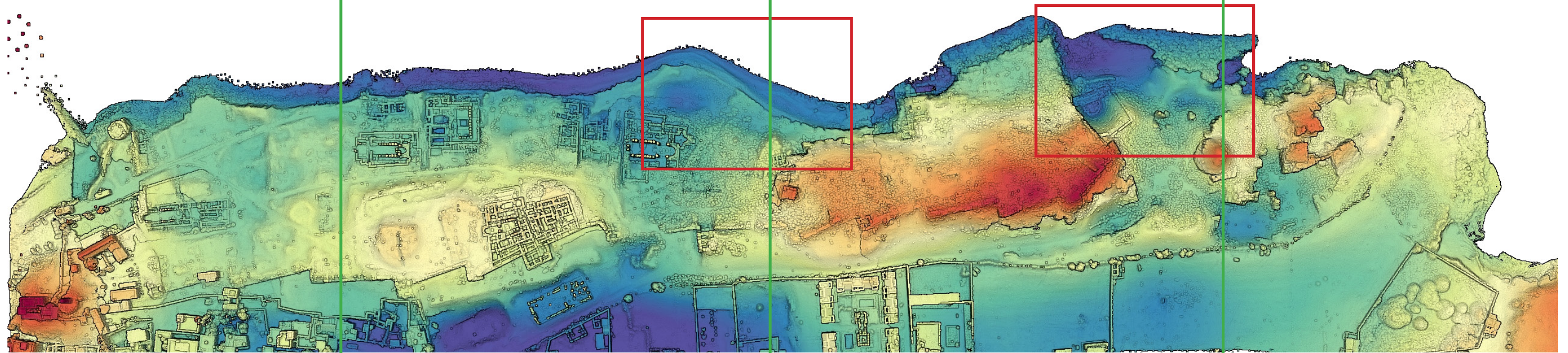
APOLLONIA

SEQUENCE 1

SEQUENCE 2

SEQUENCE 3

SEQUENCE 4



Apollonia, Elevation Orthomosaic 07-2017 Iconem



The altimetry presented is scaled but not geo-referenced

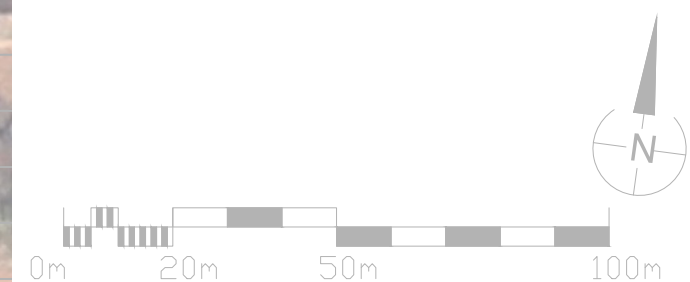
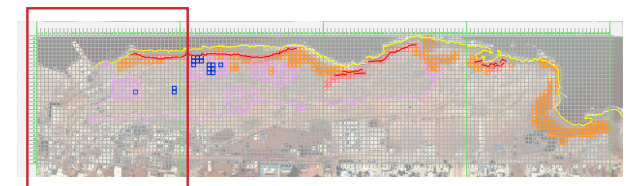
The morphology of Apollonia directly influences the observed pathologies. The areas at altitudes close to sea level have led to water intrusion in specific zones, as indicated by the red boxes.

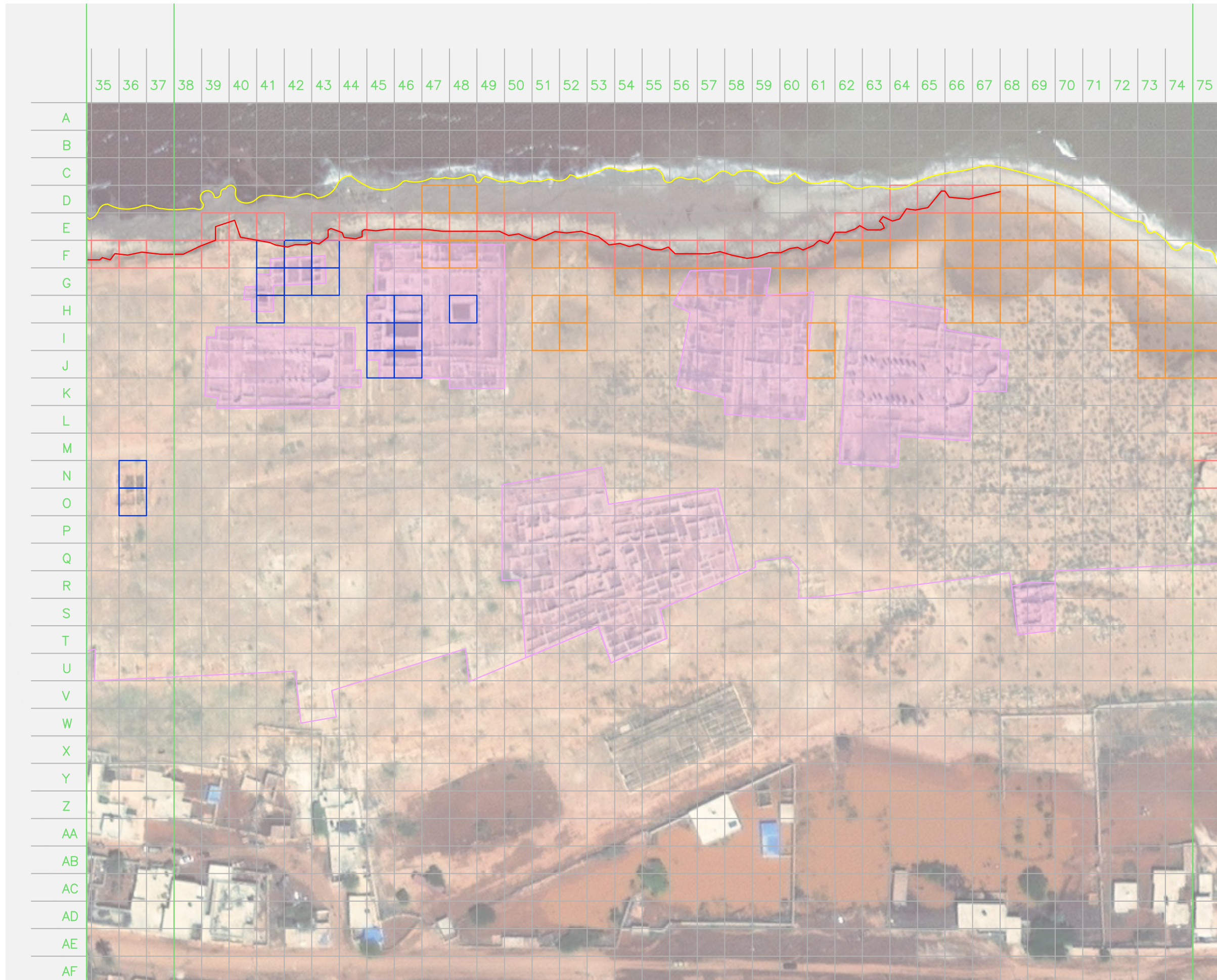









Apollonia ,Orthomosaic 07-2017 Iconem

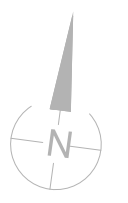
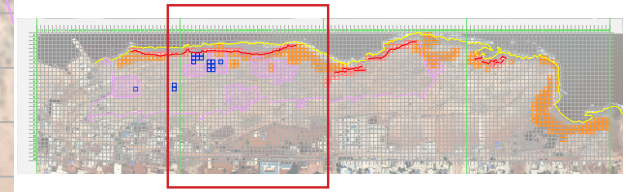


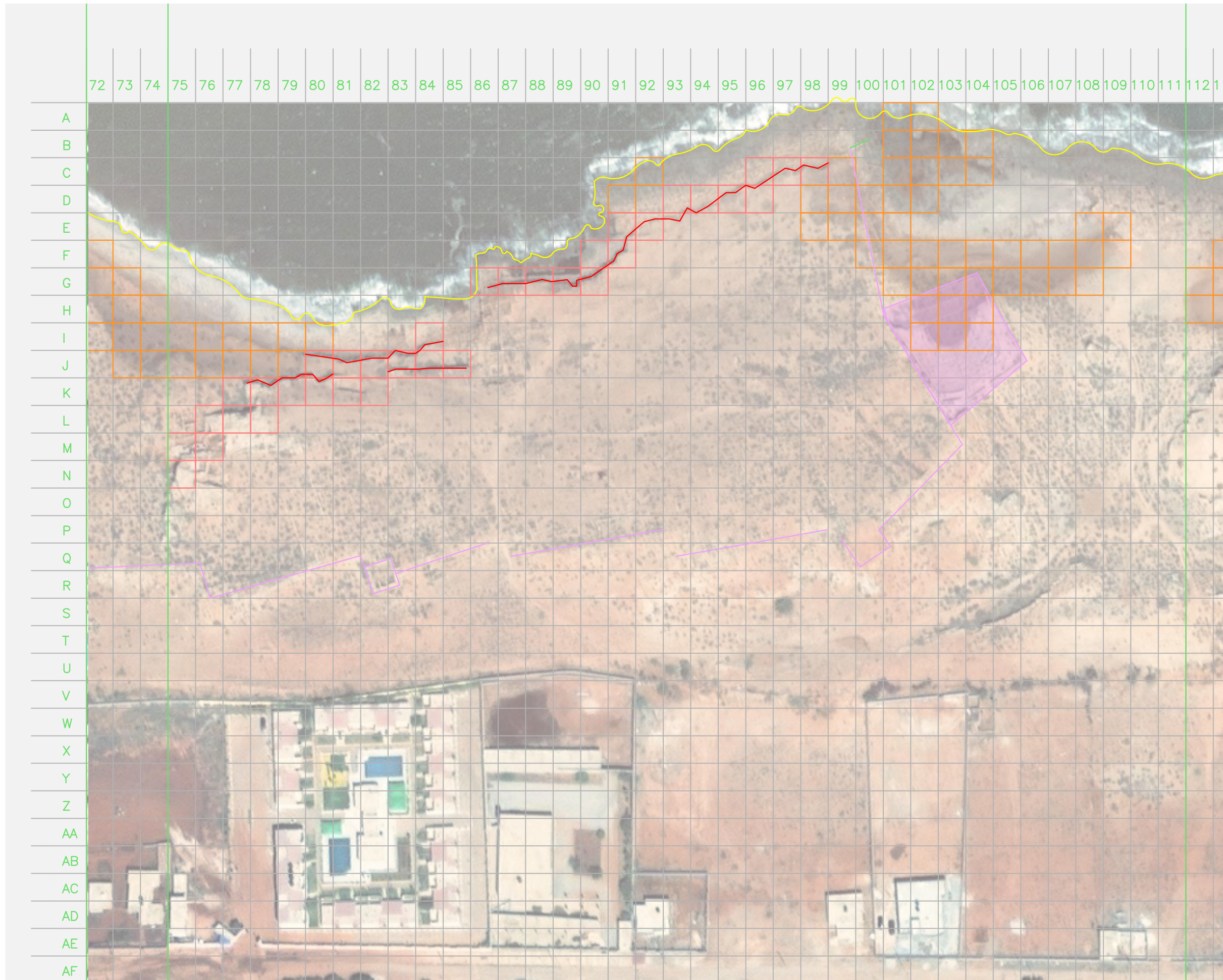
- Soaked soil
1800M2
- Water stagnation
300M2
- Landslide impact
1300M2
- Coastline
- Landslide path
138M
- Archaeological structures
- 10mx10m location grid



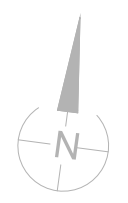
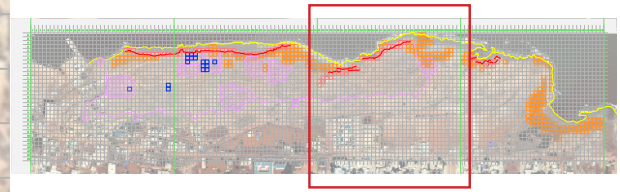


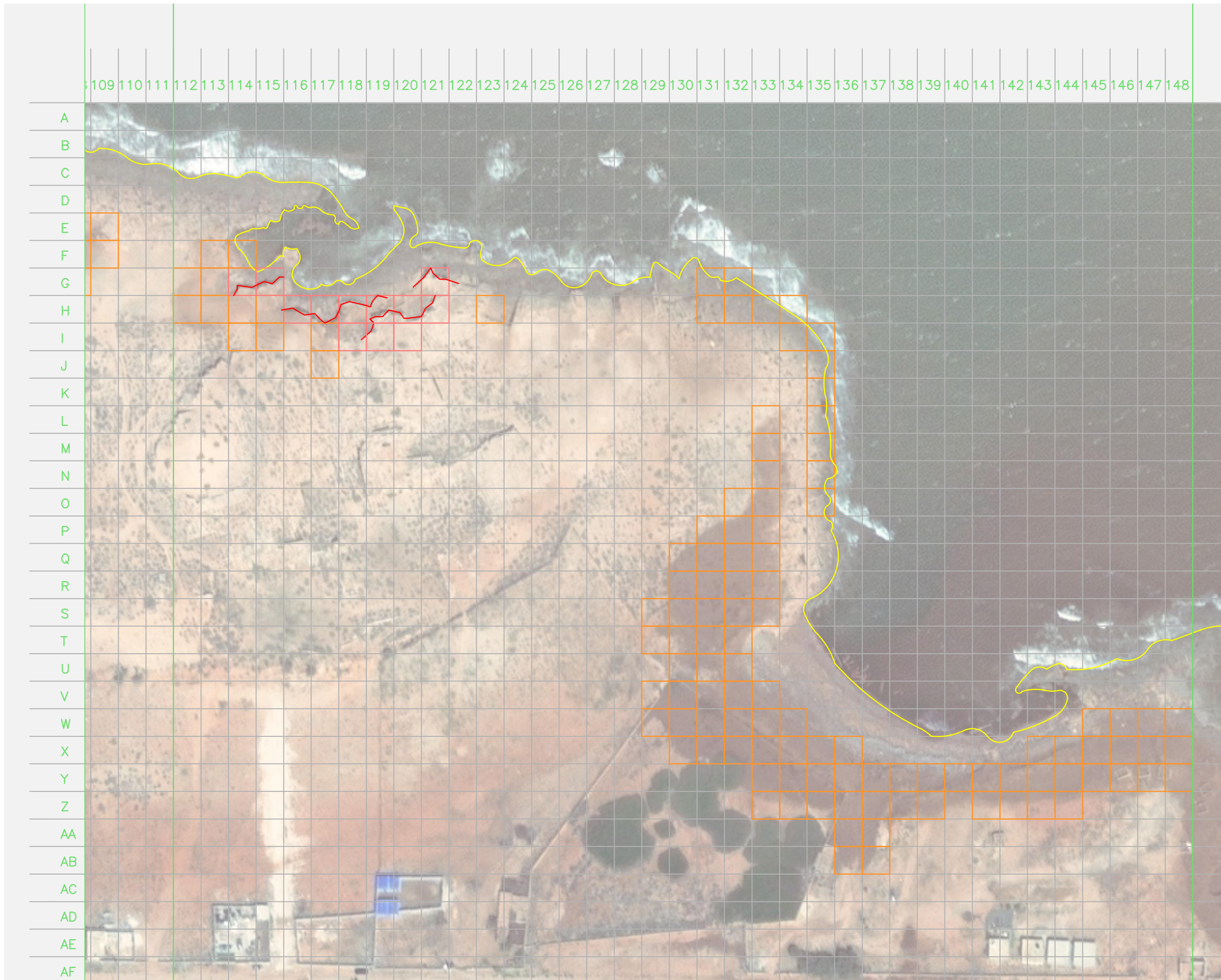
-  Soaked soil
600M2
-  Water stagnation
140M2
-  Landslide impact
3300M2
-  Coastline
-  Landslide path
342M
-  Archaeological structures
-  10mx10m location grid



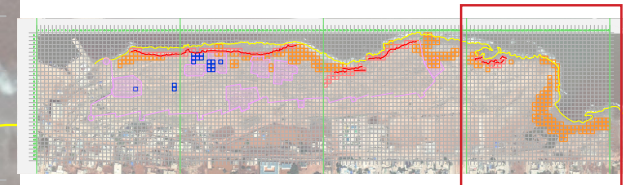


- Soaked soil
7000M2
- Water stagnation
-M2
- Landslide impact
3800M2
- Coastline
- Landslide path
265M
- Archaeological structures
- 10mx10m location grid





- Soaked soil
11100M2
- Water stagnation
-M2
- Landslide impact
1300M2
- Coastline
- Landslide path
132M
- Archaeological structures
- 10mx10m location grid



CYRENE

DAMAGE ASSESSMENT

GENERAL OVERVIEW

The archaeological site of Cyrene also fell victim to the floods. The observation and analysis of satellite data proved to be limited, failing to precisely pinpoint damages. Nonetheless, notable modifications were observed. Consequently, we opted to compare satellite photos taken before and after the catastrophe in specific areas.

The site photos provided clarity in identifying various types of damages in certain zones. The images within the report offer insight into the nature of the damages, akin to those observed at the Apollonia site: soaked soil and capillary rise, landslide, and water stagnation.



Apollonia , 09-10-2023 Iconem

CYRENE

It's essential to note that while the nature of the damages is similar, the location of the Cyrene site differs from that of Apollonia, being directly open to the sea. Therefore, a more in-depth exploration of the details becomes crucial for effectively guiding emergency interventions.



Cyrène , 09-10-2023 Iconem - soaked soil and capillary rise



Cyrène , 09-10-2023 Iconem - soaked soil and capillary rise



Cyrène , 09-10-2023 Iconem - soaked soil and capillary rise



Cyrène, 09-10-2023 Iconem - Landslide

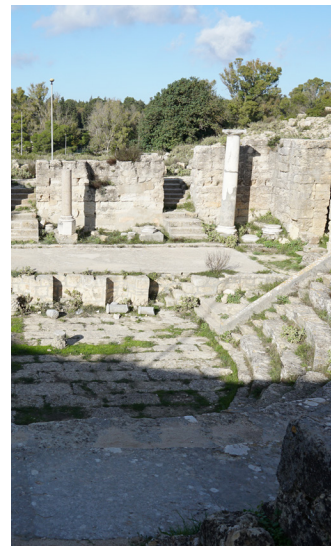
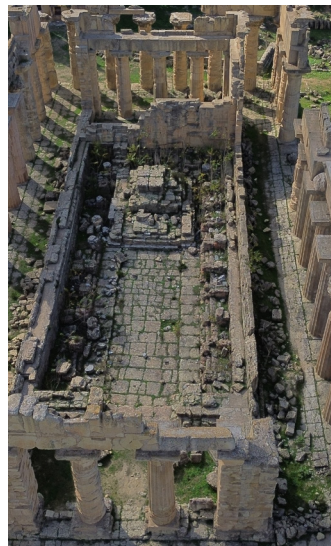


CYRENE



Satellite imagery - Apollonia , 04-2018 Maxar

- ① Amphitheatre - Temple of Apollo
- ② Theatre - Gymnasium – Odeon
- ③ Temple of Demeter
- ④ Temple of Zeus
- ⑤ Necropolis



Drone Images - Cyrene , 09-10-2023 Iconem

CYRENE



Cyrene , 09-10-2023 Iconem



Cyrene , 09-10-2023 Iconem



Cyrene , 09-10-2023 Iconem



Cyrene , 09-10-2023 Iconem



Cyrene , 09-10-2023 Iconem



Cyrene , 09-10-2023 Iconem



Cyrene , 09-10-2023 Iconem

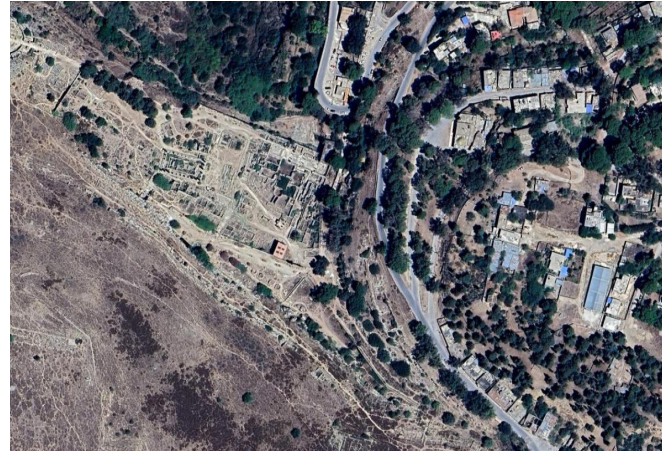


Cyrene , 09-10-2023 Iconem

CYRENE



Satellite imagery - Apollonia , 04-2018 Maxar



Satellite imagery - Cyrene , 10-2023 Maxar

CYRENE



Satellite imagery - Apollonia , 04-2018 Maxar



Satellite imagery - Cyrene , 10-2023 Maxar



Satellite imagery - Apollonia , 04-2018 Maxar



Satellite imagery - Cyrene , 10-2023 Maxar



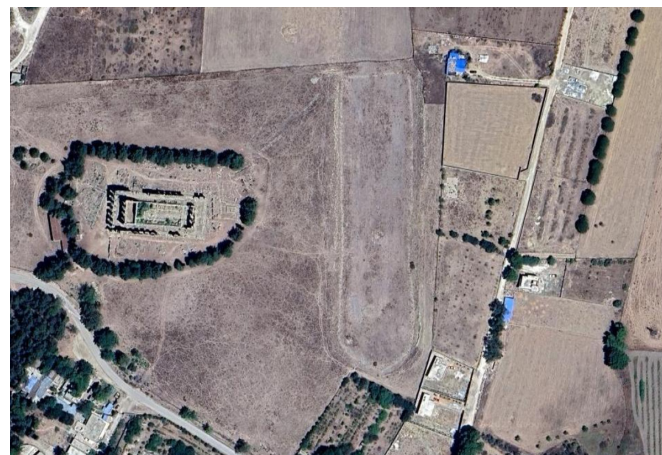
Satellite imagery - Apollonia , 04-2018 Maxar



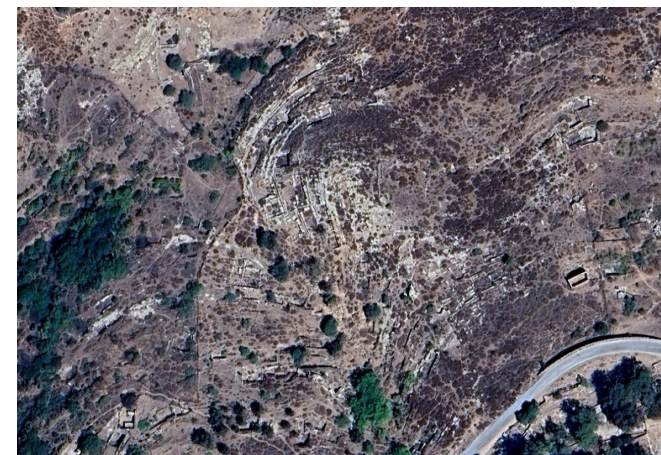
Satellite imagery - Cyrene , 10-2023 Maxar



Satellite imagery - Apollonia , 04-2018 Maxar



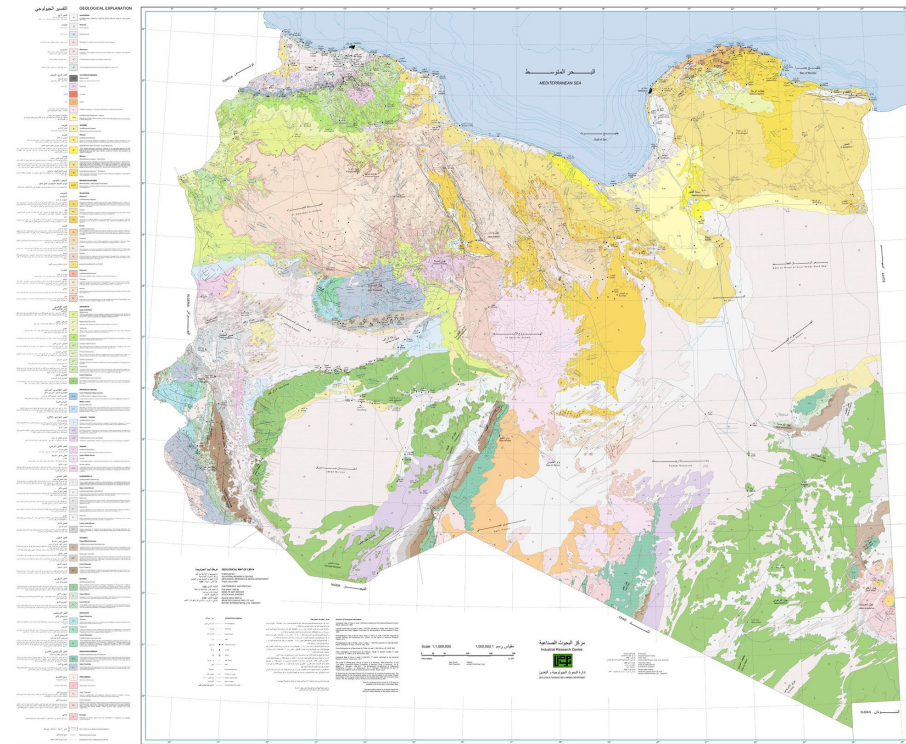
Satellite imagery - Cyrene , 10-2023 Maxar



Satellite imagery - Apollonia , 04-2018 Maxar



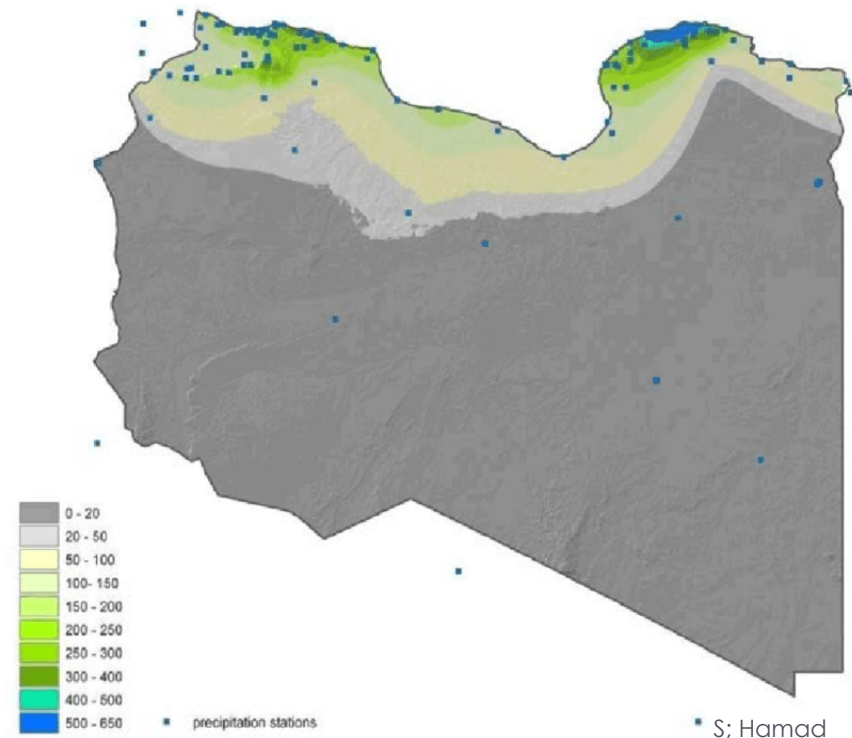
Satellite imagery - Cyrene , 10-2023 Maxar



GEOLOGICAL MAP

Geological research and mining Department

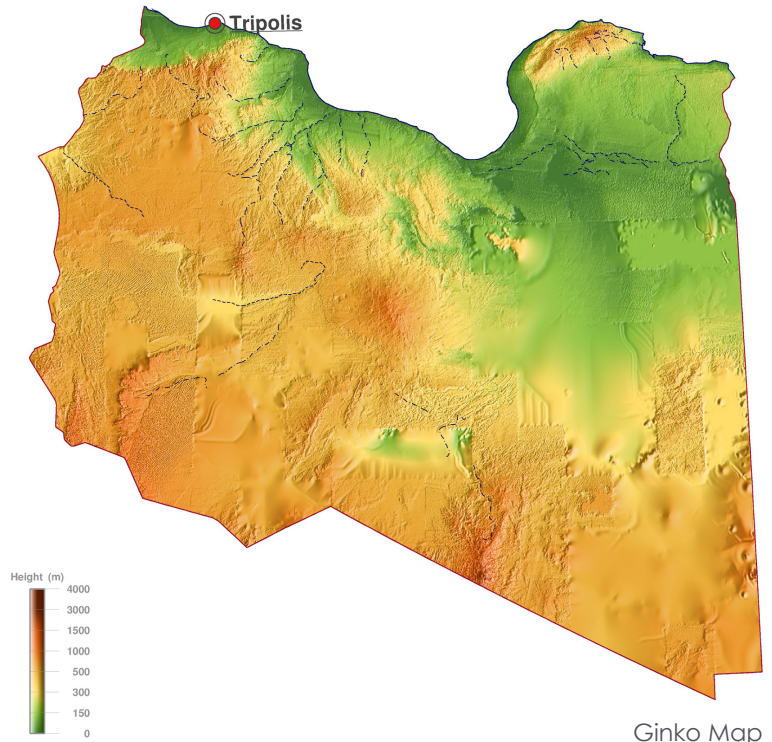
The geological map shows us that the Cyrenaic region dates back to the Miocene era, with little zones dating to the Oligocene and the Eocene. The southern region is either desertic (sand dunes) or semi-desertic (stone/gravel land), Further north, the soil changes into rangelands, as well as some cultivated land. We can also observe small patches of rain-fed and irrigated land. The Cyrenaic region is quite rich in soil diversity, which poses different challenges.



PRECIPITATION MAP

precipitation stations S; Hamad

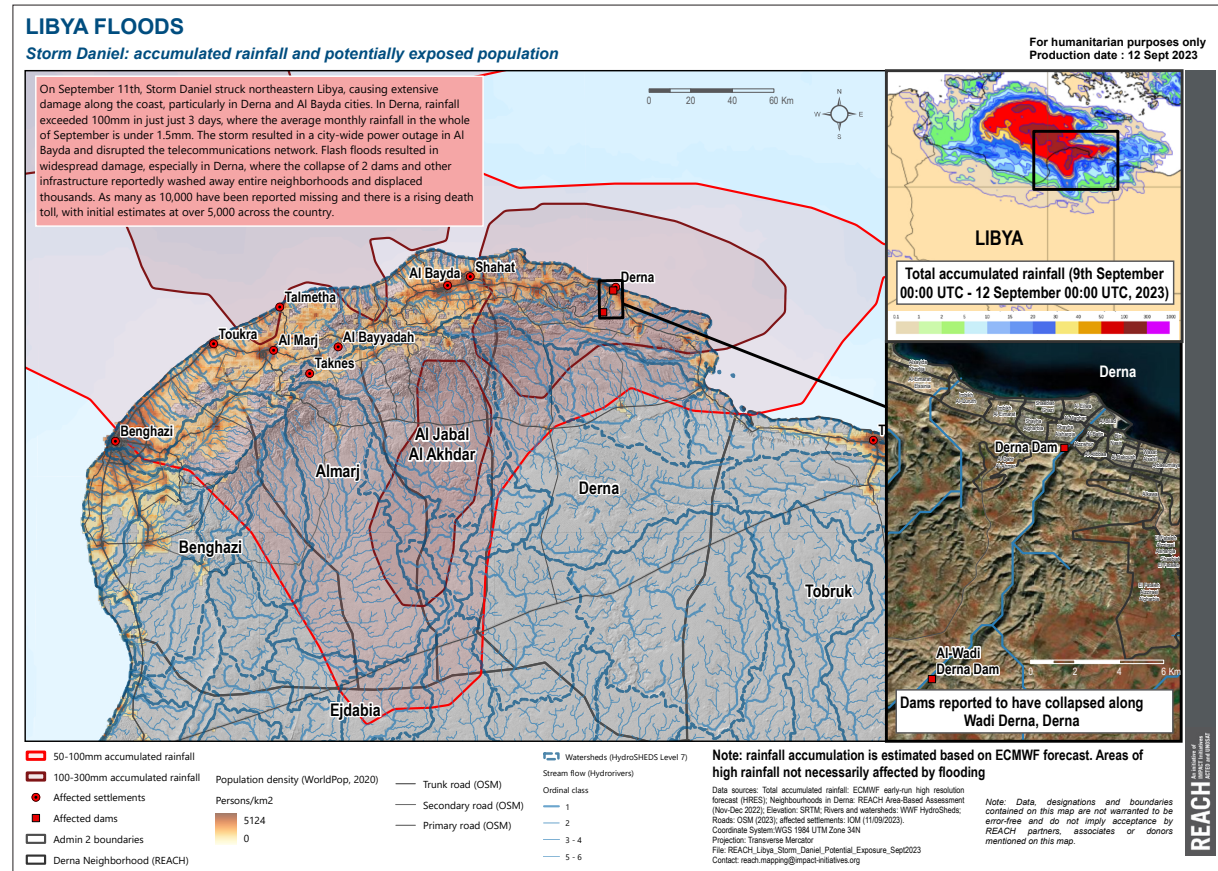
The climatic conditions in Libya are influenced by the Mediterranean sea to the north and the Sahara to the south, creating a sudden change of weather. The level of precipitation is quasi non existent on the majority of the territory. However, the coastal area is particularly prone to rainfall (primarily in late autumn and spring). The above map indicates that the Cyrenaic region is the wettest areas in the country with some 600ml of precipitation annually.



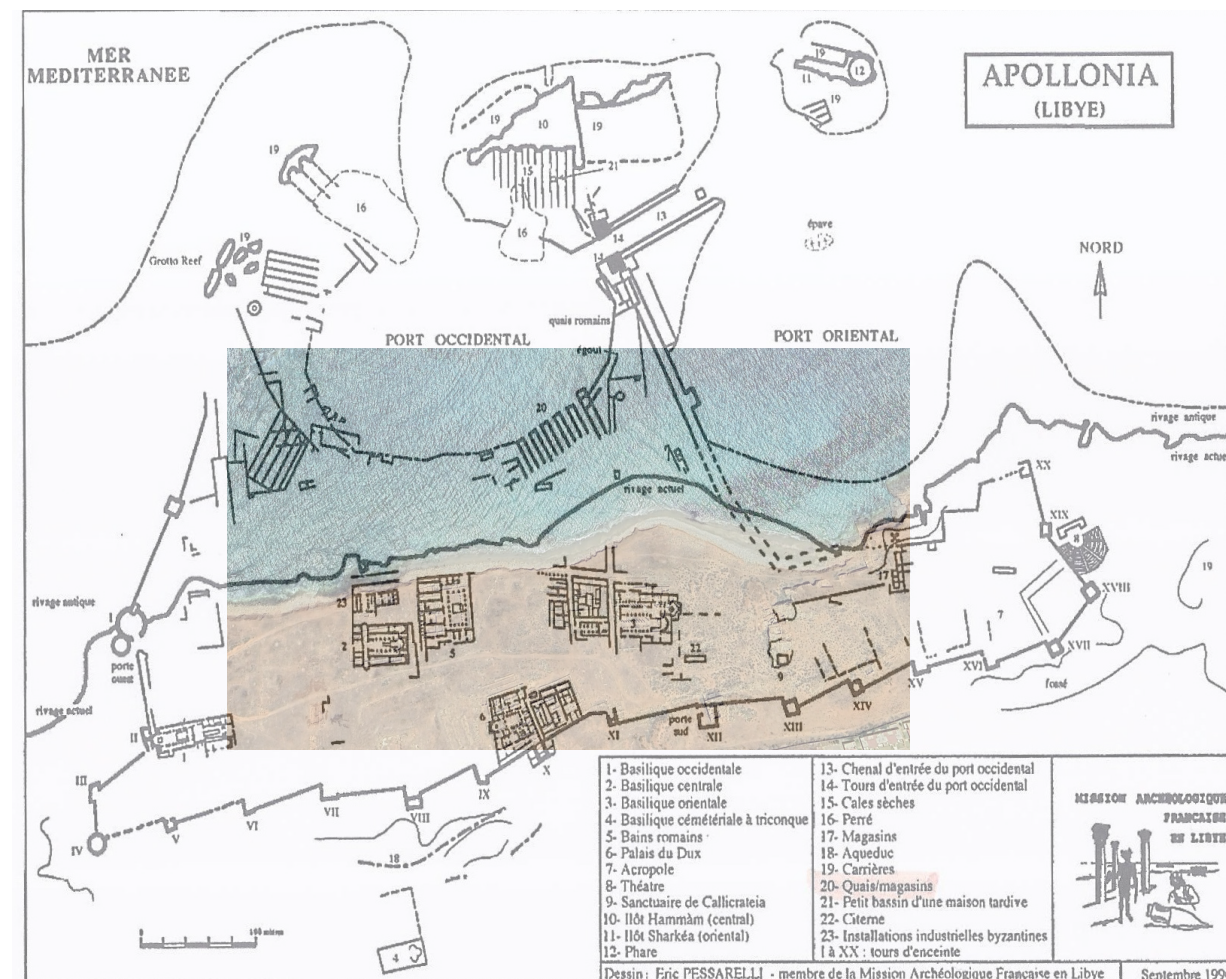
RELIEF MAP

Ginko Map

The relief map of Libya shows us that the Cyrenaic region is predominantly flat, with the exception of the Djebel Akhdar plateau which culminates at 900m, fronting the coast for 330 km and forming cliffs on the headlands. The area is highly fertile, creating a favorable environment for agricultural and herding activities marking a contrast with the rest of the territory which is particularly arid.



Accumulated rainfall and potentially exposed population map, September 12th, 2023, REACH



Map of Apollonia (1996) overlapping satellite image (2023) showing submerged ruins of the site, as well as the retreat of the shoreline between 1996 & 2023.

COASTAL EROSION

Coastal erosion is the biggest threat to Libyan archaeological sites in the Cyrenaic region. It may be precipitated by various causes including natural and anthropogenic threats, such as wind, sand & wind erosion, and varies in rate & magnitude.

DEFORESTATION

Deforestation is the conversion of forest land to agricultural or urban uses. Climate change is also a factor in the reduction of forest land. It impacts coastal heritage sites in Libya because the removal of vegetation increases rainwater runoff and the risk of mudslides. It also increases the risk of flash floods.

DESERTIFICATION

Desertification is the transformation of once fertile soil into barren land. It can be caused by overexploitation of soil and the effects of climate change. The major consequences of desertification are reduced biodiversity and lower soil productivity. It can cause a reduction of infiltration into the soil, with a corresponding increase in the maximum flood discharges.

MORE FREQUENT STORMS & FLOODS

The aforementioned causes, combined with the ever-growing climate crisis all contribute to more frequent storms and floods, just as we've seen on September 10th 2023. The primary consequence of storms and floods on coastal sites is erosion, stagnation, capillary rises, landslides and submersion.

URBANIZATION

Urbanization is a prominent threat to cultural heritage sites, as constructions of rigid structures such as dams and roads prevent water to evacuate naturally in the event of heavy rains. Population figures for Libya have risen from 1.24 million in 1950 to 6.87 million people in 2020 (UN), mainly along the coastline.

SAND MINING

Sand mining is the extraction of sand mainly from beaches for construction or manufacturing uses. It is a direct cause of erosion and impacts wildlife. Satellite imagery show us an increased rate of coastal retreat in recent years, this shoreline contraction poses a direct threat to heritage sites located in these affected

WAVE/TIDAL REGIMES

Over the last century, the sea level globally rose by 16-21 cm. For sites such as Apollonia, this means previously immersed structures are now submerged. Moreover, increasingly violent waves are causing substantial erosion and collapse to archaeological buildings.

CYRENAIC COASTAL RISKS



Copernicus, 03.11.2023

LIST OF ARCHAEOLOGICAL SITES IN THE CYRENAIC REGION

- ① ROMAN RUINS OF BENGHAZI
- ② TAUCHEIRA
- ③ PTOLEMAIS
- ④ QASR LIBYA/ THEODOREAS
- ⑤ PRE HELLENISTIC TEMPLE OF SULUNTAH
- ⑥ ROMAN RUINS OF AL BAIDA
- ⑦ CYRENE
- ⑧ ANCIENT MACAREUS CITY
- ⑨ RUINS WEST OF APOLLONIA
- ⑩ APPOLONIA
- ⑪ QASR AL MARAGH
- ⑫ KHAWLAN CASTLE
- ⑬ QASR WARTIJ
- ⑭ BYZANTINE CHURCH
- ⑮ AL ATHRUN/ ERYTHRON

CYRENAIC COASTAL RISKS



Khaled Elhaddar, 10-2023



Ahmad Al Barassi, unknown date



Maher Alawami, 2020



Eric Lafforgue, 2007



Iconem - 09-10-2023



Maher Alawami, 2018



Eric Lafforgue, 2007



Maher Alawami, 2018



Maher Alawami, 2019



Qasr Libya Museum



Google Earth 2023



Maher Alawami, 2019



Sanad Alahlafi, 2013



Iconem - 09-10-2023



Abdo Serta, 2019

CONCLUSION

The situation report presented by Iconem for the city of Derna and the archaeological sites of Apollonia and Cyrene after the September 10th floods underscores the profound impacts it had on these sites.

Our investigation reveals a bleak reality: many sites within Derna, including many historical landmarks which were recently restored following the devastation caused by Daesh and the Libyan war, have been critically damaged, if not completely wiped out. The cultural heritage of this ancient city has been irrevocably altered.

The archaeological sites of Apollonia and Cyrene, too, bear the weight of intense water damages, including capillary rise, water stagnation, and landslide. These sites, once part of vibrant civilization, are now left weakened by natural disasters.

This report serves as a reminder of the importance of preserving and safeguarding cultural heritage, and it is our hope that the recommendations outlined in the document will guide efforts to ensure the resilience of these landmarks.

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