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Research article

A comprehensive Analysis of the Application of GIS and RS Technologies in Flood Prediction and Risk Assessment, with a Focus on Wadi Baysh Dam in the Jazan region. KSA

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Keywords: Wadi Baysh dam, Geographic Information Systems (GIS), Investigation, Risk, Floods

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Abstract

This study uses GIS spatial analysis and open-source data based on flood hazards formulas to provide a thorough analysis and forecast of floods using Geographic Information Systems (GIS) and Remote Sensing (RS).

The Wadi Baysh Dam overflowed with water in 2016 as a result of the torrential downpour that hit the dam, its streams, and the surrounding surroundings results the increasing the storage capacity. In terms of water reserves, it is the dam that is thought to be the biggest in the Kingdom. Some settlements in Baysh, which are under siege since their highways are blocked off, suffered greatly as a result of flooding. However the storage capacity of Wadi Baysh Dam around 200 million cubic meters of water.

In order to identify the actual Wadi Baysh flood-vulnerable area, this study combined data from remote sensing, the Geographic Information System (GIS) technique, and an Analytical Hierarchy Process (AHP) computation.

The investigation was carried out to determine the viability of using remote sensing open-source data,basemap of the study area andArcGIS10.4 software in Wadi Baysh risk management.

Slope (10%), height (15%), drainage density (20%), distance to stream (20%), rainfall intensity (25%), and land cover (10%) all have a proportion of relative weight that determines how flooding is analyzed.
As a result of the most recent GIS analysis (weighted overlay approach), five zones are identified within the extracted flood region based on the categories of hazard. There are ten blocks in all—five in a high-risk area and five in a moderately dangerous one.

The paper looks at the flood risk in Wadi Baysh using a combination and integration betweenremote sensing opensources data and GIS models. High precipitation and runoff in the dam's downstream sections will be the main cause of difficulties, causing a great deal of death and destruction to agricultural and urban areas. Eventually, a control room connected to the GIS model and remote sensing devices will be needed in this valley to implement an efficient warning system and flood hazard management system.

1. INTRODUCTION

1.1. WADI BAYSH DAM AND FLOODING

In the Jazan region of southwest Saudi Arabia, the Baysh Dam is a significant dam that supplies drinking water and agricultural resources to nearby residential areas. Situated in one of the Tihama valleys, Wadi Bish, it was built in 1430 AH. The third-largest strategic water reserve in the Kingdom, the Wadi Bish Dam can supply the daily water needs of the coastal Jazan region's cities and villages for more than three years. Figure 1 depicts a composite photo of the Wadi Baysh dam. Floods are regarded as one of the most serious natural hazards, causing damage, disaster and death to all beings on earth, which includes hmans,animals and plants.[1] This study uses remote sensing and geographic information systems (GIS) to assess the flood risk in Wadi Baysh. An effective warning system and flood hazard management system will eventually be required. It is necessary to implement a flood risk management program in order to protect downstream dam areas. This program includes the creation of an inundation map to simulate the impact of dam failure on downstream areas.[2] With an average of 99 million people affected annually between 2000 and 2008,



Figure 1. Photographs showing; (1) Dam Lake; (2) Dam concrete wall and spillway;(3) Dam side view; (4) dam is concrete.

floods are by far the most common and destructive natural catastrophe in the world.[3] In the final ten years of the 20th century, floods alone claimed 100,000 lives and impacted 1.4 billion people, according to.[4] Many doubts have been raised about wheather the frequency and intensity of floods in recent years are related to human activity.

One of the most serious natural hazards, floods are known to result in property loss, property damage, injuries, and even fatalities[1,5,6]; and.[7] The slope, the kind and inclination of the bedrock, and the local and regional fracture patterns all have a major role in the drainage system that emerges in a particular location.[8]Drainage density, a crucial idea in hydrologic research, is defined as the ratio of the length of drainage per basin area. Drainage density is influenced by vegetation, slope, time, erodibility of surface materials, and permeability.

1.2. GEOGRAPHICAL INFORMATION SYSTEMS(GIS), REMOTE SENSING(RS)

A system for capturing, storing, manipulating, analyzing, managing, and displaying different kinds of geographic data is called a geographic information system (GIS). Since geography is an important word in this technology, part of the data is spatial. Stated differently, information that is associated with particular places on Earth. Typically, this data is supplemented by attribute data, which is tabular data. An addition to the spatial data is typically what attribute data consists of.With the help of GIS, one may identify locations that are prone to flooding and forecast areas that are likely to experience flooding in the future due to elevated river levels. Data from several maps, aerial photos, satellite images, and digital elevation models (DEM) will be compiled extensively using GIS.

Without making direct touch, remote sensing technologies gather data on objects and infrastructure on the surface of the Earth using a variety of recording instruments.[9] As a result, it is useful in situations when no physical or intimate touch is feasible[10,11]; and[12] SAR, space-based imaging tools, and satellites are examples of such technology. This strategy speeds up data collecting[13]; and.[14] Ground-based observations cannot collect data as correctly or efficiently as remote sensing technology, which covers broad spatial areas in the shortest amount of time while offering a full view of the target items.[15] Despite adverse weather circumstances, it can capture photos of faraway objects.

2. STATMENT OF THE PROBLEM

Globally, risk management techniques are essential for protecting both the environment and the economy, as well as for ensuring the safety of residents living in valleys downstream of dam sites. Despite the high safety criteria for dams resulting from recent improvements in engineering and construction, accidents can still happen due to human error, natural hazards, or simply the aging of the dam. Moreover, it's probable that the original design overlooked the potential impact of climate change. It is necessary to develop a flood risk management plan to safeguard dam areas downstream. As part of this project, an inundation map will be created to represent the effects of a dam failure on places downstream.

3. OBJECTIVES OF THE RESEARCH

The primary goal of the research is to analyze and manage flood risks in Wadi Baysh dam using a combination of Geographic Information Systems (GIS) and remote sensing(RS). Among the secondary objectives are the following ones:

1. To establish a geodatabase system for the study area for future hydrology needs.
2. To use RS opensources data and GIS spatial analysis to assessment the flood risks.
3. To determine the streams' drainage density within the study region. To estimate the dams to increase water harvesting capacity for introducing drinking water for animals, people, and agriculture during the summer.
4. To create the flood risk maps for supporting the early warning system of flooding.

4. SOURSE OF DATA, METHODS AND SOFTWARES USED

4.1. SOURSE OF DATA

In order to conduct the analysis in this paper, various data sources were used. The Universal Transfer Mircator (UTM) projection (Zone 38) and the World Geodetic System(WGS 84) Datum were applied to each dataset for georeference. The information can be classified as follows:

a) **Baysh Dam characteristics:** The Ministry of Environment, Water, and Agriculture gave the features of the dam, spillway, and reservoir, including the type, height, and length of the dam; the area and capacity of the reservoir; and the level, width, and height of the spillway.Standing at

Table 1. Detailed information of Wadi Baysh dam (Alhamid and Abdulaziz A,2004)

Item No.	Item type	Item value
1	Surface area	8 km^2
2	Height (foundation)	106 m
3	Height	74 m
4	Length	340 m
5	Width (base)	79.5 m
6	Dam volume	675000 m^3
7	Spillway type	Overflow
8	Spillway capacity	8186 m^3/s
9	Total capacity	192750000 m^3
10	Catchment area	4843 km^2

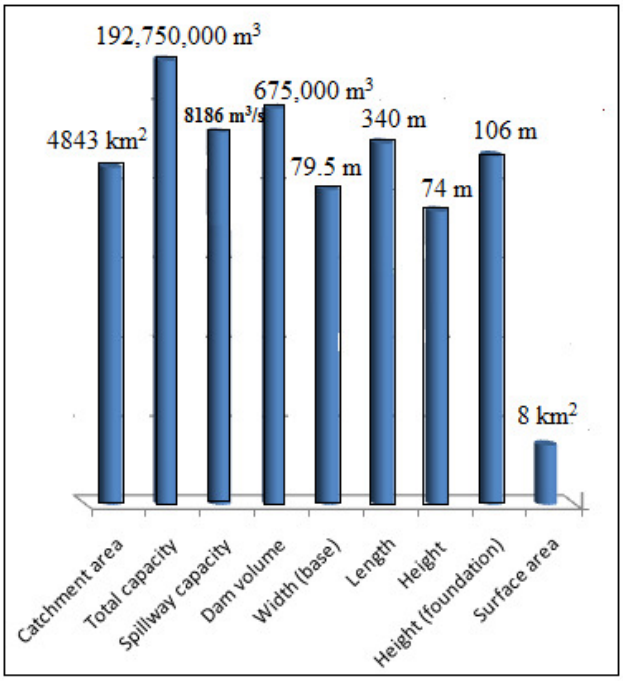

Figure 2. Graph of information of Wadi Baysh dam (derived from software)

106 meters, this dam has the highest capacity of any dam in Saudi Arabia, holding 192750000 m^3 of water. Additional details about the Wadi Baysh Dam are given in Table 1 and Figure 2.[2]

b) **Base map of the study area** :Figure 3 shows the base map of wadi Baysh. This map is obtained From the study carried by.[2]

c) **Remote Sensing(RS) data (Data of Satellite)**: The data of RS is used in this paper include

i. The Earth Explorer website provided 30m resolution[16] of a Landsat Operational Land Imager (OLI) pictures for the study area; these are open-source remote sensing data of United States Geological Survey (USGS).

ii. A high-resolution image from the ArcGIS software background (Google Earth image) was used. The Alaska

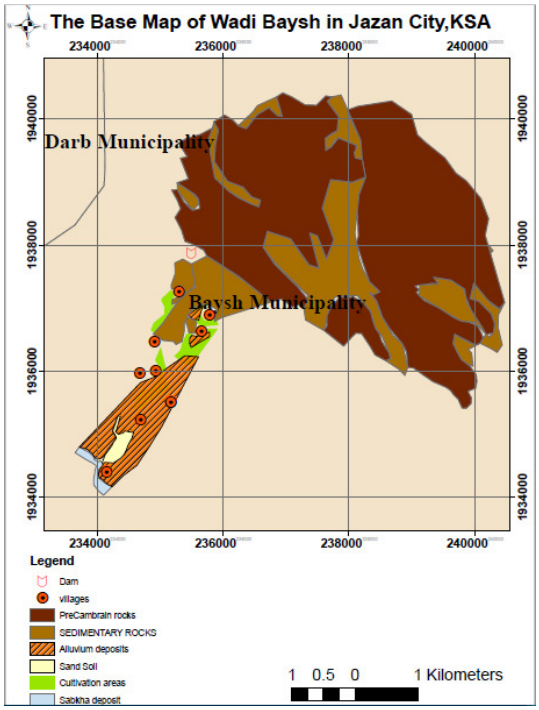

Figure 3. Base map of wadi baysh is established by on-screen digitizing (derived from ArcGIS10.4).

Satellite Facility[17] was used to obtain a 12.5m resolution Digital Elevation Model (DEM) using ALOSPALSAR digital elevation (See Figure 4).

d) **Ageologic map:** A 1:250,000 scale geologic map of the research area is shown in Figure 5, along with 1:50,000 scale topographic sheets that were provided by the Saudi Geological Survey for the research area[18] and.[19]

e) **Land use/ land cover data**

The land use/cover map of the research area is acquired from the Esri open source website and is shown in Figure 6. In order to enhance the efficacy of current artificial intelligence (AI) land classification algorithms, a vast training dataset including billions of picture pixels with human labels was incorporated. The maps were created using all of the Sentinel-2 10 meters for bands B2, B3, B4 and B8[20]scene collection and about 2,000,000 Earth observations from six spectral bands for each year between 2017 and 2022.

A surface map with nine classes—vegetation types, barren ground, water, arable land, and populated areas—is the end product. These maps are available from the ArcGIS Living Atlas of the World.These representations will help planners all over the world gain a better understanding of their surroundings and how it has changed over time, enabling them to make more informed decisions. The Land Use and Coverage Area Frame Survey (LUCAS) land cover modalities. Map Biomas classification,[21] and GlobeLand30 land cover types were among the ones used to classify the land use/land cover based on the following criteria: water, trees, grass, flooded vegetation, crops, build area, bare ground, snow/ice, clouds, and ranglands.[22]

f) **Rain fall data**

g) The core and outside rainfall stations of the catchment area were located and named near the study area.

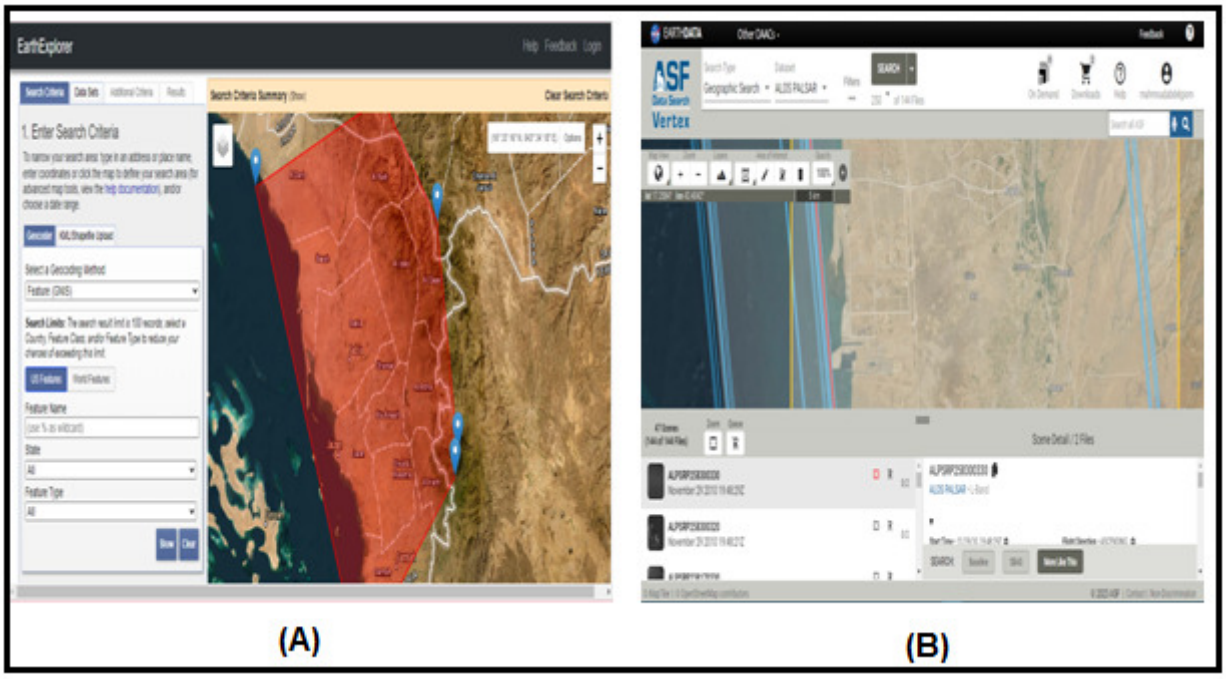

Figure 4. User interface of DEM, (A): Earth explorer USGS sources: https://earthexplorer.usgs.gov/ and (B): ALOSPALSAR (Sourse: Lawal and Umeuduji[16]).

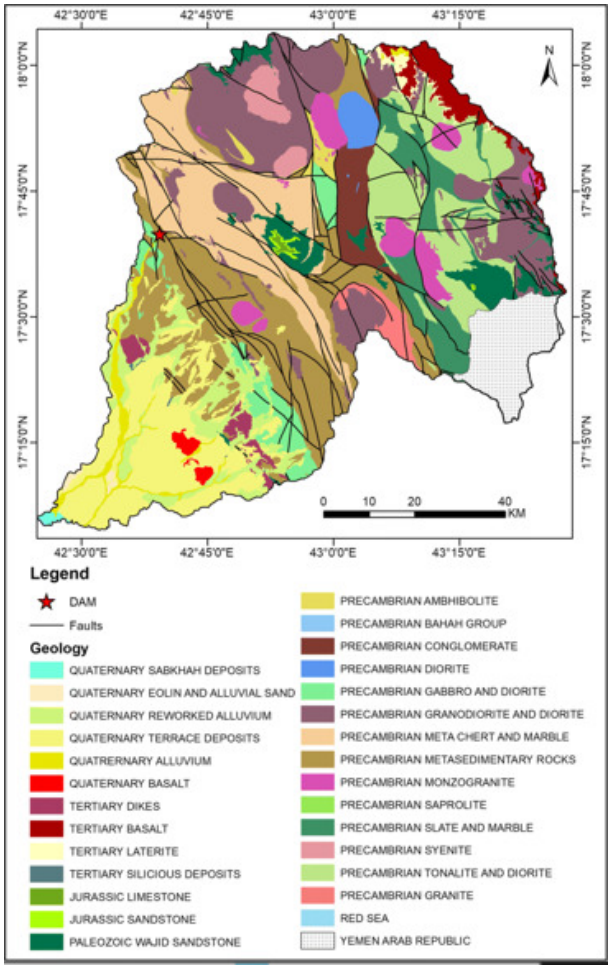

Figure 5. A geologic map of the study area.[19]

A004, A104, A121, N103, SA002, SA102, SA106, SA110, SA125, SA126, SA140, SA145, and SA204 are a few of these stations. The Ministry of Environment, Water, and Agriculture provided information used to construct the data records for these stations.[2]

Figures 7, 8, and Table 2 depict the locations of these stations as well as precipitation observations during the last 100 years.

4.2. ARCGIS10.4 SOFTWARE

ArcGIS10.4 (Aronoff Stanley,1989) is the GIS program used to create the risk map, which will also be customized to the needs of the local population using census data and other pertinent statistical abstracts.spatial analysis in ArcGIS10.4 is used for flooding assessment.[23] Generating the flood area mapping and analyzing the prospective flood area are the two key benefits of using ArcGIS 10.4 for flood management. An analysis is conducted to determine the likelihood that floods may cause damage,[23] and.[24]

4.3. ARC HYDRO SOFTWARE

A state-of-the-art geospatial relational database management system (RDBMS) for fusing hydrology and hydrography with GIS is called Arc Hydro. Arc Hydro is a spatial and temporal data model for water resources that is intended to be used with ArcGIS10.4[25]; and.[26] The Arc Hydro model is tested using a set of ArcGIS tools called Arc Hydro Tools. It populates different fields in an Arc Hydro geodatabase for a river basin (DEM) using a digital elevation model. This document describes the Arc Hydro data model and Arc Hydro tools for ArcGIS. A case study is provided that shows how to simulate a watershed and streams in Jazan's Wadi Baysh us-

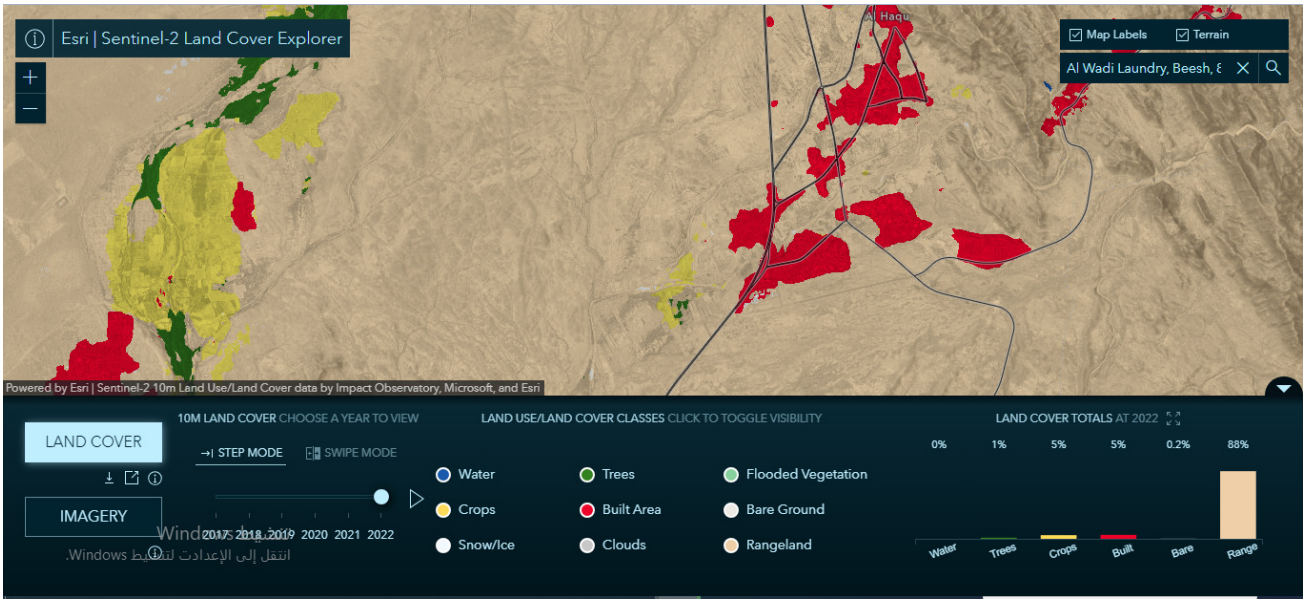

Figure 6. An esri sentinel-2 10-meter land use/land cover[20]

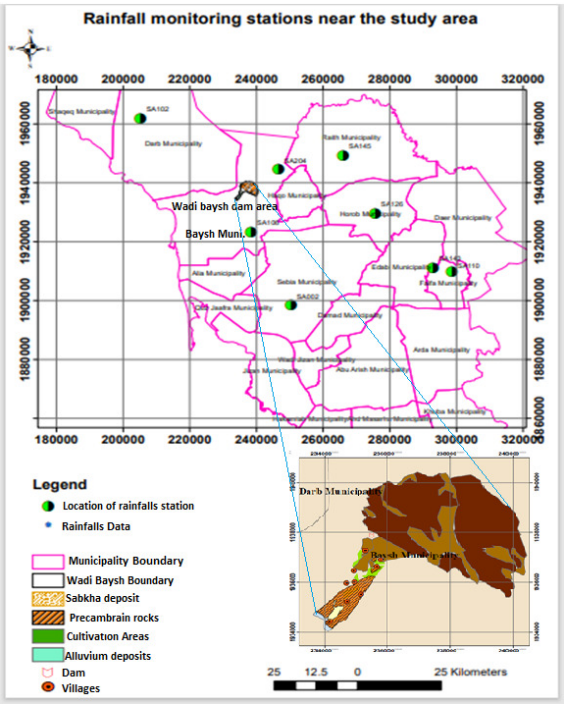

Figure 7. Rainfall station near the study area (adapted from ArcGIS10.4)

ing Arc Hydro tools.[25] Arc Hydro Groundwater used in this paper(.[27]

4.4. MATERIALS AND METHODS USED FOR FLOOD RISK ASSESSEMENT OF WADI BAYSH DAM

The utilization of the rainy season is crucial to the paper methodology.For the study area, make a town, settlement, and contour map using various GIS software layers and techniques.

In section 4, the gathered data is explained in depth.were employed to create the research area's stream network and define the watershed.

Draw the basin's border using the research area's extracted DEM. The program is used to carry out computations and build digital models. The following are some of the instruments utilized to produce the outcomes in this paper:

1. ArcGIS 10.4 is used for mapping, analysis, layout, and plotting application
2. Arc Hydro 9 is used fo the hydrology analysis.

4.4.1. STUDY AREA CLASSIFICATION

In the southwest of Saudi Arabia, in the Jazan region, is the Wadi Baysh basin is shown in Figure 9. Its boundaries are latitudes 17°02′57″ to 18°04′12″ N and longitudes 42°20′30″ to 43°27′54″ E. Along the downstream portion of the dam, there are several urban neighborhoods. according to.[19]

The Wadi Baysh serves as a model basin for a number of other basins in the southwest of the kingdom that flood on a regular basis, causing soil erosion, infrastructure damage, and a large loss of water to the Red Sea.[2]

The downstream region was susceptible to Wadi Baysh flash floods before the dam was built. Before draining into the Red Sea, this wadi drains the high mountain regions upstream of the dam site into the floodplain area downstream of the dam site. There are numerous tributaries in the upstream catchment of the dam site, including the Wadi Dafa, Wadi Dhibah, Wadi Lajb, Wadi Bishah, and Wadi Yakhraf. The research area's elevation varies from 0 m above mean sea level on the coast of the Red Sea to 2750 m at the eastern part of the basin.The upstream catchment of the dam site has many streams, including Wadi Dafa, Wadi Dhibah, Wadi Lajb, Wadi Bishah, and Wadi Yakhraf. The elevation of the research region varies from 0 m (on the shore of the

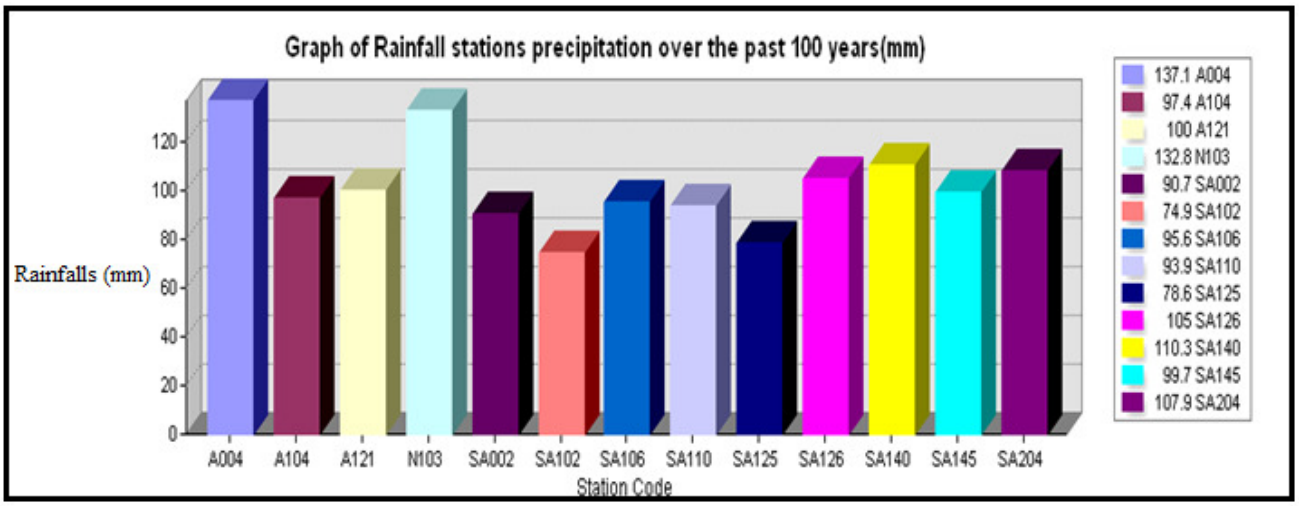

Figure 8. Graph of Rainfall stations near the study areaand their precipitation over the past 100 years.(adapted from ArcGIS10.4)

Table 2. Coordinates of the rainfall stations and their precipitation over the past 100 years.

Station Code	Easting (m)	Northing(m)	Precipitation(mm) over the past 100 Years
A004	303259.591	1992739.817	113.8
A104	326919.066	1983600.722	87.8
A121	263464.000	1991457.202	93.1
N103	343571.642	1953211.476	113.4
SA002	250304.874	1898426.508	81.4
SA102	205214.094	1962000.626	70.6
SA106	238382.769	1923457.740	88.9
SA110	298635.958	1910074.384	90.1
SA125	226451.069	1785935.113	72
SA126	275628.656	1929532.667	98.5
SA140	292917.470	1911330.484	101.2
SA145	265969.444	1949324.102	94.6
SA204	246590.601	1944484.319	97.6

Red Sea) above mean sea level to 2750 m. (in the basin's eastern section) Located in the Jizan Region in southwest Saudi Arabia, 35 kilometers (22 miles) northeast of Baysh on Wadi Baysh is the location of the gravity dam known as the Baysh Dam. The dam controls flooding, provides irrigation, and recharges groundwater, among other uses. The dam was constructed in the years 2003–2009.

4.4.2. METHODOLOG OF THE FLOOD RISK INVESTIGATION USING RS AND GIS

Figure 10 shows the following procedures are used in the fullment methodology steps to determine the flood risk areas:

1. Base map and a 1:250,000 scale geologic map of the study area.
2. Remote sensing data which include a 12.5m resolution Digital Elevation Model, (DEM) using ALOSPAL-SAR, and a 30m resolution of a-Land sat Operational Land Imager (OLI).
3. An esri sentinel-2 10-meter land use/land cover map
4. Rainfall data over the past 100 years
5. Carry out basic analysis using arc hydro and ArcGIS10.4 software's and determined the maps
6. of fill area, flow direction ,slope, contour(elevations), accumulation, streams, and drainage boundary.
7. Finally, Perform the Advance(spatial) analysis using GIS technology for flood risk assessment of wadi baysh.

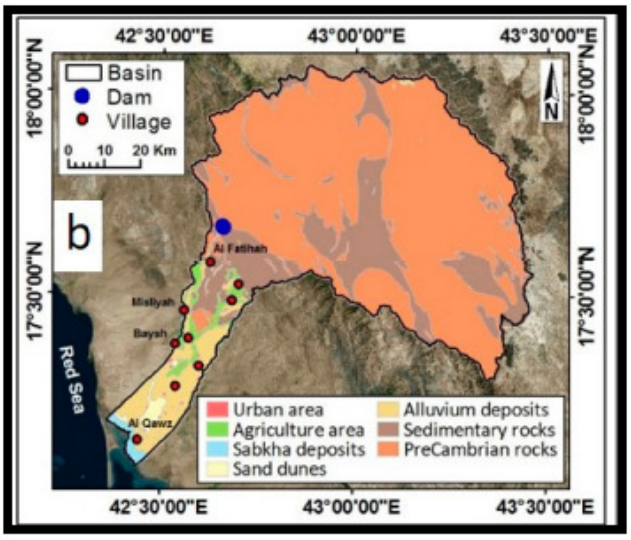

Figure 9. The base map of the study area.[2]

5. RESULTS OF SPECIAL ANALYSIS

5.1. ANALYSIS USING ARCGIS10.4 AND ARCHYDRO

Delineating streams and watersheds and gathering basic watershed data, such as area, slope, flow length, stream network density, and so forth, is the first stage in any hydrologic modeling process. Historically, this was done by hand using topographic/contour maps. Digital elevation models (DEM) and GIS technology have made it possible to obtain watershed features automatically. Watershed division of a Digital Elevation Model (DEM) is known as terrain pre-processing. For pre-processing terrain, there are several online tools accessible, such as the Hydrology geoprocessing tools in the Arc Toolbox. In this exercise, we will use Arc Hydro tools to define watersheds, sub-watersheds, stream networks, and other features of watersheds that together characterize the drainage patterns of a basin. The hydrological analyses were created with ArcGIS10.4 in order to meet the goals and calculate. The steps of ArcHydro analysis are include:

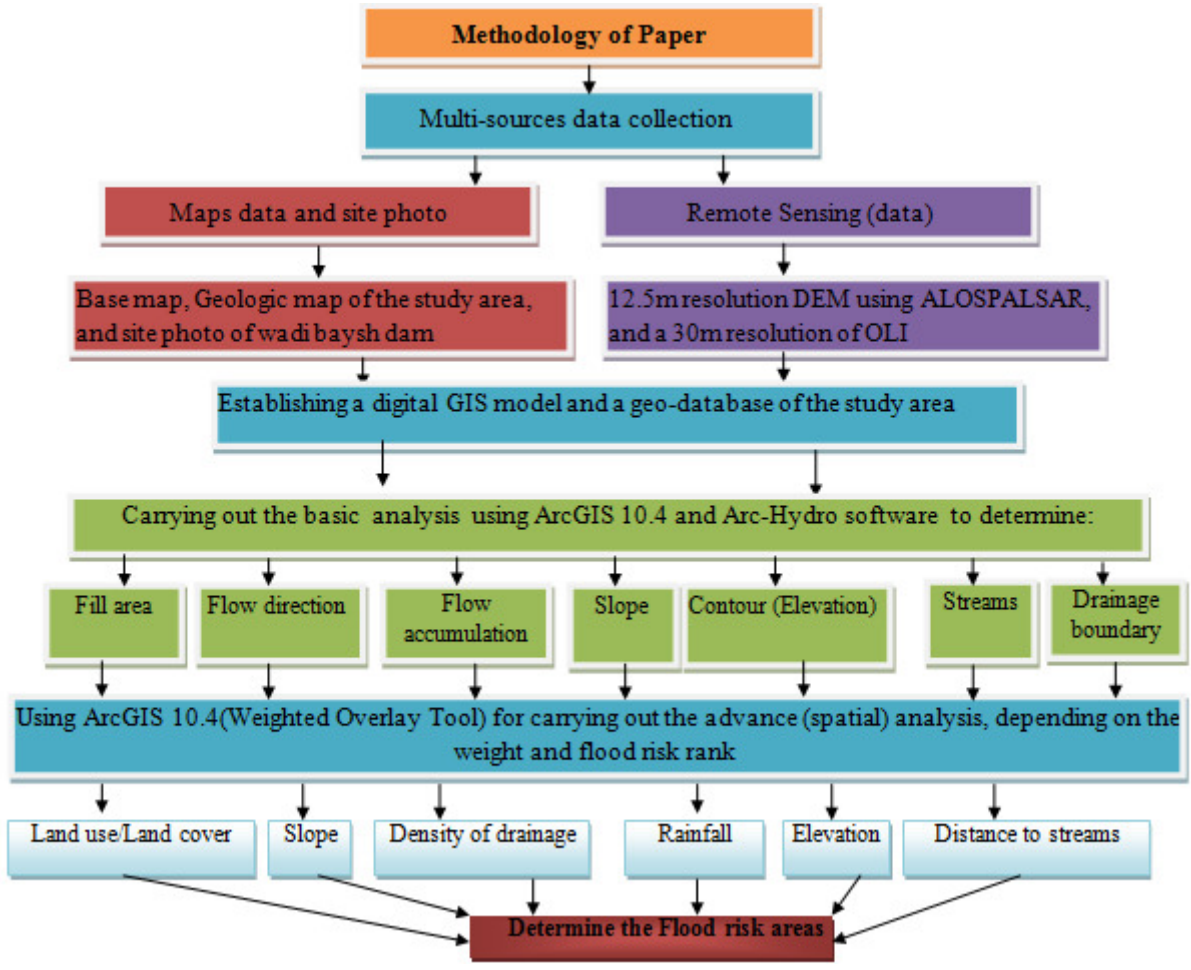

Figure 10. The paper Methodology flow chart

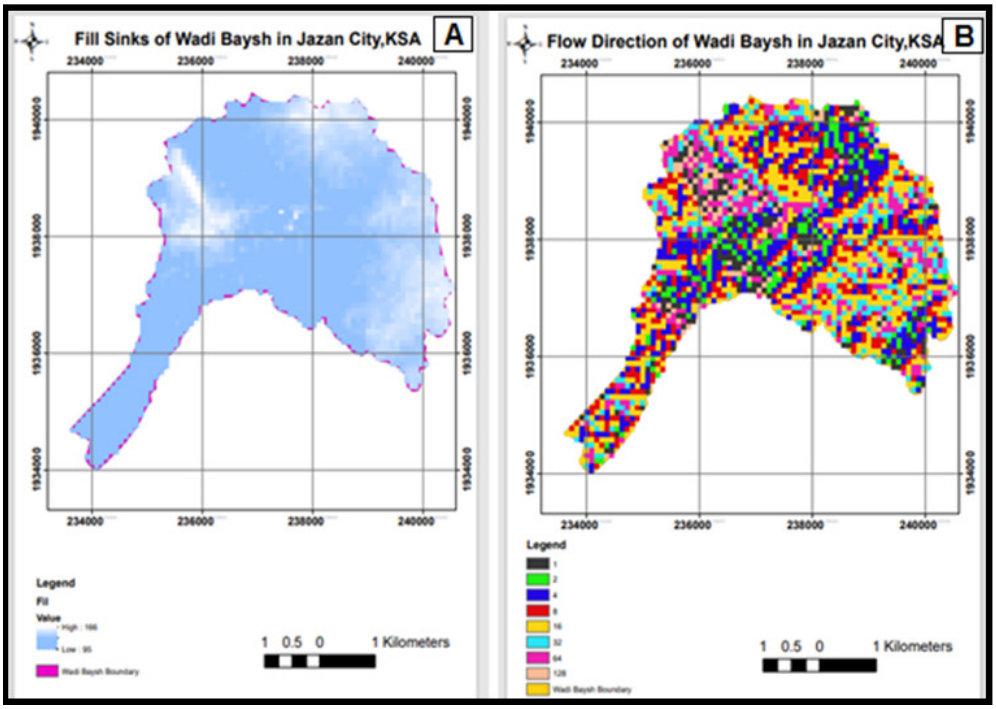

Figure 11-A and 11-B]. Analysis using Archydro and ArcGIS10.4 showfill skins and flow direction(Drived from ArcGIS10.4).

5.1.1. BASIC ANALYSIS OF GIS USING ARCGIS10.4 AND ARC-HYDRO SOFTWARES

The following are the steps in ArcGIS 10.4 or ArcHydro (basic analysis):

a) Establish the fill map of study area(See figure 11-A.

b) Evaluate the flow direction map of the study area(See figure 11-B).

c) Determine the wadi Baysh slope (See figure 11-C.

d) Draw the contour map of wadi Baysh(See figure 11-D.

e) Prepare the flow accumulation map of the study area(See figure 11-E.

f) Assess the stream definitionof the study area(See figure 11-F.

g) Calculate the stream to feature and drainage boundary map of the study area(See figure 10-G).

The graph of 128 drainage lines, or streams, that the arcHydro analysis program assessed is displayed in Figure 12. The research area's dam lake receives water from several streams.

5.1.2. ADVANCE ANALYSIS OF GIS TECHNOLOGY FOR FLOOD RISK ASSESSMENT OF WADI BAYSH

This method of analysis depend on the varables and the results of the basic analysis.To perform the advance GIS by using ArcGIS 10.4 , the analysis variable should be determined to achive the last result of the flood risk assessment of wadi baysh according to the weight and flood risk rank. The weight of the all varabiles is selected according to The Analytic Hierarchical Process (AHP). The Analytic Hierarchical Process (AHP) has been applied globally in many domains, including industry, education, transportation, and healthcare, particularly since it facilitates collaborative decision making.

The study region's spatial distribution of flood threat was assessed and mapped using weighted overlay analysis with pairwise comparisons. A map that enabled the ranking of dangerous zones was produced as a result of the GIS-based multi-criteria hazard analysis,[28] and.[29] Tables 3 and 4 show these variables. The ranges of flood susceptibility criterion and subcriteria standards, as well as AHP, are used to compute and choose the weight values.[30]

5.1.3. REQUIRT MAPS FOR PERFORMING ADVANCE (SPATIAL) ANALYSIS

The advance analysis of flood risk assessment and mapping using GIS analysis techniques had performed, because a lot of maps prepared and reclassed according to the flood risk rank (See table 3.). Figures(12,13,14,...and 17 respectevily) show the layout maps of Wadi Baysh.These mapsinclude the following:

(a) Land use / Land cover;
(b) Slope;
(c) The density of drainage;
(d) Rainfall;
(e) Elevation; and
(f) Distance to streams(drainage lines).

Table 3 show the percentage of weight were distributed according of six factors(Landuse/land cover, slope, drainage density, rainfall, elevation,and distance from streams also were ploted in above figures 13, 14, 15, ...18. Using ArcGIS10.4,

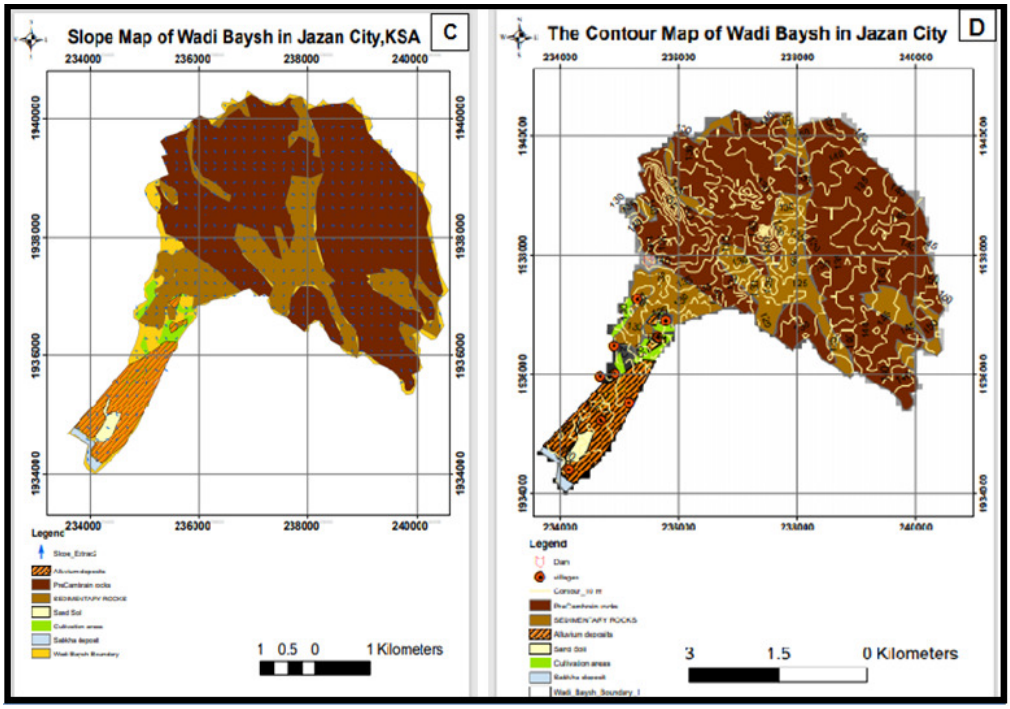

Figure 11-C and 11-D. Hydrologic Analysis using Archydro and ArcGIS10.4 showslope of Wadi Baysh and contours (Drived from ArcGIS10.4).

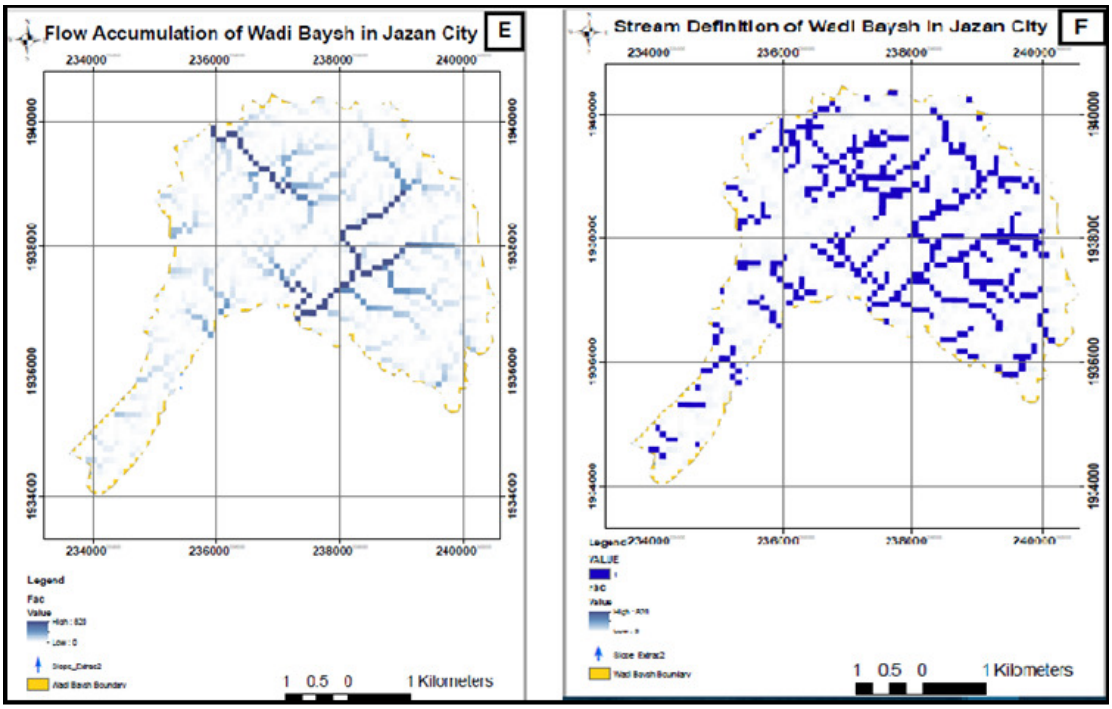

Figure 11-E and 11-F. Hydrologic Analysis using Archydro and ArcGIS10.4 show theflow accumulationof wadi Baysh and Stream definition (adapted from ArcGIS10.4).

5.1.4. LAST RESULT OF ADVANCE ANALYSIS OF FLOOD RISK USING ARCGIS 10.4

The flood risk assessment's last analysis is carried out with the help of ArcGIS 10.4's weighted overlay tool.The Weighted Sum tool allows for the weighting and combining of multiple inputs to get an integrated analysis. In that several raster inputs representing various elements can be easily blended while integrating weights or relative importance, it is comparable to the Weighted Overlay tool.

The analysis keeps its resolution by not scaling the reclassified values back to the assessment scale. In a suitability model, for instance, if there were 10 input criteria that were classed on a scale from 1 to 10. Table 3 shows

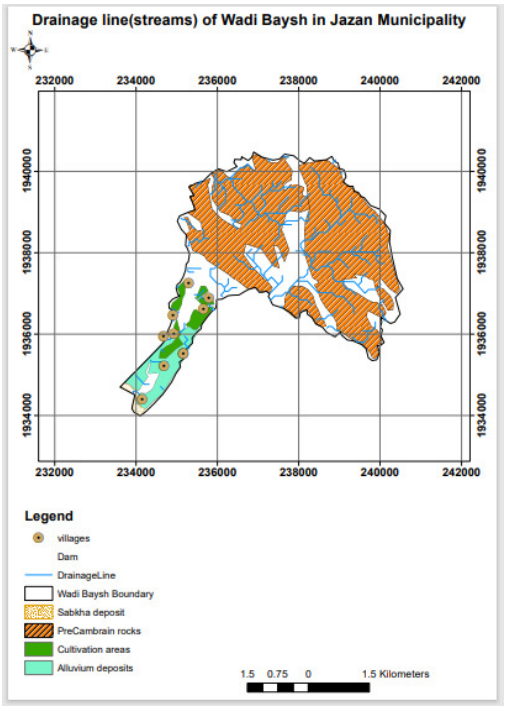

Figure 11-G. Hydrologic Analysis using Archydro and ArcGIS10.4 shows the stream to feature and drainage boundary map of the study area (adepted from ArcGIS10.4).

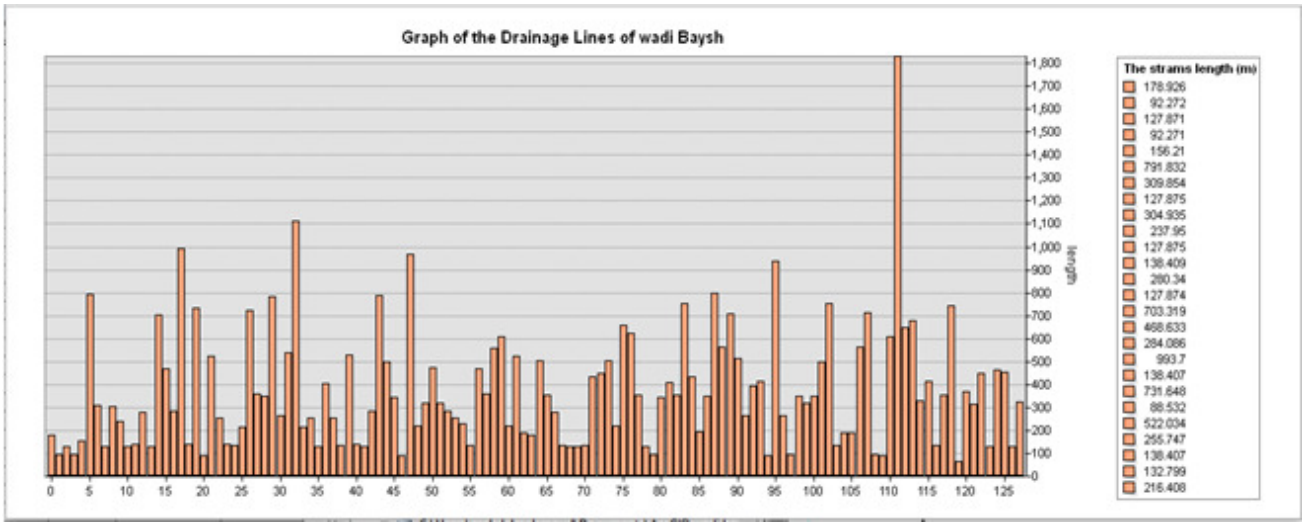

Figure 12. The Graphs of the lengths of the drainage lines (Streams) in Wadi Baysh(drived from ArcGIS10.4).

the percentage of weight were distributed according of six factors(Landuse/land cover, slope, drainage density, rainfall, elevation,and distance from streams also were ploted in above figures 12, 13, and 14. Using ArcGIS10.4 depends on the flood hazard formula.

The final result of flood risk assessement is calculated according the following formula (Equation 1):

Flood hazard= $W_i * X_i$ ..... (1).[31]

Where W_i= weight of factor i; X_i=criterion score of factors i. Then in case of this paper the fnal food hazard map was calculated using the following equation 2

Flood hazard= 0.10* [Landuse/Land Cover] +0.10* [Slope] + + 0.20× [Drainage density] + 0.25*Rainfall+ 0.15* [Elevation] + 0.20× [Distance from streams] ..... (2).[31]

Figure 15 displays the last flood risk assessment result.

Table 3. Variables (factors for flood assessments and mapping of Wadi Baysh)

S,N	Name of variable of the study area	Weight
1	Land use and land cover	10%
2	Slope	10%
3	Drianage dencity	20%
4	Rainfall	25%
5	Distance to streams	20%
6	Elevation	15%
Total	100%	

Table 4. The flood risk rank

Very high flooding	5
High flooding	4
Moderate	3
Low	2
Very law	1

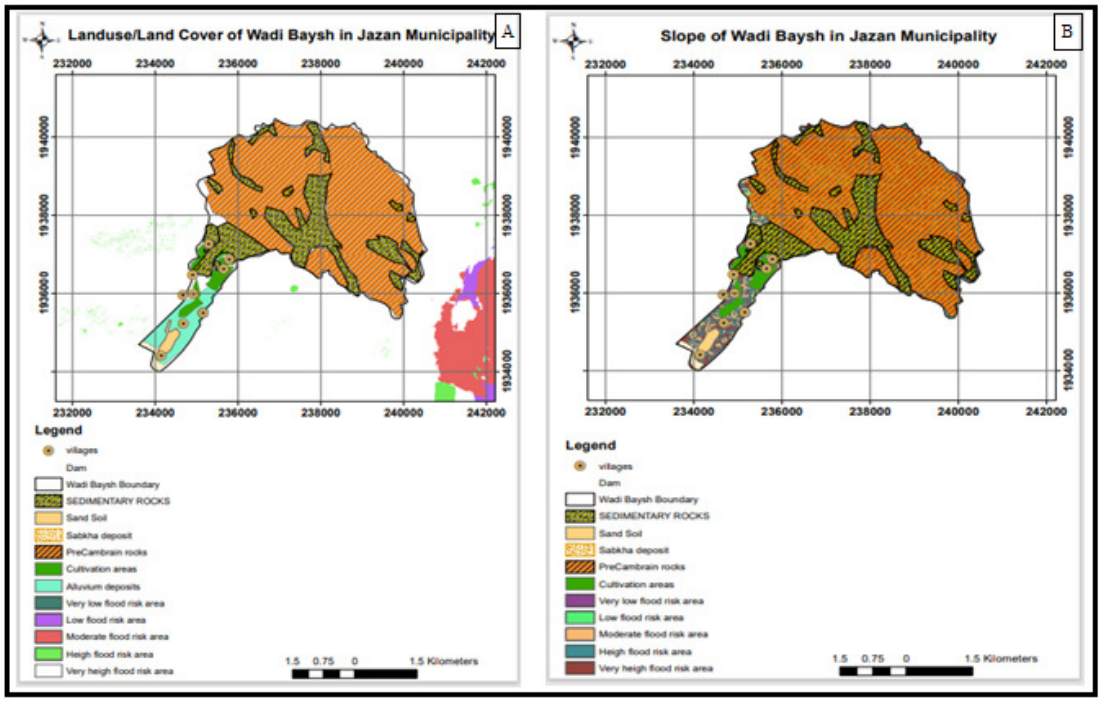

Figure 13. (A): Land use / land cover Map; (B): Slope Map (adapted from ArcGIS10.4).

5.1.5. THE FOOD HAZARD MAP'S VALIDATION

The validation of the flooding maps depends on the input data according to the requirements of the analysis. In this paper, the coordinates and projection system are revised and considered before analysis, moreover the flood hazard is calculated according to the specific formula.[31]

The practice of methodically contrasting model outputs with impartial real-world observations to evaluate both quantitative and qualitative concordance with reality is known as model validation. Researchers employ a variety of models to evaluate a food's susceptibility around the globe, but it is important to examine the model's results to make sure the model accurately captures the real world or documented data. It is possible to calibrate and validate a model by comparing its output to observable data.

Figure 15 shows the study in Jazan region was classified into five classifications based on the flood susceptibility

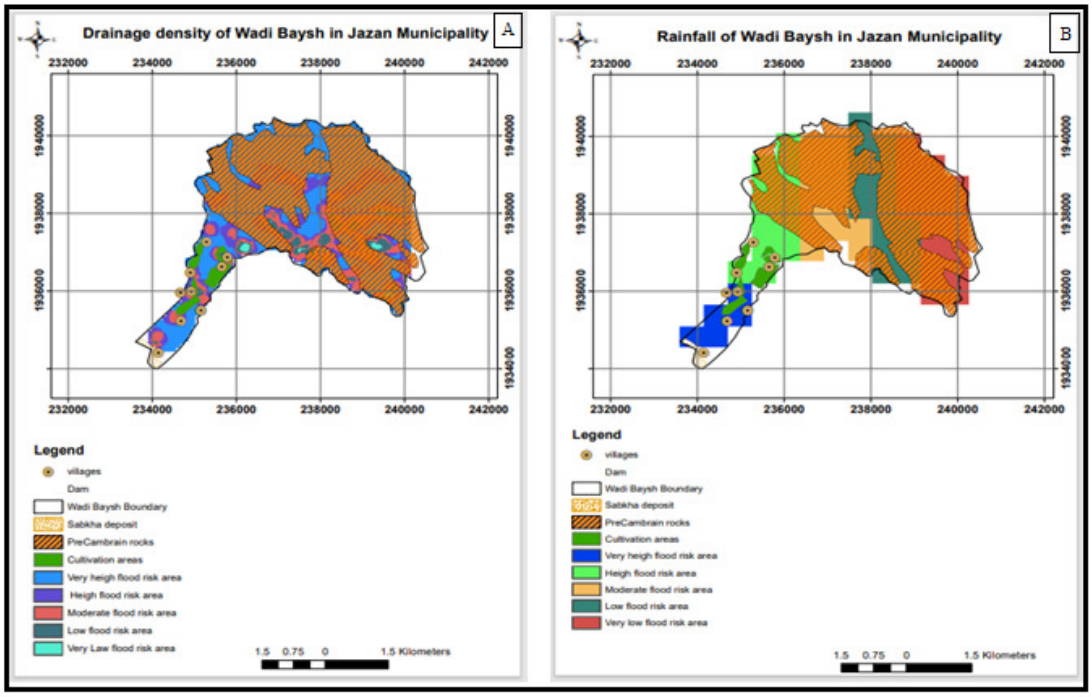

Figure 14. (A): Drainage density Map; (B): Rainfall Map (adapted from ArcISG10.4).

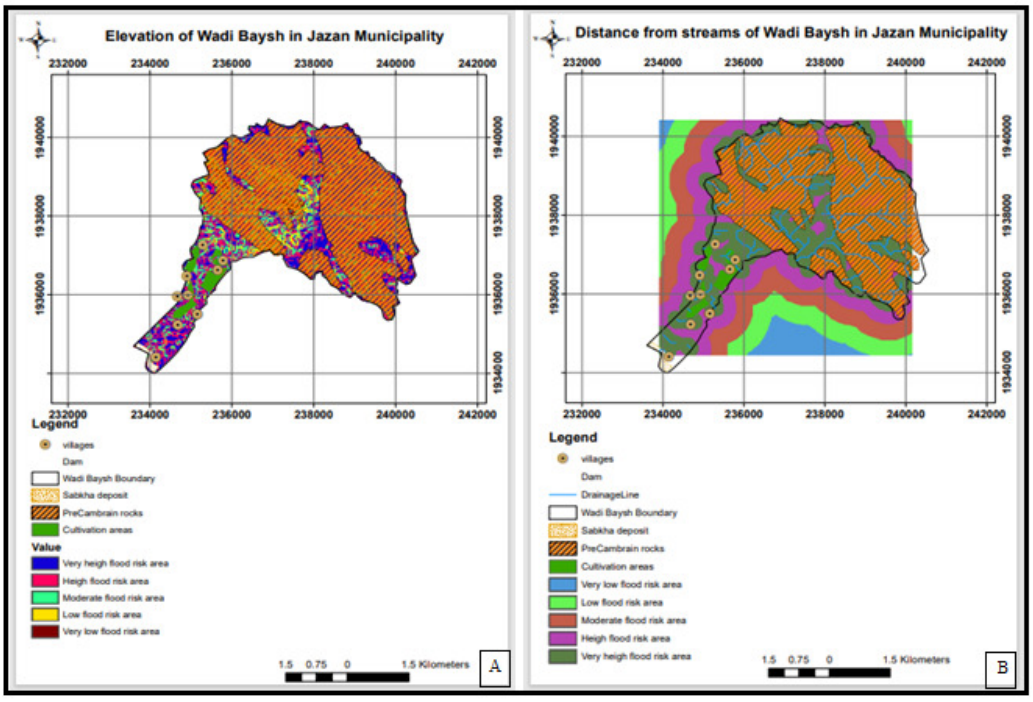

Figure 15. (A): Elevation Map; (B): Distance from streams Map (adapted from ArcGIS10.4).

map: very low susceptibility,low susceptibility, medium susceptibility ,high susceptibility, and very high susceptibility.

5.1.6. THE SUGGESTION FOR FUTURE WORK

Securing the Baysh Dam from earthquakes and floods is crucial to ensuring its continued operation and protecting the surrounding communities. Engineering, technical and security measures must be taken to increase the dam's resistance and address potential challenges. The author of the paper suggested the following:

1. Building auxellary dam in the downstream region to safeguard the settlements and preserve 43532820 m^3 of water for use in supplying groundwater and farm wells throughout the valley's course.

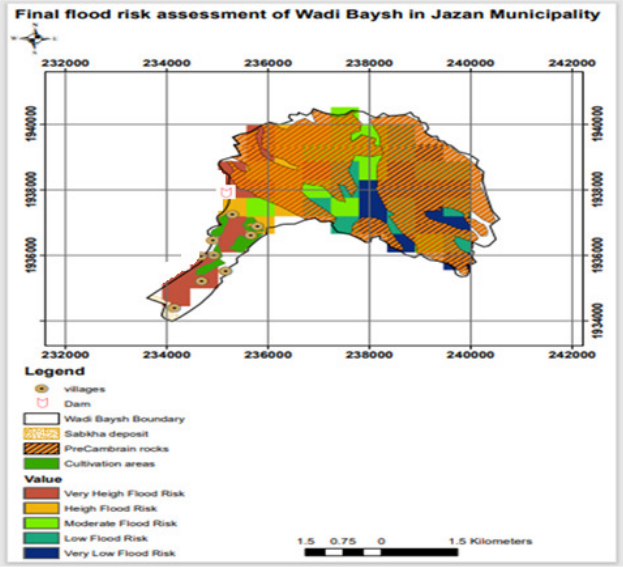

Figure 16. Final flood risk assessment analysis result (adapted from ArcGIS10.4).

2. Flash flood warning systems are used to alert households and road users to rapid flooding by installing rain and runway monitoring stations.
3. Using analytic GIS analysis by using open-source remote sensing data to track the weather and locate hazardous locations in downstream areas of Wadi Baysh
4. Utilizing studies of the anticipated flow times and flood volumes to warn the locals of these places by the authorities in charge of them.
5. Monitoring the dam during the peak period by drone, early warning system.
6. Using satellites equipped with radar imaging sensors to see clouds, through which flood mapping and forecasting of flood events can be improved.
7. Providing well-trained and equipped security teams to monitor the Baysh Dam and ensure its safety and continuity of operation
8. Use of drainage, segmentation and piping systems to control water flow and discharge efficiently at Baysh Dam.
9. At Baysh Dam, drainage, segmentation, and piping systems should be used to efficiently control water flow and release.
10. Officials and observers must constantly communicate with communities living in the downstream areas via social media, radio, and television.
11. Using the Internet of Things (IoT) system[32] for monitoring the water level in the wadi baysh dam. Figure 17 shows the components of this system. Automated river water level measuring is possible using IoT-based level monitoring instruments. On the riverbank are sensors that use RADAR and ultrasonic technology. These sensors project a wave towards the river and calculate the distance between them and the water's surface by timing the wave's return trip. Sensor data is gathered by gateways and transmitted to a cloud layer, where all measurements are stored. Our end-to-end IoT dashboard provides real-time access to these readings from anywhere at any time. The system's autocalibration algorithms analyze the sensor signals to precisely determine the river's level.

6.CONCLUSIONS

Flooding and Earthquakes are usually described as natural disasters that have no human involvement in their occurrence. However, some studies have recently begun to pay attention to types called "induced earthquakes," which, as their name suggests, are caused by human activities that stimulated their occurrence. Among these activities that scientists mention is "construction."

For the purpose of protecting agricultural and urban regions from flooding, decision makers and planners must create GISs and conduct remote sensing studies for the downstream areas of dam sites. This section of the article offers a high-level overview of the findings and suggestions. GIS and GIS techniques have proven to be an accurate and efficient tool in Hydrology studies, and they have introduced the forcasting of flooding data in order to save the lives of people who live near the downstream area. The Hydrology model is very simple to use for data input, storage, retrieval, plotting, and updating. The visual interpretation of the DEM of Wadi Baysh in Jazan City shows moderate and high relief, high runoff and slope, and high precipitation during the rain season, with an early mature stage of erosion development. Density of drainage, texture ratio. The comprehensive geological map and morphometric analysis of the drainage basin show that the given area has good expected groundwater. According to the study, Baysh Valley is important for agriculture because its water is rich in alluvium soil. This soil is ideal for agriculture.

It is classified as a valley in its youth (erosion) because it is a mountainous valley that descends quickly, erodes, and carries a heavy load. It flows on a flat surface (plain) with many bends and meanders when it enters the Dam basin in Wadi Baysh. To raise the flow level and fill all or part of the meadow in this system, a flood control structure could be built just upstream of the valley tributary confluence point. A study of groundwater availability to supplement surface flow is also required.

It should be emphasized that any implementation must take into account the sensitive environmental conditions that must be preserved in order to avoid any negative consequences. The study discussed the flood risks in the study area. This study looked into GIS modeling and analysis for assessing the risks of flooding in Wadi Baysh in Jazan province.

The findings of this study are summarized as follows:

a) To complete the final analysis, digital elevation models, maps, attribute data for the study area, and GIS analysis methods must be considered.

b) In this study, GIS software extension tools (Arc hydro) are available, free, and very simple to use by GIS analysts.

c) Because software engineering development within GIS software can be extended (Arc GIS10.4).

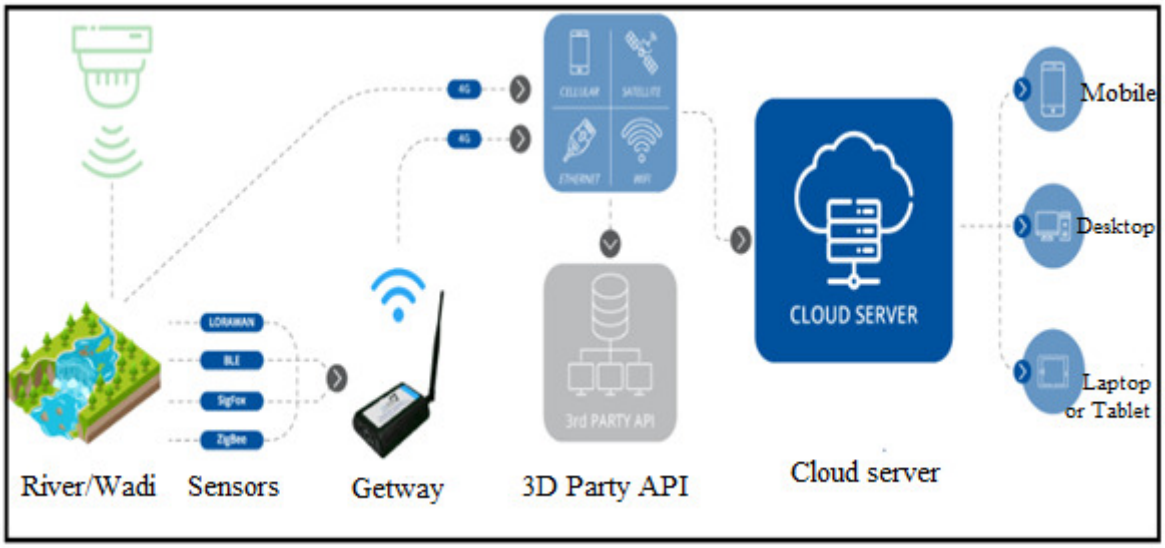

Figure 17. Components of Internet of Things (IoT) monitoring system.[32]

d) There are numerous advantages to using the ArcGIS10.4 and Arc Hydro softwares.

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