CASE STUDY

Integration of Remote Sensing and GIS for modelling surface run-offSurface rain-waterflooding:

The Case of SharqElneel, study, SudanKhartoum state, Sharq Elneel area.

Abstract:

This study investigates severity of floods influencing the SharqElneel region of Sudan. epaper 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, along with adaptive and mitigation measures needed to avert these hazards. 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.Findings proved the region The study area is directly affected by small catchment area (182 km^2) and indirectly by a large one (1386 km^2). The core drivers of flooding events could be attributed to 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 remains represents an important source of water source world-wide, particularly in in general and rural areas in particular. However, most of the world areas across the globe are affected by surface run-off, especially after heavy or lengthy rainfall rainfall floods. Most of the countries are affected by these surface rainfall flooding disasters, especially in the under-developed areas. Typical examples of flooding events in Sudan constitute are the Sudan floods in 2007, 2013, 2014 and 2016, [1], [2], [3], [4]. In Bangladesh, major flooding events occurred in 1987, 88, 89, 93, 98 and 2000, [5], whereas, Somalia experienced a historic event in November, 2019 [6]. Pakistan, on the other hand, experienced one recently in July, 2022 [7] etc. However, the efforts made in this paper is devoted to the essence of role of integrating remote sensing data andwith geographical information system facilities/techniquesto mitigate for mitigating, flooding events and its repercussions s disasters effects in affected areas, coupled with and providing preventive measures for newly developed areas. The investigation was based on the integration of the geographical and hydrological models of the study area to point out the

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Comment [K1]: Title:
--I humbly suggest a modification of the title to avoid ambiguity. The title could read as:
"Integration of Remote Sensing and GIS for modelling surface run-off:The Case of SharqElneel, Sudan"

Comment [K2]: Abstract:
-Some repetitive phrases within the abstract have been deleted.
-The abstract must have a concluding sentence which briefly states the significance of the study's outcome.

Comment [K3]: Introduction:
-There should be additional paragraphs which briefly captures some underlying theories which engulfs some sustainable development goals, risks and disaster management, climate variability and so on to enrich the literature or background to this study.
-Again, the other paragraph could capture or cover research progress, in relation to other studies conducted elsewhere which utilized GIS and remote sensing techniques.
-Authors could briefly highlight the contribution of this study or study's significance to industrial players, policy-makers, development strategists and the international research community in the last paragraph or last but one paragraph. --The current introduction is certainly not enough and must be expanded.

main causes of ~~the rainfall~~ floods, ~~and~~ suggesting possible solutions to tackle ~~for~~ existing problems. ~~and preventive measures for newly developed areas.~~

1.1

~~2.~~ The study area.

The study area lies in SharqElneel locality, Khartoum state. It is a residential area called Marbeea-Alshareef, ~~and~~ bounded by an agricultural area to ~~in~~ the north ~~direction~~, an irrigation canal to ~~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 ~~f~~Figure 1, ~~below.~~

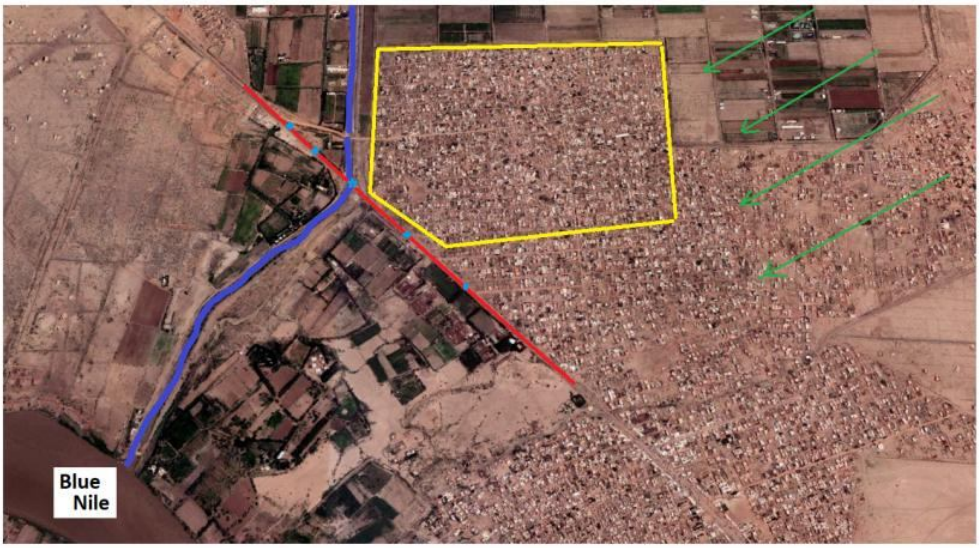

Figure 1, The study area (yellow), irrigation canal (blue), Highway (red), general drainage direction (green arows), Agricultural areas and the Blue Nile , drainage elements (light blue stars).

~~3.~~ 1.2Research objectives.

The primary purpose of this study was to address the research question on ~~main objective of the investigation is to answer the question,~~ why the study area is highly susceptible to ~~most~~

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Comment [K4]: Study Area:
-**Figure 1:** I humbly suggest the authors separate the caption of fig.1 from the image. It is inappropriate and unacceptable to crop or merge the caption along with the image. In this instance, it isn't a legend; hence, must be separated.
-Since this study is a case study, authors are advised to use or state the coordinates (longitudes/latitudes) for the study area since the key elements applied are GIS/remote sensing.

Comment [K5]: -the word "below" was deleted because Figure 1 is self-explanatory and does not need anything to show its position or qualify it.

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~~severely affected by~~ floods, compared to other areas in the ~~whole~~ entire residential area.~~?This is exactly, what happened in the years, 2007, 2013, 2014 and 2016 [1], [2], [3], [4].~~

~~4.~~2. 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.

~~4~~ 2....Data Analysis

Comment [K6]: Methodology:
-The methodology section needs to be restructured or re-organized with more details. What is presented here is unacceptable.
-Authors need to state the source of data acquisition, specific version of the QGIS software used, the key variables or parameters which were used for the topographical/hydrological models.
-Studies like these require a workflow or flow-chart that could guide readers on reference and input data, software or tools for data processing and analysis, among others.

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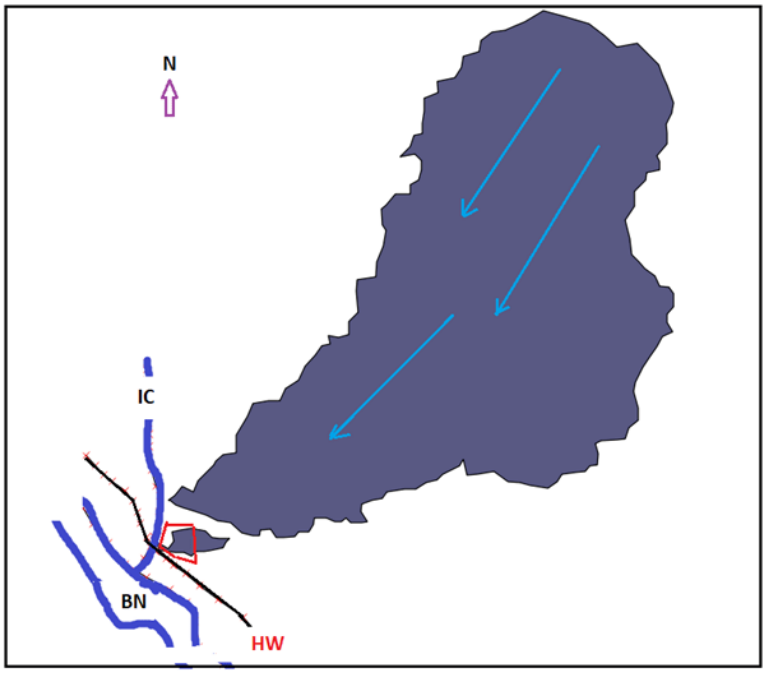

Figure 2, The catchment areas affecting the study area (solid dark black), irrigation canal (IC), highway (HW), the Blue Nile (BN) and the study area (red).

Fig. 2: The catchment areas .....

~~5.~~3. ~~Data processing and r~~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.~~ 3.1Highway and irrigation canal drainage elements.

Comment [K7]: -Just like Fig. 1, authors need to separate the caption of Fig. 2 from the image. It is suggested that authors use legends to describe the parameters in Fig. 2. Scales could be added where necessary.
-For data analysis/processing, it is important for authors to highlight what specific analysis techniques were employed or utilized with justifications. Example: ROI, Maximum Likelihood Algorithms, Type of classifications used and so on.

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Comment [K8]: Results:
-For clarity, consistency and coherence, results must be presented in orderly and precise manner.
-Since Fig. 2 forms part of the results, the section must first be introduced, followed by a presentation of the study's results. All the explanations or discussions must be moved to the discussion section.
-The causes or drivers and implications must be clearly presented in tabular or image formats.
-Authors could use tables to highlight historic flooding events in the study area.

Comment [K9]: -Authors should kindly adhere to the journal's standardized format of organizing sections (**Abstract, Introduction, Study Area/Methodology, Results, Discussions and Conclusions**, followed by the references, acknowledgements, conflicts of interests and so on) in their manuscript. Data processing or analysis is always placed in the methodology section. The results section must stand on its own since it is an important aspect of the work.

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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.~~4. 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.

Comment [K10]: Lines 87-89: All data analysis or processing parts must be moved to the methodology section and be placed under the data analysis section.

Comment [K11]: -Same here. Kindly separate the caption from the image.

Comment [K12]: Discussion:
-The discussion must have a brief introduction followed by an explanation to the results presented.
-The results of this study were not adequately explained or digested. Authors failed to compare the study's results to existing literature or other studies conducted elsewhere with similar scope.
-Does the study's results support/agree or refute with/against existing literature. If it disagrees with studies elsewhere, what could be the reasons. If it agrees with other studies, it ought to be stated here with existing literature to back or substantiate it.
-The drivers or causes of flooding events must be clearly explained with examples or reports to enrich the discussion aspect.
-Again, trends or historic flooding events and its implications on economic activities/livelihoods, infrastructure and so on ought to be explained in the discussion section.
-Mitigation/Adaptive measures and its effectiveness could be explained briefly also.

Comment [K13]: -same for Fig. 4

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.~~ 4.1 Demonstration of the irrigation canal and highway effects.

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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.

Comment [K14]: -Same for Fig. 5

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

~~9.~~5. 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 flow ~~follow~~ in its natural drainage course to the Blue Nile. This clearly indicated that whenever, there is a heavy ~~rain~~ downpour in the area, the rate of flood occurrence will be very high ~~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 enter ~~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:

[1] https://en.wikipedia.org/wiki/2007_Sudan_floods.

Comment [K15]: Conclusions:
-The study's significance must be integrated in the last part of the conclusion.
-The study's limitations/gaps and opportunities that could potentially drive further or future studies must be stated also in the last part of the conclusion.

Other comments:
-Major grammatical defects and syntax errors were identified throughout the manuscript. Moderate revisions were made to draw authors' attention to such errors. Authors are advised to seek for the help of someone with command over English Language or excellent proficiency skills to improve the proficiency and flow of the manuscript before resubmission after revision.

Comment [K16]: References:
-Wikipedia references are unacceptable and inappropriate for scientific papers. Again, authors should refer to the journal's format of citing data or information on websites. The current format is wrong and incomplete.
-The reference section needs to be recited or worked on. Poorly cited with less literature linked to journal papers, reports and so on.

[2] Migiro, Kathy (7 August 2013). Sudan government under fire as flash floods kill 11, displace 100,000. trust.org. Thomson Reuters Foundation. Retrieved 24 August 2013.

[3] http://reliefweb.int/map/sudan/flood-waters-over-khartoum-state-sudan-8-august-2014.

[4] http://floodlist.com/africa/sudan-floods-70-dead-july-august-2016.

[5] https://en.banglapedia.org/index.php/Flood

[6] https://climateknowledgeportal.worldbank.org/country/somalia/vulnerability.

[7] https://www.reuters.com/graphics/PAKISTAN-WEATHER/FLOODS/zgvomodervd/.

Comment [K17]: -Wrongly cited and incomplete.

Comment [K18]: -Wrongly cited and incomplete.