CASE STUDY

Integration of Remote Sensing and GIS for Surface rain-water flooding:

Case study, Sudan Khartoum state, Sharq Elneel area.

Abstract:

The paper investigated the severe floods affecting the study area. The hydrological and topographical models of the area were integrated to point out the causes of the floods in the study area and suggest solutions. The integration was based on the digital elevation model of the study area. Data processing and analysis were carried out using QGIS hydrological modules and Google Earth on-line GIS facilities. The study area is directly affected by small catchment area (182 km^2) and indirectly by a large one (1386 km^2). The causes of the floods in the study area are the man-made features (highway and irrigation canal) and the low topography of the study area. Floods in the area can only be mitigated by establishing an efficient drainage network in the man-made features in the area.

Key words: Floods, catchment area, irrigation canal, highway, topographical model, hydrological model.

1. Introduction.

Water is very important for life and rain-water represents an important water source world-wide in general and rural areas in particular. However, most of the world areas are affected by surface rainfall floods. Most of the countries are affected by these surface rainfall flooding disasters, especially in the under-developed areas. Typical examples are the Sudan floods in 2007, 2013, 2014 and 2016, [1], [2], [3], [4]. Bangladesh, 1987, 88, 89, 93, 98 and 2000, [5]. Somalia November, 2019 [6]. Pakistan July, 2022 [7] etc. However, the effort made in this paper is devoted to the role of integrating remote sensing data with geographical information system facilities for mitigating, floods disasters effects in affected areas and providing preventive measures for new developed areas. The investigation was based on the integration of the geographical and hydrological models of the study area to point out the main causes of the rainfall floods and suggest solutions for existing problems and preventive measures for newly developed areas.

2. The study area.

The study area lies in Sharq Elneel locality, Khartoum state. It is a residential area called Marbeea-Alshareef and bounded by an agricultural area in the north direction, an irrigation

canal in the west direction and a highway in the south west direction. In the east and south east directions the area is bounded by residential areas running in the direction opposite to the natural drainage direction. The natural drainage of the study area runs from the north east to the south west towards the Blue Nile River. Some drainage elements are constructed along the main irrigation canal and the highway. The location of the study area and its main topographical and man-made features are presented in figure 1, below.

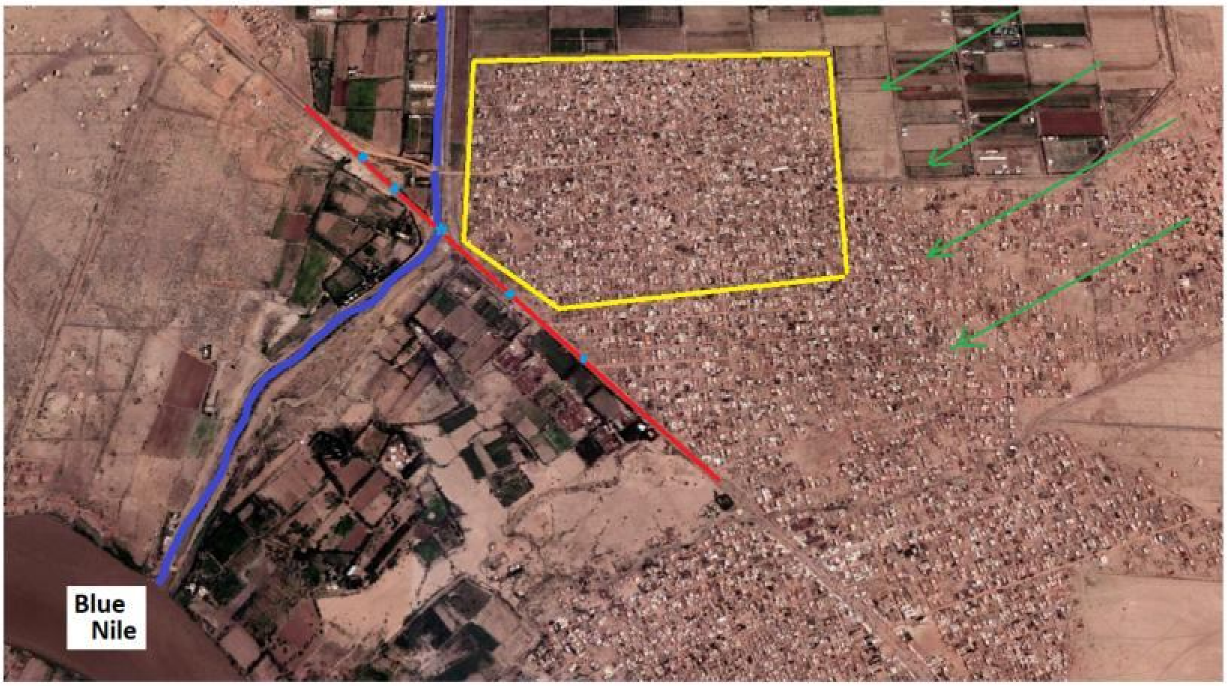

Figure 1, The study area (yellow), irrigation canal (blue), Highway (red), general drainage direction (green arows), Agricultural areas and the Blue Nile , drainage elements (light blue stars).

3. Research objectives.

The main objective of the investigation is to answer the question, why the study area is most severely affected by floods, compared to other areas in the whole residential area? This is exactly, what happened in the years, 2007, 2013, 2014 and 2016 [1], [2], [3], [4].

4. Methodology.

The research methodology used in the investigation was as follows:

1- The main man-made and natural features in the area were identified using Google Earth photos and on-line GIS facilities (geographical model of the area)
2- The hydrological model of the area was formed using its SRTM90 digital elevation model and the hydrological modules in QGIS application program.
3- The main catchment draining areas affecting the study area were identified and their geometric information was derived.
4- The topographical and hydrological models parameters were integrated to answer the research question.

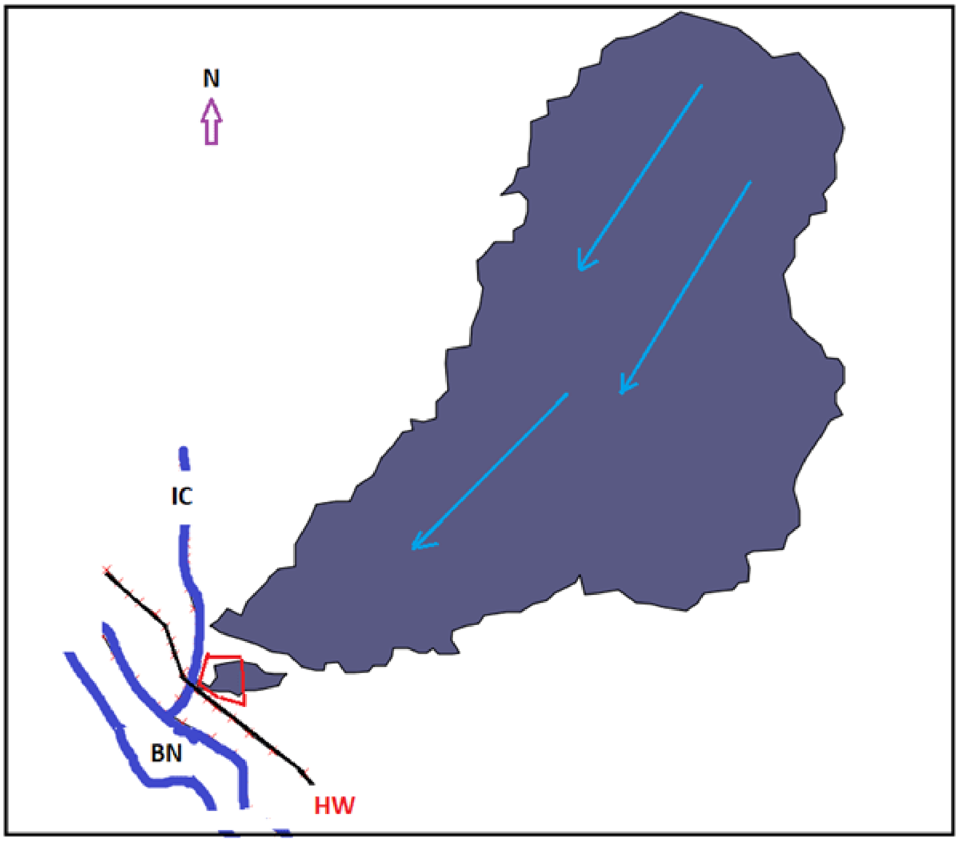

Figure 2, The catchment areas affecting the study area (solid dark black), irrigation canal (IC), highway (HW), the Blue Nile (BN) and the study area (red).

5. Data processing and results.

The hydrological model of the area demonstrated that there are two catchment areas in the vicinity of the study area, small area (182 km^2) and large area (1386 km^2). However, Figure 2 demonstrated that the study area (red) is directly affected by the small catchment area, which is not capable of causing the severe damage experienced in the years 2013, and 2016. However, though the large catchment area is not directly affecting the study area, but it is not far from it and suspected. This catchment area water is passing the irrigation canal (IC) first on its way to the Blue Nile which the natural drainage out let for the whole area. To reach the Blue Nile this catchment area water should also pass the highway (HW). The very important question is that, is it possible for this large volume of water to pass through the irrigation canal and the highway. The answer to this question requires an investigation of the drainage elements associated with these features.

6. Highway and irrigation canal drainage elements.

The draining elements in the area were explored using Google Earth on-line GIS facilities. Three elements were identified in the highway (marked red H). One large culvert (27x5 meters) and two small culverts (7x3 meters). There are no draining elements in the irrigation canal and it is surrounded by agricultural areas and has an embankment three meters high approximately (Figure 3).

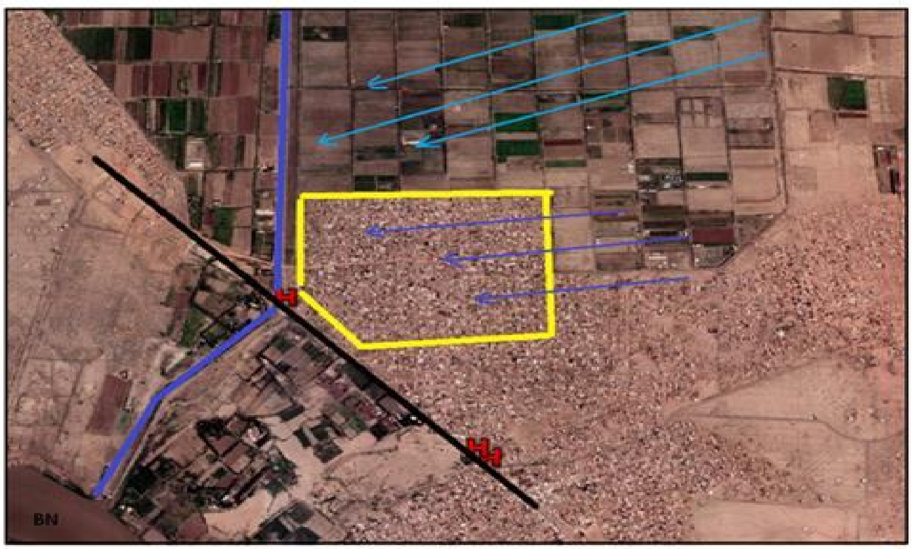

Figure 3, The drainage elements in the area (H red), large and small catchment areas directions of flow (light blue and blue arrows respectively), irrigetion canal (thick blue), highway (blck) and the Blue Nile (BN).

7. Discussions.

Figure 3, clearly demonstrated that the large catchment surface rainfall water will be blocked by the irrigation canal, back-up and flow parallel to the canal through the study area (yellow) on its way to the Blue Nile, causing flood crises. The situation even get worse when the running water blocked by the highway with an embankment 2.7 meters high, with a very limited drainage elements which are not capable of passing this large volume of water. The result is that blocked water will back-up and accumulate in the low

areas. As demonstrated by Figure 4, the study area (yellow) is the lowest area in the investigated area. This explained why the study area was the most severely affected by floods in 2007, 2013, 2014 and 2016.

Figure 4, Google Earth topographic data of the study area, the study area (yellow), irrigation canal (blue), the highway (black) and direction of Blue Nile (light blue arrow).

8. Demonstration of the irrigation canal and highway effects.

The large culvert was located in the highway at its intersection with the canal (Figure-3). Figure 5, demonstrated the strong effect of these two man-made features on the study area. As mentioned before the surface rain-water from the large catchment area hit the canal and back-up following the natural drainage course in the direction of the Blue Nile. The bulk of this water runs by the side of the canal creating a very wide (30-40 m) and deep (2-3 m) water course by erosion. The back-up water hit the highway and accumulate due to the lack of an efficient drainage network. The result is that the water back-up again and accumulate in the low areas. As demonstrated in Figure 4, the study area is the lowest area in the vicinity. Thus it was severely affected in all of the past floods.

Figure 5, Back up water direction (blue arrows), large culvert (H), irrigation canal (IC) and highway (H).

9. Conclusions.

The results obtained and the discussions made in this investigation demonstrated that the severe floods affecting the study area are caused by the two man-made features (highway and canal). If these are not present the study area will be affected by the small catchment area only and the large catchment area water will follow in its natural drainage course to the Blue Nile. This clearly indicated that whenever, there is a heavy rain in the area the study area will be flooded. The only solution to this problem is to establish an efficient drainage network along these features to allow the rain water to pass to the Blue Nile. The investigation also, demonstrated that the integration of remote sensing and GIS can play an important role in the surface rainfall water flooding disasters.

10. References:

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