ISSN: 2690-0688

Research Article

Journal of Humanities & Social Sciences

# Early Alert Mapping for Future Planning in Marsa Alam, Egypt

**Waleed Omar[1] and Hadeel El Naggar[2*]**

*[1]Professor of Architecture-Faculty of fine arts, Alexandria University.*

*[2]Assistant professor of Architecture-American Univeristy in Dubai*

**[*]Corresponding Author**
Hadeel El Naggar, Assistant professor of Architecture- American Univeristy in Dubai

**Submitted**: 10 Mar 2023; **Accepted**: 25 Mar 2023: **Published**: 20 Apr 2023

**Citation:** Omar, W., Naggar, H. E. (2023). Early Alert Mapping for Future Planning in Marsa Alam, Egypt. *J Huma Soci Scie, 6*(4), 140-146.

***Abstract***
*Most of the Arab region is at risk of natural disasters with significant economic, social, and environmental impacts. In Egypt, floods are a real threat to biological life and assets. Significant efforts must be made to overcome damages caused by floods, either on the country level or the regional one. This study will overview one of Egypt's tourist areas, Marsa Allam. It is considered an economic asset and tourism destination; therefore, it should be protected from flood risk. The study will demonstrate a flood mitigation, preparedness, and early warning project in Marsa Allam will be presented as one of the most critical stages to protect this area from the coming flood disasters.*

**Keywords:** Mitigation, Flash Flooding, Early Mapping

## Introduction

Riverine floods, surplus water (from increasing groundwater tables), coastal floods, and flash floods are the four major types of floods. Different types of floods pose a consider- able threat to human life and property. Heavy rainfall is typically highlighted as an essential but insufficient factor for causing flash floods. Flash floods are appropriate subjects for physical geography inquiries since the entire physical environment influences their origin. Found that soil moisture levels before rainfall events are critical hydrological constraints on flash flood formation. The flood/no flood threshold may be determined reasonably using information about the watershed's topography, soils, and human effect (steep slopes, drainage density, impervious surfaces, saturated soils, and land use). therefore, specific basins respond remarkably quickly to high rainfall in the aftermath of natural drainage disruptions, anthropogenic factors are critical. In order to prevent future events or minimize their consequences, such as pre- venting an emergency, reducing the likelihood of an emergency occurring, or reducing the detri- mental impacts of inevitable emergencies a flood management life cycle should be introduced on all the risk areas which start with warning and preparedness for the risk zones, followed by response to put this preparedness plans into actions, then recovery phase which includes getting financial assistance to help pay for repair and lastly the mitigation phase which includes all activities that prevent an emergency, reduce the likelihood of occurrence, or reduce the damaging effects of una- voidable hazards. [2].

## Materials and Methods

### Potential of Early Alert and Risk Mapping

Data analysis, environmental conditions, and site visits are essential information to help decision-makers and planners to help in the future urban planning and support the current situation tackles. GIS provides practical tools for risk assessment and general natural-hazard management. Flood-prone locations can be identified using natural hazard maps. Risk and vulnerability maps assist decision-makers in promptly assessing the possible implications of natural disasters and initiating suitable mitigation actions. The information provided above assists planners and decision- makers in taking the appropriate and timely measures during the pre-disaster period. They also assist them in assessing flood-related damages and losses during post-disaster actions. Moreover, Using GIS tools to determine flood-affected areas or predict flood-prone areas using drainage basin analysis. Maps of hazard assessment and vulnerability measures are simple to produce for areas threatened by flooding and mass garbage. As a result, a developed plan for preventative measures to decrease the effects of floods and mass deposition.

An early alert can help in the prediction of a disaster 100 years ahead. Disaster risk factors should be defined clearly through morphometric analysis, quantitative description, and study of landforms, which can be applied to a specific type of landform or drainage basins and huge regions, a clear assessment and accurate predictions are to be followed.

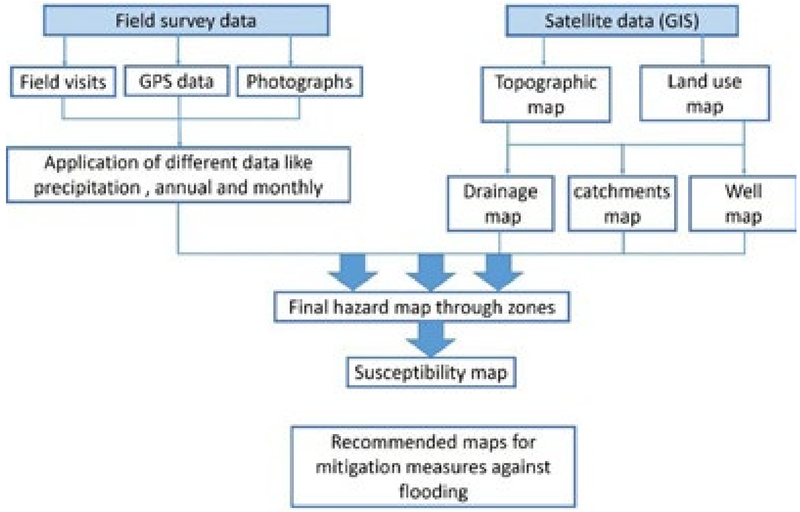


**Figure1:** Risk mapping flow chart

## Flash Flood in Egypt

Egypt is one of the arid and semi-arid Arab countries facing flash floods along the coast and the Nile Valley system. Drainage basins are a type of dry reverberation that can drain much water after heavy rain. There have been widespread flash floods in Egypt recently. Many floods have occurred in the Sinai Peninsula, mainly due to the topography of the Eastern Desert and the Red Sea Valley. The drainage basin system in Egypt is based on downstream features, channeling water towards coastal areas or the Nile/desert plateau. From 1975 to the present, Egypt has experienced severe flooding, with an estimated total economic impact of more than $1 billion each year. In addition, floods may occur in small flushing areas that affect neighborhoods or communities, as in 1992 floods, or entire river basins, such as floods in 1996 and 2010, which not only hit the Red Sea coast of Egypt but also affected the Sinai Peninsula with more the 200 death and $ 1million infra- structure damages. However, in some potential river valleys, the flood is a significant water source for the growth and establishment of new sustainable communities.

## Flash Flood Hazard in Marsa Alam

The area of Marsa Alam is consideres one of the most critical areas that are exposed to heavy rains; intensity severity of these torrents varies from one valley to another, which may cause torrential and destructive torrential rains that lead to heavy losses, among which are various types of water. The study area location is on the western side of the red sea.

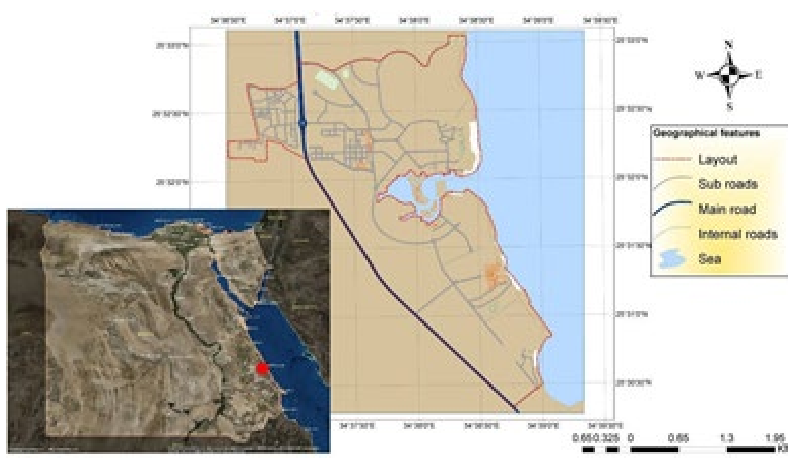


**Figure 2:** The study location" Marsa Alam "

Flash floods have become increasingly widespread and forceful in Egypt in recent years, resulting in fatalities and considerable property damage. As indicated in Table 1, destructive flash floods occurred regularly in Egypt between 1972 and 2015. According to Eliwa et al., the material in this table was acquired from available reports, newspapers, dissertations, and published articles (2015). These floods wreaked havoc on major infrastructures such as highways, buildings, power towers, villages, agricultural lands, and pipelines, injuring and killing people and animals. For example, the Taba flash flood in the Sinai Peninsula in 2014 caused 1 billion EGP in economic losses. Un- fortunately, the hazard and climate stations in the study area are minimal and need to be updated with information, reading, or records. Also, it needs to cover the total area of Marsa Alam.

**Table 1: The unpredictable flood events in the study area since 1979 to 2010**

| | | |
|---|---|---|
| May 1979 | Marsa Alam | 20 death and demolished houses |
| October 1979 | Marsa Alam- Al Qusier | 15 death and demolished houses |
| October 1990 | Marsa Alam | Destroyed houses |
| March 1991 | Al Qusier | Destroyed houses |
| September 1994 | Al Qusier | 100 deaths, destroyed roads and demolished houses |
| November 1996 | Marsa Alam | 30 deaths, destroyed roads and demolished houses |
| May 1997 | Safaga-Al Qusier | 70 deaths, destroyed roads and demolished houses |
| October 2010 | Marsa Alam | 7 deaths, destroyed roads and demolished houses |

## Results

Early alert can help in prediction of the disaster till 100 years ahead, to work on efficient early alert, disaster risk factors should be defined clearly. through morphometric analysis, quantitative description, and study of landforms, which can be applied to a specific type of landform or drainage basins and huge regions a clear assessment and accurate predictions are to be followed.

The development of numerous quantitative techniques has facilitated the determination of valley slopes, relief, area, the type and breadth of drainage networks, and other drainage basin characteristics. Attempts to link statistical parameters characterizing drainage basin features and basin hydrology, such as sediment yield studies, are commonly referred to as morphometric analyses.

## Morphometrical Analysis

### Typography

The study area is in the eastern desert valleys that flow into the Red Sea. The study area includes three drainage basins: Wadi Al- Anz, Wadi Mubarak, Wadi Shony and Wadi Ghalib, in addition to the occurrence of part of Marsa Alam International Airport within the drainage basin of Wadi Al-Anz in the north. The study area is characterized by its location within the eastern desert, which is characterized by the diversity of its topographic features, where the height rate in the study area range between (6-430) meters from sea level, where the heights start from the west, that considered as the initial tributaries of the valleys begin at a height of 430 meters from the sea surface flow, and then the elevation levels gradually decrease as we head to the mouth in the east until it reaches a level of about 6 meters near the coastal road.

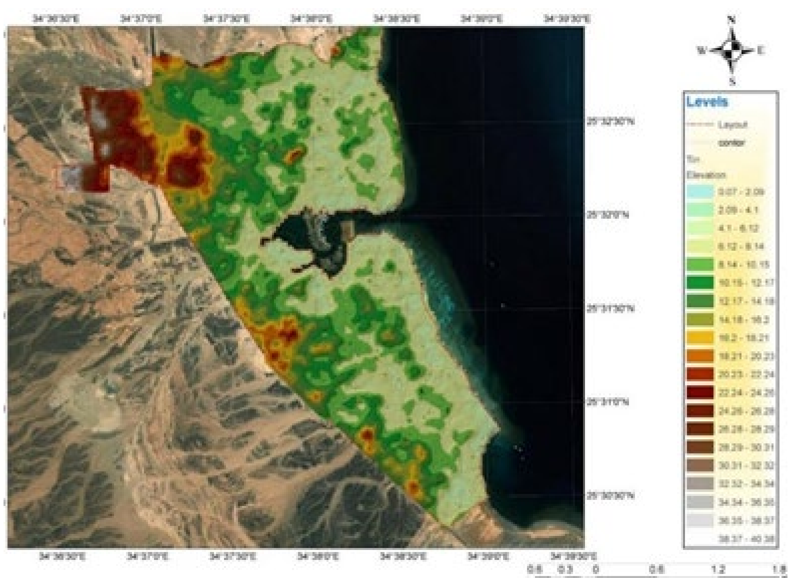

**Figure 3:** The study area topography

### Basin Width, Length, and Perimeter

Geomorphological, the area can be divided into three central units: The Red Sea high moun- tains, the hilly coastal area, and lower mountains, and the coastal plain and the Red Sea coast. The coastal plain comprises several morph tectonic features: rift shoulder, fault scarp, alluvial fans, inselberg, piedmont plain, and raised beaches. A massive, elongated block of ultramafic rocks forms the highest mountains in the area, sep- arating the watersheds of the Nile basin from that of the Red Sea basin. The hilly coastal area and the lower mountains form conspicuous topographical features between the coast and the main Red Sea hills. The isolated ranges and prolongation of the main igneous mass within the coastal plain elped protect the sedimentary rocks (especially gypsum deposits) by breaking the general ero- sional processes. The granitoid rocks are strongly weathered, forming low to moderate country. On the other hand, the gabbroic rocks are more resistant to weathering and form relatively higher hills. The coastal plain has a low topography of a variable breadth ranging between0.6 km in the-north (Wadi Ghadir) to more than12 km in the south at Hamata. Numerous parallel wadis draining the mountains dissect the coastal plain. Sedimentary systems from the piedmont to the Red Sea coast comprise alluvial fans, wadis, and littoral (reef) terraces. Modern fringing coral reefs (50– 100 m wide) extend along the coast. Coral reefs are lacking at the mouths of some of the larger wadis due to sediment (sand and pebbles) deposits during floods. Hence marsas (landing spots) often occur at wadi mouths.

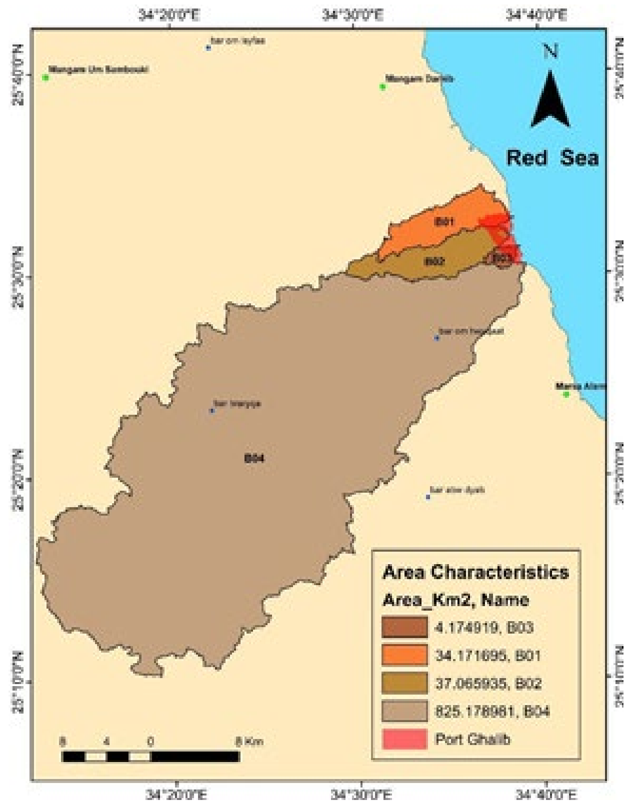


**Figure 4:** The drainage basins in the study area

## Shape of the Basin

The design of basin form analysis to represent the way runoff will discharge at the outflow. Based on the premise that a circular watershed enables runoff from all watershed areas to arrive at the outflow simultaneously, resulting in a high flood peak. An elliptical watershed with the same size as a circular watershed, on the other hand, would spread out the runoff over time, resulting in a lower flood peak than a circular watershed.

• Circular basins between 0.4 and 0.5 such as wadi Shony "B03"

• Elliptical drainage basins between 0.2 and 0.4 such as wadis Al Anz "B01", Ghalib "B02" and Mubarak "B04".

## *Hydrological Analysis*

### Available Rainfall Data

The amounts of rain analysis are needed to conduct hydrological analysis and estimate torrential water amounts. Many statistical analysis programs use rain data to analyze the maximum daily rainfall values. Due to the need to use many probability distributions to compare and determine the most appropriate and accurate distribution, which represents the available data accurately, the statistical analysis program HYFRAN PLUS was used.

These statistical analyzes help determine the optimal expected values of rain at different re- curring times. The short recurring times, which range from 2 to 10 years, reflect the availability of surface water resources for sustainable development, especially concerning the provision of drink- ing water and the social stability it causes. As for the high recurring times, which range from 25 to 100 years, express medium and high floods, which negatively affect the existing facilities within the valleys and streams.

**Table 2: Basin's runoff analysis**

| | B01- Basin AL ANZ | B02- Basin GHALIB | B03- Basin SHONY | B04- Basin MUBARAK |
|---|---|---|---|---|
| Area Km2 | 34.171695 | 37.065935 | 4.174919 | 825.178981 |
| Runoff coefficient (Rc) | 0.17 | 0.17 | 0.17 | 0.17 |
| H | 8.025 | 8.025 | 8.025 | 8.025 |
| L | 14018.6 | 18528.04 | 3003.8 | 88475.2 |
| Time of concentration (TC) (min) | 5.93 | 7.64 | 1.72 | 18.87 |
| Time to peak (Tp) | 3.95 | 5.09 | 1.15 | 12.58 |
| Peak Discharge (QP) | 2.45 | 2.06 | 1.02 | 18.61 |

## Design Storm

The hydrological calculations depend on the characteristics of the design storm, whose division is estimated at different recurring times from the statistical analysis of the rain measured by the meteorological stations affecting the study area. And then, the design rain distribution was obtained for use in hydrological analyzes, as it shown in figure 67the temporal distribution of rain (the depth of rain with time). Furthermore, by dividing the time into equal periods, the corresponding rain intensity is calculated.

Calculating Peak discharges from minor drainage regions using the Rational Method to design storm sewers, channels, and other stormwater facilities that handle runoff from drainage regions smaller than 20 acres. The Rational Formula is Q = CiA, where Q is the peak rate of runoff in cubic feet per second. C =Runoff coefficient, an empirical coefficient is representing the link between rainfall and runoff. I =Average rainfall intensity in inches per hour at the time of concentration (Tc) for a specific frequency of recurrence or return period. A =average of the watershed Tc =The rainfall intensity average time in minutes, also known as the time of concentration, equal to the time necessary for water to flow from the watershed's farthest distant point to the point of the design.

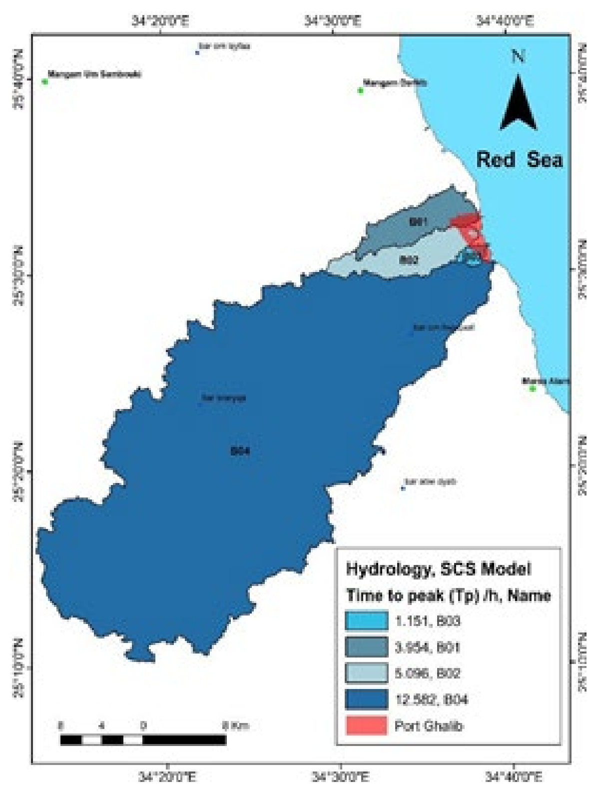


**Figure 5:** Basin's peak time

## Discussion

The mathematical model was fed with the results of analyzes deduced from previous geological, morphological, and meteorological studies. Furthermore, due to the lack of measured data on the torrential rains in the region, one of the synthetic methods, SCS, was used to calculate the hydrograph unit curves for the drainage basins of the valleys of the study area to obtain the hydrograph of the torrential waters required to design the appropriate industrial works to protect the existing facilities at the exits of these basins.

Through the photographic confirmation of the flood susceptibility map to calculate the flood peak per hour, indicated the following:

The flood susceptibility areas corresponding to return periods of 10, 20, and 40 years for the study area. As shown in table 3 and figures 6 and 7, flood vulnerability areas corresponding to return durations of 50 and 100 years extended to areas of flood- plains.

**Table 3: Basin's runoff characteristics at repetitive tense**

| | **Max discharge m3/sec** | | | **Peak time for max. discharge Hr** | | |
|---|---|---|---|---|---|---|
| | 10 years | 20 years | 40 years | 10 years | 20 years | 40 years |
| **B01- Al anz** | 3.00 | 15.93 | 47.88 | 3.954 | 3.954 | 3.954 |
| **B02- Ghalib** | 2.52 | 13.41 | 40.29 | 5.096 | 5.096 | 5.096 |
| **B03- Shony** | 1.26 | 6.62 | 20.10 | 1.151 | 1.151 | 1.151 |
| **B04-Mubarak** | 22.74 | 120.89 | 363.33 | 12.582 | 12.582 | 12.582 |

In a more quantitative examination, the Cross-Tabulation Method was used to con- firm the validity of both flood susceptibility maps. to be considered "observations" the selected recorded data of flood places measured during the main event of January 1997. The selected two flood susceptibility maps were also "predicted" to be credited. Based on transitory factors, the first map depicts simulated flood-prone areas over a return period of 40 years, which corresponds to the worst-case scenario. Fig. 6 shows the flood sensitive delimitation described as "High," which shows areas where simulated flooding based on hydraulic modeling occurs in places with a high natural susceptibility to riverine floods. This strategy was used in a densely populated urban area.

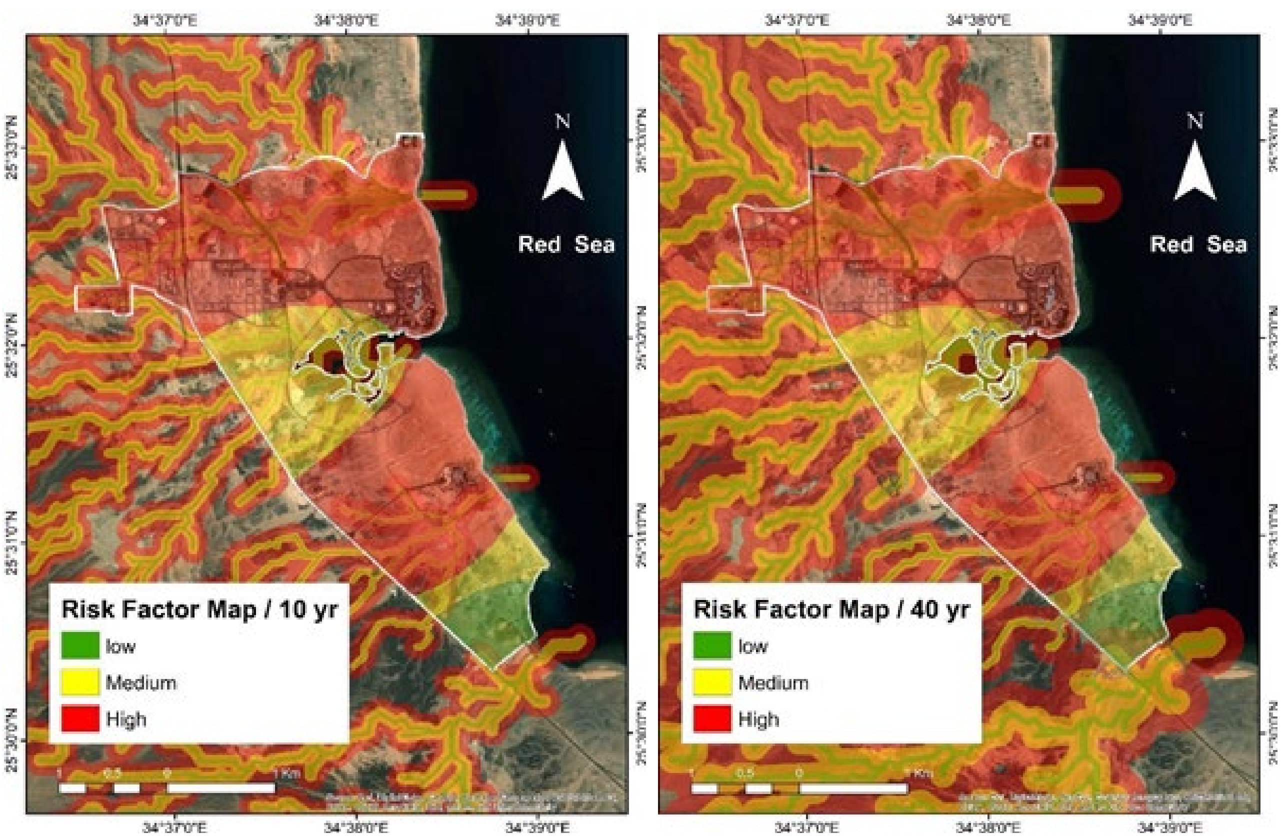


**Figure 6:** The Risk maps for 10 and 40 years

## Conclusions

Floods in recent years have plagued the city of Marsa Alam. According to the statistics, the last flood in 2001 could have been controlled with structural defenses because the return period was less than 100 years; however, the occurrence in 2017 had a very long return period, necessitating the development of new defenses. As a result of development pressures and increased public expectations, flood risk management is changing. These forces are projected to intensify, emphasizing the need for a new approach to dealing with Marsa Alam urban growing towards the threat of flooding.

The following steps were concluded as an important approach to mitigate flood in the risk zones through the following:

### Site Visits and Interviews

A detailed analysis of the planning papers was conducted to get a clear image of the munici- pality's ongoing measures, including meetings, interviews, and a workshop session. Involving social media as an informational source to have a good knowledge of the stakeholders in- volved, their relationships and having a different version from the institutional version. The key findings reveal that one of the most serious issues is a lack of or complicated coordination among stakeholders, which must be addressed. As a result, the matrix depicting the relation- ships between them may differ. On the other hand, a comprehensive analysis of the study area was conducted using morphometric and hydrological characteristics as well as artificial fac- tors to demonstrate natural hazards, and an assessment plan was developed to highlight the gaps in the current planning situation and to develop a new planning technique to assist more vulnerable areas.

### Early Warning Tools and Risk Assessment

An accurate description of the flooded areas and their upstream catchment can be achieved by morphometric analysis and hydraulic simulations and the development of several scenarios for the optimal structural design. Furthermore, the most dangerous places were identified using hydraulic models. The 10-, 20-, and 40-year return times are computed to aid in developing plans (non-structural defenses) in the event of major calamities. To emphasize the necessity of understanding the climatic characteristics of the research area and the critical function of early warning systems in lowering projected damages.

### Risk Impacts Analysis

Site mapping and land use maps were created based on the preceding analyses. This phase depicts various site amenities and governmental and private authority in each community. Flood hazard impacts, both direct and indirect, were estimated by merging the land use analysis with the risk assessment maps to generate adaptation and mitigation methods.

### References


1. Nicholls, R. J. (2014). IPCC Climate Change-Impacts, Adaptation and Vulnerability. Cambridge Univ. Press.
2. Training, F. (2017). National Response Framework Resources. United states: Emergency management institute.
3. Bethany A. Kurz, W. D. (2008). An Overview of the Waffle® Concept. North Dakota: Energy & Environmental Research Center.
4. Abdouli, K. A., Hussein, K., Ghebreyesus, D., & Sharif, H. O. (2019). Coastal runoff in the United Arab Emirates—The hazard and opportunity. Sustainability, 11(19), 5406.



**Copyright:** *©2023 Hadeel El Naggar, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.*