Modern technology applications and rainfall flooding disasters prevention.

Mohamed Gar Al-nabi Ibrahim Mohamed¹ and Faisal Althobiani²

¹Hydrographic Surveying Department, Faculty of Maritime Studies, King Abdulaziz University, KSA.
E-mail: gar958gar@gmail.com.

²Department of Marine Engineering, Faculty of Maritime Studies, King Abdulaziz University,
E-mail: dr.althobiani@gmail.com.

ABSTRACT:
The paper presents a case study that investigated the role of modern technology applications in rainfall flooding disasters prevention. The results reported demonstrated that modern technology facilities can be used to derive preventive measures for rainfall flooding disasters. Free of charge application programs and space technology data can be downloaded and used to achieve this purpose. The derived parameters of the hydrological and topographical models can be integrated with the drainage network of the area to ensure the draining of the water and prevent it from backing up and accumulating in the low land areas. An appreciated relief effort had been made by the local governments and non-government organizations related to rainfall flooding disasters across the world. However, it is high time to devote some of this effort to the application of modern technology facilities to tackle these rainfall disasters existing causes and provide future preventive measures.

Keywords: modern technology, flooding disasters, space technology data, application programs, draining area, drainage network. Preventive measure. Volume of draining water.

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1. INTRODUCTION.

Most of the rainfall flooding disasters causes world-wide in general and in the third world in particular are closely related to water draining issues by a way or another. A digital elevation model of the study area (SRTM90) [6] was downloaded, processed using QGIS application program [7] and used to derive the topographical and hydrological models of the study area. Google Earth on-line GIS facilities were applied to locate the study area, its main features and drainage network elements.

The effort made in the paper was devoted to the role of modern technology in rainfall flooding disasters application area. The free of charge QGIS application program was applied using the digital elevation model of the area to derive its topographical and hydrological models. The two models were integrated to point out the rainfall disasters causes in the study area. Draining areas derived by the processing of the space technology data were used to calculate the volume of draining water using the rate of rainfall in the area. The volume of the draining water was related to the existing man-made features and the capacity of the draining network in the area and the causes of the rainfall disasters in the area were pointed out. Based on the latter preventive rainfall flooding disasters measures were derived.

2. THE STUDY AREA.

The study area lies in Khartoum state, Sudan. It is bounded by latitudes 15.55 and 16.05 N and longitudes 32.65 and 33.45 E. It is characterized by the north Sudan arid climate, with a rainy season that extends from July to September with a 161 mm average annual rainfall [5]. The main features in the area are the highways, irrigation canals, agricultural areas and residential areas (Figure 1). The topographical and hydrological models of the study area are shown in figures 2.

Fig 1: The geographical location of the study area, showing residential area (bounded red), agricultural area (bounded green), irrigation canals (blue lines), highways (black lines) and the Blue Nile (BN).
3. OBJECTIVES.

The main objective of this study is to investigate the role of modern technology applications, in rainfall flooding disasters prevention with the aim of deriving preventive measures. The effort made was based on the free of charge space technology data and application programs.

4. METHODOLOGY.

The methodology adopted in conducting this research was based on the integration of the hydrological and topographical models of the study area. The relationship between the main features of the topographical model, such as the highways and irrigation canals and their associated drainage elements and the elements of the hydrological model such as the drainage network, draining areas and their main water courses and directions was investigated and rainfall disasters preventive measures were pointed out.

5. DATA PROCESSING AND RESULTS.

The digital elevation model data of the study area (SRTM90) was processed using the free of charge QGIS application program and the topographical and hydrological models of the area were derived (figures 2). The hydrological model revealed five draining areas affecting the study area (CA1-CA5) with different sizes and directions. These areas range between 10.109 to 1386.536 km$^2$, with a total draining area of 1,627.448 km$^2$.

The drainage elements associated with the man-made features in the study area were located and their geometric information was derived using Google Earth on-line GIS facilities. This drainage network is composed of nine different drainage elements with different cross-sectional areas that range between 24 to
100 m², with a total cross-sectional area of 198 m². Figure 3 is a typical example of the drainage elements in the study area.

![Diagram of drainage elements](image)

**Fig 3: A typical example of the drainage elements in the study area (20x5m).**

6. DISCUSSIONS.

Based on the hydrological model of the study area (figure 2) most of the draining areas are not capable of causing rainfall disasters. An exception is draining areas CA1 (1386.536 km²), and CA2 (181,898 km²). The water course of draining area CA2 passes through residential areas RA3, RA4, RA5 and RA6 and that of draining area CA1 passes through residential area RA2 and partially through RA3. However, although these mentioned residential areas are subjected to the two large draining areas but they are not seriously affected by the rainfall flooding disasters in the area. Although residential area RA1 is subjected to small draining area (CA3) and far away from the water courses of the two large draining areas (CA1, CA2) but, it is frequently affected by severe rainfall flooding disasters. This of coarse should not happen if the natural drainage course in the area is properly functioning. The natural drainage course in the area is from the north-east to the south-west where all the water drains in the Blue Nile. The problem is that this natural drainage course is blocked by the man-made features in the area, mainly the highways and the irrigation canals. So, the draining water coming from the five draining areas should pass through the draining elements in these features otherwise it would accumulate and back up in the low areas and cause flooding disasters.

The capacity of the drainage network in the area is 25,747,200 m³ per day (24x60x60x298), assuming that the water velocity is one meter per second. Accordingly, a rainfall covering the whole study area with the average rainfall rate (161mm), would result in a draining water volume of 262,019,128 m³ (1,627.448 x10⁶x0.161 m³). This requires 10.177 days to drain in the Blue Nile using the available drainage network in the area (262,019,128 /25,747,200). This is a quite enough period of time for the water to accumulate and back up in the low lands causing flooding disasters. Luckily, the rains do not cover the whole study area at the same time with the same rate and usually it rains in different areas in different times and with different rainfall rates. In such cases the drainage network would accommodate the draining water and no flooding...
disasters. However, when the rains cover the whole area, with the same rate and at the same time, the situation would be quite different and the rainfall flooding disasters happen. This frequently happens in August which has the maximum average rate of rainfall (75.2 millimeters) and longest rain period in the rainy season in the study area[1], [2], [3], [4].

The above discussion clearly revealed that the main causes of the surface rainfall water floods in the study area are the blockage of the draining water by the topographical features and the very low capacity of the available drainage network in the area. Accordingly, at any time the draining volume exceeds a certain limit the area would be affected by floods. This certain limit and the level of flooding of course depend on factors such as, the rains coverage, level and period of time.

The information derived from the integration of the hydrological and topographical models facilitated the establishment of the relationship between the volume of the rainfall draining water and the capacity and distribution of the drainage network in the study area. This would allow the chances of proper drainage of the rainfall water in the Blue Nile and preventing it from accumulation in large volumes and backing up in low lands and causing flooding disasters. This can be achieved by the modification of the existing drainage network and proper planning and establishment of the new man-made feature’s drainage elements.

8. CONCLUSIONS.

Based on the research findings and the discussions made above it is clearly revealed that the open space technology data and application programs sources can play a very important role in the rainfall flooding disasters prevention. This is particularly true for tackling rainfall flooding disasters existing causes and providing future preventive measures. The hydrological and topographical models of the area can be integrated and the volume of the draining water can be related to the capacity of the drainage network in the area. The existing drainage networks can be modified to accommodate the draining water and prevent rainfall flooding disasters in the area. This is also, true for the newly established man-made features where the hydrological model parameters can be related to the capacity and distribution of the drainage network in the area to prevent rainfall flooding disasters.

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9. References: