Multiple Hazards Model, Analysis of The Geomorphological Hazards of Flash Floods on The Archaeological Sites of The El-Ambagi Basin, Eastern Desert, Egypt

Emad El BARDAN¹, Magdy TORAB², Samah ABO ZEID³, Shahenaz EL GAMMAL⁴

Abstract:

The term "multi-hazard risk analysis" refers to a comprehensive concept that includes the analysis of the risks in a given time and place, their size, the description of how they interact and the interpretation of the cumulative effects on a target group. It builds on single-hazard analysis and produces results that go beyond the simple sum of its elements. Extreme hazards are defined as those whose statistical significance is exceptionally high or which exceed a predetermined threshold. Multi-hazard risk analysis is a general term that refers to the analysis of the dangers in a given time and place, their magnitude, the description of how they interact and the interpretation of the results of this compounding on a target group. The basin of Wadi El-Ambagi is located east of the city of El-Quseir, on the Red Sea coast, between the Hurghada and Marsa Alam Cities. The basin extends from 25° 40´ to 26° 15´ N and from 33° 45´ to 34° 15´ E, and it covers about 1930 km². The objective of this paper is to build a model of the multiple hazards risk resulting from the flash floods on the Wadi El-Ambagi basin, and analyze their effects on the road connecting the cities of El-Quseir and Qift, as well as the archaeological observation points built by the Romans to secure the gold mines road in Wadi El-Hamamat. The multi-hazard risk analysis can be categorized as qualitative, quantitative, and semi-quantitative, in addition to field geomorphic surveying, RS interpretation and GIS mapping.

Keywords: multi-hazard risk analysis; Wadi El-Ambagi, El-Quseir; The Red Sea; Egypt.

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1. Introduction:

1.1. Location:

Wadi El-Ambagi basin is located in the central part of the Eastern Desert of Egypt about 60 km to the west from El-Quseir City and drains directly to it (Fig. 1). Wadi El-Ambagi main course is bounded by longitudes 33°45ʹ E to 3415ʹ E and latitudes 25°40ʹ N to 26°15ʹ N. It covers an area of about 2000 km² and can be reached easily through Qift/El-Quseir Road where most of the tributaries of the wadi and the main course lies on the southern flank of the road and the small eastern part of it lies on the northern flank just before its drains to El-Quseir city on the Red Sea coastal zone. That eastern reach of Wadi El-Ambagi is what so called “El-Ambagi Protected Area” where a lot of surface water, desert plants, birds and occasionally desert wild animals can be seen.

Source: Using ARC MAP software, based on satellite visualization Landsat ETM+, 11 band, 2023.

Fig.1: location of the study area
1.2. Objective:
The objective of this paper is to build a model of the multiple hazards risk resulting from the flash floods on the Wadi El-Ambagi basin, and analyze their effects on the road connecting the cities of El-Quseir and Qift, as well as the archaeological observation points built by the Romans to secure the gold mines road in Wadi El-Hamamat.

The current study aims to identify the geomorphological hazard facing the sites of towers (Forts A, stations), Roman castles, and Arab facilities that were built in the valleys. The study focuses on those located in Wadi El-Ambagi, and the extent to which they are affected by floods resulting from torrents. The geographical survey and analysis showed that the sites of towers and castles The Roman era was carefully chosen from the Pharaonic era to the Roman era and then the Arab (Islamic) period. However, some of the Arab facilities that pilgrims used to rest were built in the depths of the valleys and thus disappeared due to the effects of torrential floods.

1.3. Previous work
1.3.1 Previous work concerning the Geology:
(El Bahariya, 2021) stated that the Eastern Desert of Egypt is part of the Neoproterozoic Arabian–Nubian Shield and displays different occurrences of Neoproterozoic ophiolitic mélanges. The mélanges contain exotic and native blocks and fragments of variable sizes and types set in a sheared and schistose volcaniclastic matrix. The main exotic blocks are ophiolitic and include metamorphosed ultramafic rocks, metagabbros, massive and pillowved metabasalts and pelagic sedimentary rocks. Based on the mode of occurrences of the ophiolitic components and the processes of mélange formation, the ophiolitic mélanges of the Central Eastern Desert are classified and mapped into tectonic mélange, olistostrome and olistostromal mélange. The whole rock associations of these mélanges were subjected to two different events of deformation (D1 and D2) and contemporaneous metamorphism (M1 and M2).

He, also, added that the ophiolitic components represent fragments of oceanic lithosphere that formed in a back-arc/arc environment, and were incorporated into the mélange through tectonic and/or sedimentary processes. Both tectonic and sedimentary processes played a major role during mélange formation in a back-arc or inter-arc setting.
(Yousif and Sracek, 2016) wrote on water resources assessment in arid lands which is of a particular interest, not only in scientific terms, but also under the concept of sustainable development. The study area (El-Ambagi basin), represents a remote arid area with a scarcity of data. The measured effective porosity and permeability revealed high potentialities of the Nubian sandstone and Oligocene sediments. The hydrogeologic setting indicates favourable conditions for groundwater accumulation where there is an opportunity of recharge, and thus, the sustainability of the groundwater. They based on their work on geological investigations as well as several data layers in the GIS environment including landforms, lithology, slope, soil, morphometric parameters, structural lineaments, and geophysical data.

1.3.2. Previous work of the geoarchaeology:

(Schörle, 2010) stated that the archaeological work over the last decade has considerably revised and revived the Roman Eastern Desert. The combined evidence for marble quarries, the mining of precious ores, and gems, as well as passing trade offers a new perspective on this now relatively desolate landscape. The role of the state, and in particularly of the military, should not be underestimated, and much has been written on the presence of the military in the Eastern Desert. Transience happened through specific networks of fixed settlements in the landscape; praesidia offered animal lines, hydreomata the water resources; these sites presumably offered food, safety as well as shelter, even if traders were probably most often accompanied by private escorts. She, also, added that the meetings of cultures of the Eastern Desert and its coastal stretch happens on the local, regional, provincial and inter-provincial levels, when the fisherman on the road meets the prostitute, gem traders, transporters and the likes of Gaius Peticius in charge of costly goods from India for prominent Italian families.

(Bülow-Jacobsen, 2013) studied the Communication, travel, and transportation in Egypt’s Eastern Desert during Roman times (1st to 3rd century AD). He concluded that: In Roman times, Egypt’s Eastern Desert, i.e. the arid zone between the Nile and the Red Sea from modern Za’farana in the north and Berenike in the south, was economically important for stone and minerals, especially granite from Mons Claudianus and porphyry from Mons Porphyrites. It was also important because the trade routes to Arabia, Eastern Africa and India passed that way. Three main desert roads, equipped with fortified stations (praesidia) at more or less regular intervals, are known: (1) the
road to Myos Hormos (Qoseir al Qadim), (2) the road to Berenike, and (3) the quarry-road to Mons Porphyrites and Mons Claudianus. There was also the Via Hadriana, from Antinoopolis to Berenike, which was mostly of military importance. In Roman times the most important trade route was from Koptos (now Qift) to Berenike (Barinees). It was longer than the road to Myos Hormos, but preferred because of the prevailing northern winds in the Red Sea which made it difficult to come back to Myos Hormos. The road from Koptos to Myos Hormos was kept manned and fortified at least into the third century and may have been important only for the ship-building in Myos Hormos, because it was easier to transport timber the shorter way from Koptos to Myos Hormos. This conclusion is based on the apparent absence of wagons on the road to Berenike, while they are well attested on the Myos Hormos Road. Myos Hormos and the road leading there seem to have been abandoned in the third century.

The roads to the quarries started in Kainepolis (Qena). Most of the stone was moved on wagons, some of them with twelve wheels, although the very largest columns must have been transported on rollers.

The work that had been done by (Gates-Foster et al. 2018) was dealing with the Eastern Desert Roads Surveys that brings together the research of two survey projects, the Michigan-Assiut Koptos-Eastern Desert Project and the University of Delaware-Leiden University Eastern Desert Surveys. The work had been started 1987 and were continued to 2001 and intermittently thereafter until 2015. These two survey teams worked independently to explore and document the archaeological remains along the routes connecting the Nile Valley cities of Koptos (modern Qift) and Apollinopolis Magna (modern Edfu) to the Red Sea port city of Berenike (now Bareneese) in Egypt. This work was resulted in the documentation of seventy discrete and different archaeological sites ranging in date from the late Dynastic to the Late Roman periods, with many sites demonstrating long-term, multi-period occupation. The survey also recorded road sections, route marking cairns and graves or cemeteries.

1.3.3. Previous work concerning the Methodology:

(Van Westen and Greiving, 2017) stated that one of the difficult issues in natural hazards risk assessment is how to analyses the risk for more than one hazard in the same area, and the way they interact. They also demonstrated that a generally accepted definition of multi-hazard still does not exist. In practice, this term is often used to indicate all
relevant hazards that are present in a specific area, while in the scientific context it frequently refers to “more than one hazard”. Likewise, the terminology that is used to indicate the relations between hazards is unclear. The simplest approach is to consider that the hazards are independent and caused by different triggers. This means that the expected losses from one hazard type are independent from the losses expected from the other hazard type. If that is the case, the risk can be calculated by adding the average annual losses for the different types of hazards.

In a technical report published by (Davies et al. 2020) which deals with Multi-Hazard Risk Model, Flooding Case Study: Selection of River System and Potential Hazard Cascades. They demonstrated that the Case Study is designed to develop a forecastable multi-hazard scenario environment with a lifespan/forecast horizon of 10-20 years. The purpose is to provide a testbed for multi-hazard forecasting, impact/operability analysis, economic analysis and decision-making tools. The river systems in the central/southern North Island were investigated systematically to establish their suitability for the Study, using the following (unranked) criteria:

a) Methodology developed will be transferable to other North Island River systems
b) Potential for realistic multi-hazard cascades
c) Potential for substantial social & economic impact, principally rural-based
d) Opportunity for internationally publishable science
e) Flood-derived impact is not made insignificant by other impacts
f) Potential for Māori exposure and linkages
g) Information available from prior research
h) Existence of realistic management options
i) Involvement of river management infrastructure
j) Potential links to other (RNC2) programs.

1.4. Methods

The research methodology consisted of two main stages: data collection and the development of a Multiple Hazards Model Geomorphological, followed by fieldwork to identify factors impacting archaeological sites.

First, the creation of a Multiple Hazards Model involved several steps. Initially, a model for geomorphological risks was developed by identifying factors affecting the study area, creating layers based on
these factors, and analyzing maps. This process involved integrating data from various layers or maps using Geographic Information Systems (GIS) software to produce a comprehensive map representing high-risk sites. This included the creation of a hydrological model to identify dry valleys and their tributaries, a slope layer derived from a digital elevation model, a land use layer based on aerial photographs, and the incorporation of climate change projections to assess future flood risk scenarios.

Secondly, the field study phase involved conducting measurements using surveying equipment and visiting the study area to monitor and identify potential risks to archaeological sites. Meetings with the research team were held to establish the objectives of the field study and ensure thorough data collection.

In summary, the research approach involved the development of a comprehensive model to understand and mitigate geomorphological risks, followed by on-site fieldwork to validate and further identify potential risks to archaeological sites.

2. discussion and results:

2.1. Geological setting:

Wadi El-Ambagi basin is covered, by both basement and Phanerozoic sedimentary rocks as seen in the geological map (Fig. 2). These two major tectonic units constitute the following chronological sequence from older to the youngest:

<table>
<thead>
<tr>
<th>Wadi Deposits ------------------------------- (Youngest)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old Alluvium</td>
</tr>
<tr>
<td>Gabal A Russas Fm (Miocene)</td>
</tr>
<tr>
<td>Nakhil Fm (Oligocene)</td>
</tr>
<tr>
<td>Thebes Fm (Eocene)</td>
</tr>
<tr>
<td>Esna Shale (Paleocene)</td>
</tr>
<tr>
<td>Tarawan Fm (mastrichtian – Paleocene)</td>
</tr>
<tr>
<td>Dakhla shale (campanian- mastichtian)</td>
</tr>
<tr>
<td>Dawi phosphate (Campanian)</td>
</tr>
<tr>
<td>Quseir variegated shale (Cenomanian – Tourmnian)</td>
</tr>
<tr>
<td>Nabia Sandstone (Taref Fm) (Cenomanian)</td>
</tr>
</tbody>
</table>

~~~~~~~~~~~~~~~~~~~~~ UNCONFORMITY ~~~~~~~~~~~~~~~~~~~

Hammamat Group
Dokhan Volcanics
Older Granitoids (granodiorite)
Metavolcanics
Ophiolitic Melnge rocks
Serpentinite
Meatiq Gneisses ------------------------------- (Older)
The following is a description of the above-mentioned rock unites exposed through Wadi El-Ambagi basin:

2.1. The Pre-Cambrian Basement Rocks:

2.1.1.1. Meatiq Gneisses:

These rocks comprise various gneisses, migmatitic gneisses, orthogneisses, and mylonites, forming a dome-like mountainous terrain at G. Meatiq. The Meatiq Dome is a metamorphic complex in the Precambrian basement of the Eastern Desert of Egypt, exhibiting features of Cordilleran metamorphic core complexes, with an antiformal structure and low-dipping foliation. The core consists of granitic gneiss followed by granodiorite gneiss, covered by tectonized mylonitic rim. The outer part transitions into low-grade ophiolitic rocks. The absence of a brittle detachment surface at Meatiq Dome distinguishes it from similar complexes (Sturchio et al. 1983) (Fig.2).

Source: Using ARC MAP software based on the Geological Map of Egypt (Qusayr) (1:500000) produced by CONOCO, 1987

Fig. 2: Geological map of Wadi El-Ambagi Area
2.1.1.2. Serpentinite:
These rocks are part of the dismembered ophiolitic sequence along Qift El-Quseir Road, intimately related to surrounding ophiolitic melange. The serpentinite exhibits characteristic large exposures with varying colors and types. In W. El-Ambagi, it occupies the central northern and southern parts, forming moderately elevated topography with gentle slopes and distinctive cavernous nature. The serpentine often changes into talc-carbonate rocks with light brown to yellowish-brown color (Fig.3).

![Fig.3: Quartz veins cut through metamorphic volcanic rocks; it appears on the left side of the main stream at a distance of 42 km from the city of Qusayr](image)

2.1.1.3. Ophiolitic Melange Rocks
These rocks are an association of part of old oceanic crust embedded in a matrix of metamorphosed sediments (schist). They are well exposed in the central part of W. El-Ambagi, covering a part of the southern flank of Qift-El-Quseir Road, with low hills of well-foliated and folded metasediments containing blocks of ophiolitic affinities.

2.1.1.4. Metavolcanics:
These rocks represent island arc volcanics formed by subduction processes of oceanic crust during the Pan-African orogeny and the closing of the Mozambique ocean. They form a relatively high
mountainous terrain in the central and western part of the mapped area, with repeated cycles of lava flows and pyroclastics, including metabasalts, metadolerite, andesitic tuffs, and agglomerates. Metarhyolites are seen forming small thick sheets and plugs surrounded by volcaniclastic sediments (Stern et al. 2004; Fritz et al. 2013 and Khamees et al. 2020) (Fig.4).

![Fig.4: A hill composed of Precambrian metamorphosed volcanic rocks on the left side of the main stream](image)

2.1.1.5. Older Granitoids (granodiorite)

Exposed in the central part of the mapped area between W. El-Ambagi and tributaries of W. Kariem, these rocks are of composition ranging from tonalite to granodiorite. They have a light grey to whitish-grey color, coarse to medium-grained texture, and are moderately to well jointed. The granodiorite cuts and intrudes both the metavolcanics and the ophiolitic melange rocks, carrying xenoliths and enclaves of them.
2.1.1.6. Dokhan Volcanics

These rocks are of limited distribution in the study area of W. El-Ambagi and covering only 51 Km2 which represent 2.69 % of the total surface area. Qift/ El-Quseir Road directly at El-Quseir town. Dokhan volcanics are a series of interlayered lava flows and pyroclastics volcanic rock that formed at the extensional within plate tectonic environment. They are typically including basaltic andesite, andesite, dacite, and rhyolite as lava flows together with tuffs, ignimbrite, and agglomerates as pyroclastics. They extrude the older rocks of serpentinite and metapyroclastics and they are, themselves, overlain unconformably by the Phanerozoic sediments from cretaceous to Miocene ages.

2.1.1.7. Hammamat Group (Hammamat molasses sediments)

These rocks form a wide basin at the area between W. Kareim and W. Abu Hammad within W. El-Ambagi area. They are a very important rock unite in the Egyptian basement rocks. They represent a group of non-metamorphosed post-orogenic sediments that formed at the late stages of shield formation. They are of continental affinities formed as products of braded stream to alluvial fan sedimentation environment. These sediments are accumulated in inter-mountainous basins and grabens with large thicknesses taking clasts, fragments and boulders from the pre-existing uplifted rocks of metavolcanics, ophiolites, granodiorites and Dokhan volcanics.

2.1.1.8. Phanerozoic Sedimentary Sequences

According to the geologic map of the study area (Conoco 1987), the measured composite section of Gebel Duwi, and the works of (Youssef 1957; Said 1992). These sediments form isolated outcrops as in Gebel Duwi and the entrance of W. Kariem at the phosphate mines area. The succession of these outcrops from bottom to top is as follows based on Geologic setting of the study area, extracted from geology maps (Conoco 1987) (Fig.5):

- Taref formation, Nubian sandstone (Turonian–Santonian): The Nubian sandstone represents the oldest sedimentary beds resting uncomfortably over the basement complex rocks and forming low topographic hills. It is built of non-fossiliferous sandstone with intercalations of mudstones. The measured thickness in the study area reaches 85 m.
Duwi (phosphate) formation (Campanian): is made of limestone with three phosphate horizons separated by beds of marl, shale, and oyster limestone. The phosphate-rich rock is dark in color and has silicified phosphatic nodules. It has a thickness varying between 6 and 10 m. (Fig.6).
- Dakhla formation (Masstrichtian–Paleocene): This formation is composed of marl and shale. In Gebel Duwi, its measured thickness reaches up to 100 m and can be subdivided into a lower marl member (Hamama) and an upper shale member (El-Bayda) (Fig.7).

- Tarawan formation (Paleocene): The formation is made up of marl and marly limestone, ranging in thickness from 6 to 10 m. (Fig.7).

- Esna formation: This formation is made up of grey laminated shale with a middle limestone member of about 50 m thick in Gebel Duwi (Fig.7).

- Thebes formation (Eocene): This formation uncomfortably overlies the Esna Shale. It is made up of limestone with flint bands or nodules and interbedded chert concretions, which forms the important topographical features of Gebel Duwi (about 285 m thick). The Thebes Formation forms old white cliffs running sharply to ground level with a dip slope of 10° to 15° (Fig.7 & 8).

Fig.7: A general view of Jabal Al-Atshan, as a part of the Jabal Dawa system, it composed of the following formations from oldest to newest:
1 Dakhla formation with loam and marl inside
2 Turan formation composed of marl and limestone
3 Esna formation composed of loam
4 Taiba formation composed of limestone
The ages of these formations range from the Paleocene to the Eocene

Fig.8: A general view of Jabal Al-Atshan: The geological formation is the Taiba Formation, whose age is the lower Eocene, it consists mostly of limestone rocks
2.1.2. Structural setting:

The Central Eastern Desert is generally covered by Neoproterozoic rocks and is characterized by the presences of two major basement tectonostratigraphic units:

A. structural basement of gneisses and related amphibolites (El-Gaby et al.; 1990; Loizenbauer et al., 2001).

B. ophiolite-island arc associations of low-grade metamorphism (Akaad et al., 1996; Wallbrecher et al., 1993).

The later was intensely deformed during oblique collision and accretion of island arc onto the Saharan Metacraton (Abdelsalam et al., 2002) forming an ophiolitic mélangé. (El Bahariya 2021) identified different Neoproterozoic ophiolitic mélangé occurrences in the central eastern desert. The structural basement and the deformed nappes are intruded by syn-tectonic calc-alkaline granites and metagabbros. The third tectonostratigraphic unit is the Phanerozoic sedimentary succession ranging in age from cretaceous to Miocene which is structurally entrapped in a structural graben formed during the Red Sea rifting tectonic. These rocks are spectacularly exposed at G. Dawi at the Eastern promontories of Qift- El Quseir road.

2.2. Geomorphic characteristics:

2.2.1. Wadi El-Ambagi basin:

The total area of the basin is about 1,500 km², the basin includes four sub-basins: Wadi Al-Bayda, Wadi Al-Nakhil, Wadi Karim, and Wadi Abu Hammad. The study area needs to provide water sources for active mining operations, for phosphate extraction and gold detection. However, the basin is exposed to sudden floods, which cause some losses to facilities and the road linking the cities of Qift and El-Quseir.

2.2.2. Drainage orders:

This layer represented the dry valleys in the study area and its tributaries. This layer was created using the Arc Map program based on the digital elevation model (DEM), and by applying hydrological analyzes a map of the dry valleys and their tributaries in the study area was obtained. Analyzing the distance from the valley body (Euclidean) to create a new layer that shows the extent of the influence of each tributary or the main valley body according to its ranks (Fig.9).
Fig. 9: The stream orders of the Wadi El-Ambagi basin’s network

2.2.3. Slope:

Using the Arc Map program, a slope layer was produced from the digital elevation model (DEM). This layer represented the slope degrees of the study area and was divided into three categories (lightly sloping lands, moderately sloping lands, and steep lands). After reclassing it, it was divided into three categories. Classes according to degree of risk (Fig. 10).
Source: Using ARC MAP software, based on a digital elevation model of the (Aster GDEM satellite).

Fig.10: Degrees of slope of the land surface in the Wadi El-Ambagi basin

2.2.4. Rainfall:

The region is characterized by little or rare rainfall. It is irregular, as it is characterized by sudden rain. It is heavy and falls in quick, short showers. It varies from one place to another and this style is known as rain with thunderstorm rain, or what is called with ascending rains, as the region is affected by depression. Seasonal Sudanese are active in spring and fall and become abundant thunderstorms (Fig.11).
2.3. Geoarchaeology:

The eastern desert of Egypt is the arid region located between the Nile and the Red Sea from El-Quseir in the east to Qift in the west (Wadi El-Ambagi), heading towards (Nile Valley). It was of economic importance for minerals, especially gold and precious stones, in the Pharaonic era. Followed by the Roman era, which followed the lead of the Pharaonic era in excavation operations, with a difference in the type of exploitation. The Romans were interested in searching for precious stones only, especially granite and porphyry. The Wadi El-Ambagi Road was also important from a commercial perspective, as it was one of the most important trade routes linking the Arabian Peninsula East...
The publication of the Eastern Desert Roads Surveys brings together the research of two survey projects, the Michigan-Assiut Koptos-Eastern Desert Project and the University of Delaware-Leiden University Eastern Desert Surveys. From 1987 to 2001 and intermittently thereafter until 2015, these two survey teams worked independently to explore and document the archaeological remains along the routes connecting the Nile Valley cities of Koptos (modern Qift) and Apollinopolis Magna (modern Edfu) to the Red Sea port city of Berenike in Egypt. The result of these surveys was the documentation of seventy discrete archaeological sites ranging in date from the late Dynastic to the Late Roman periods, with many sites demonstrating long-term, multi-period occupation. The survey also recorded road sections, route marking cairns and graves/cemeteries (Sidebotham and Gates-Foster 2018).

In Roman times, the most important trade route was from Coptos (Qift) to Myos Hormes (ancient El-Quseir). The route remained inhabited and fortified at least until the third century. Although it was longer than other routes, but preferred because of the prevailing northern winds in the Red Sea which made it difficult to come back to Myos Hormos. The road from Koptos to Myos Hormos was kept manned and fortified at least into the third century and may have been important only for the ship-building in Myos Hormos, because it was easier to transport timber the shorter way from Koptos to Myos Hormos (Jacobsen, 2013).

The watchtowers start at kilometer 90 to El-Quseir in Wadi El-Ambagi until the end of the Qift Road. The Romans used them as forts or Roman stations after the Pharaohs to secure the road and protect mining operations for the aforementioned precious stones. These towers were also very important for following up on permits to allow passage through that road. See the permits from the ruler on (papyrus papers or pottery sherds) for the Marians to permit them to pass. They are four forts called, respectively, El-Bayda, El-Hamra, El-Sayyala, and El-Zarqa (Fig.12).
The role of the army in the Eastern Desert, its location in those forts or towers along the eastern desert roads (Fig. 1), its organization, and its function in maintaining the safety of travelers, supervising the quarries of the empire, and building hydromassages (water sources) were the basis of the activity of trade operations at that time (Schorle, 2008).

These towers continued to be used until the Arab (Islamic) era to protect and secure the route for pilgrims, as the pilgrims used to move, because it was the shortest distance on the Hajj route, through Hammamet and then up to the old port of El-Quseir, which is 7 kilometers away from the present El-Quseir, and from which the old city of El-Quseir disappeared.

Many geomorphology forms appear in Wadi El-Ambagi. At the beginning of the geographical survey, lateral erosion appears, followed by a group of mountain flumes that cut off the breaking edge from the east, with the spread of Hog backs on both sides of the road, passing through the Roman towers in Wadi El-Ambagi, the number of which
increases on the convex side than on the concave side. Their number increases on the northern side than on the southern side.

These towers located in Wadi El-Ambagi are preserved are some 3.5 m high, solid and with a platform on top, and they are placed on mountains or on the plain at varying distances (from 0.4 to 6 km) (Fig. 13). The immediate thought is that they formed some kind of optical telegraph. This idea is so obvious that the Baedecker guide to Egypt from 1913, p. 358 (p. 398 in the English edition from 1929), tells us that they were built by Mohammed Ali. This is, however, not so, since they were noticed already by G.M. Browne in 1792. Their age is still debated, but they are in any case ancient, although they may be considerably younger than the praesidia. Since there are no traces of fire at the top of any of them, they cannot be beacons. The Romans did know about optical signalling with beams, perhaps something like the ‘Chappe’ optical telegraph, but such a system would presumably demand a structure for supporting and managing the beams that should still be visible in the better preserved towers (Jacobsen, 2013).

Fig. 13: One of the ancient watch towers on the sides of the main stream of the basin, it is built on the side of Wadi Qanana, one of the tributaries of Wadi El-Ambagi, which consists of Precambrian metamorphic schist rocks
2.4. Multi hazards:
2.4.1. The effect of multi-hazard spatial modeling on the road:

The Qift /El-Quseir Road, which is about 70 km long, passes through high-risk zones in the middle of the road, while the road passes through the sources of the valley with a moderate to less dangerous zone, while the road passes through the mouth of the valley with a high-risk zone, causing the destruction of parts of the road with every torrent that occurs. Therefore, the researcher believes that the road should be rebuilt on scientific foundations, to avoid the passage of floodwaters above the road by creating flood paths under the road (Fig.14 & 15).

![Fig.14: Part of the Qift /El-Quseir Road was destroyed by torrential floods](image1)

![Fig.15: The hazards of water accumulation on the Qift /El-Quseir Road](image2)
2.4.2. Hazards on the archaeological towers and fortresses:

Archaeological towers in the Qift Road are considered one of the most important roads linking the Red Sea to the Nile Valley. The Pharaohs and later the Romans paid attention to it to secure commercial convoys and also secure the gold mines in the valley. A group of guard towers were established located along the valley, and we find here that the locations of the towers were chosen very carefully so that they are located on hilltops, which has helped them survive until now, and after applying multi-hazard modeling, we find that the towers are located in medium-risk areas and less-risk areas (Fig.16).

Fig.16: One of the forts built in the Islamic period within the valley of the El-Ambagi basin collapsed

2.4.3. Multi hazards map:

2.4.3.1. Hazards on the archaeological towers:

The Qift Road is considered one of the most important roads linking the Red Sea to the Nile Valley. The Pharaohs and later the Romans paid attention to it to secure commercial convoys and also secure the gold mines in the valley. A group of guard towers were established located along the valley, and we find here that the locations of the towers were chosen very carefully so that they are located on hilltops, which has helped them survive until now, and after applying multi-hazard modeling, we find that the towers are located in medium-risk areas and less-risk areas (Fig.17).
2.4.3.2. The effect of multi-hazard spatial modeling on the road:

The Qift /El-Quseir Expressway, which is about 70 km long, passes through high-risk zones in the middle of the road, while the road passes through the headwaters of the valley in a medium to low-risk zone, while the road passes through the mouth of the valley in a high-risk zone, causing the destruction of parts from the road with every torrent that occurs, the researcher reconstructs the road on scientific foundations, to avoid the passage of flood waters above the road by creating flood holes under the road.

Preparing a geomorphological risk model requires identifying the factors affecting the study area, preparing layers for them, and processing is done on geographic information systems programs to produce the final result (Fig.17).
Conclusion:
The study concludes by presenting a map of the multiple dangers that the basin may be exposed to, and from its study, we find that the lower parts of the basin are most affected by the dangers of torrential rains, especially the town of El-Quseir located at the mouth, but the Romans succeeded in choosing most of the watch towers and securing the road in locations that are not affected by the dangers of torrents.
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