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Evaluation of the effectiveness of the concrete protection channel for the urban expansion area of the western part from the risk of flooding, the case of the city of M'sila - Algeria

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Abstract. The study aims to evaluate the efficacy of the completed concrete canal in the urban expansion area of the city of M’sila to prevent the flood risks of river Portem, by performing a hydraulic simulation using the 2D river simulation program HEC-RAS 2D and geographic information systems (SIG), in this research and after determining The water catchment, extraction of morphological characteristics, and calculation of the maximum flow quantity $Q_{maxm}{}^3$/s based on the series of rainfall data for the reed station for a period of 37 years after processing it spatially in geographic information systems. The areas exposed to the risk of flooding have a direct relationship with the period of return, so that an area of 9.98 hectares was recorded in the return period of 10 years, 12.72 hectares in 50 years, and 14.31 hectares in 100 years. The study also showed the importance of using HEC- RAS 2D and (SIG) in evaluating the efficiency of the concrete channel to prevent floods and contribute to decision-making to reduce the resulting disasters.

Keywords. Flood Risk, HEC-RAS 2D, Flood Modeling, PortemRiver, M’sila

1. Introduction

Climate change is one of the biggest issues of our time and natural disasters [1](floods, earthquakes, landslides...) One of the challenges that concern most of the officials of the countries of the world, especially in this era, because of its negative effects on society and on the infrastructure of urban circles, as many developed cities of the world and third world countries witnessed many natural disasters[2].

Among these natural hazards are floods in light of climate change and rising temperatures as a result of global warming, and the resulting sudden and heavy rains that result in devastating floods. And construction on the banks of valleys and rivers, as well as construction in areas designated for easements

Flood disaster is a natural disaster that often encounters huge losses in the world[3], causing environmental, social and economic losses and damages and may lead to loss of life[4]

The disastrous consequences of the floods also constitute a major obstacle to economic and social development[5] The international academic and political community has recognized the need to strengthen the resilience of cities [6] Algeria was also subjected to several natural disasters, including the state of Boumerdes, an earthquake on May 21, 2003, with a magnitude of 7.3 on the Richter scale, which left 2,278 dead and 130,000 homeless. November 2001, which left 733 dead and destroyed many facilities and infrastructure, material losses in the billions of dinars, and floods rank second after earthquakes and geological hazards in the great national ranking of risk Due to the extent of the material and moral damage caused[7] The city of M'sila also witnessed several recurring floods, including the floods of Aprl 23 2007[8], which hit the western side (the urban expansion side of the city), leaving about 20 dead and material losses of about 200 billion centimeters, and the floods of 2011 and 2014. Because the legal nature of the land belongs to the state, while the rest of the lands belong to private individuals. There are also natural obstacles in the urban expansion area (the western side), represented in the Portem Valley, which cuts through the expansion area from north to south[8].

And in order to protect the urban expansion of the city from the risk of flooding, the Directorate of Water Resources of Msila Province completed a closed underground canal of reinforced concrete on the axis of river Portem, at a distance of 1.4 km, that cuts through the urban expansion area of the city north-south.

Several studies have been conducted in Algeria, several studies on flood risks and mapping areas exposed to them[9, 10] Through this study, we tried to assess the effectiveness of the canal to protect the completed area of the urban expansion of the western part of the city of M'sila from the risk of flooding[11]

Using the Geographic Information Systems (SIG) program to determine the catchment basin and all the morphological characteristics of the catchment water basin with calculating the amount of maximum flow $Q_{maxm}{}^3$/s based on the rainfall data of the reed station for a period of 37 years, with determining the return time period through the Hyfran plus program and making Hydraulic modeling on a canal using 2D river analysis software (HEC-RAS 2D)[12] And try to evaluate the role played by the canal in reducing or contributing to the occurrence of flooding[13]

2. Study area

The city of Msila is located in the northwestern side of the Chott El Hodna basin, bordered on the northern side by the Hodna mountain range, and on the south side, Chott El Hodna. It is 230 km from the capital, geographically located between latitudes 35°42′7″N 4°32′49″E. The state is predominantly agricultural and agricultural. The city is distinguished by an important hydrographic network, as it is located between river Al-Qsob from the eastern side of the city, in addition to river Portem from the western side. The area of the city is estimated at 232 square kilometers. It is occupied by about 214,669 people, or an average of 922 people / hectare [14]

The Portem Valley is located on the western side of the city, and it is currently the expansion area. The estuary meets the Al-Qsob Valley outside the city from the southern side. Collective housing by public bodies, which forced city water resources directorate to complete a reinforced concrete ground channel along the course of the valley in order to drain rainwater and avoid flooding. This risk is a major concern that has been discussed nationally by several authors[15]

It is located in the partial catchment basin of river Portem within the partial catchment basin No. 10, which is located in the large catchment basin No. 05 El Hodna, which is

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considered the fifth catchment basin in Algeria Its area is 26,000 square kilometers[16] As well as a map of the major catchment of Algeria [17]

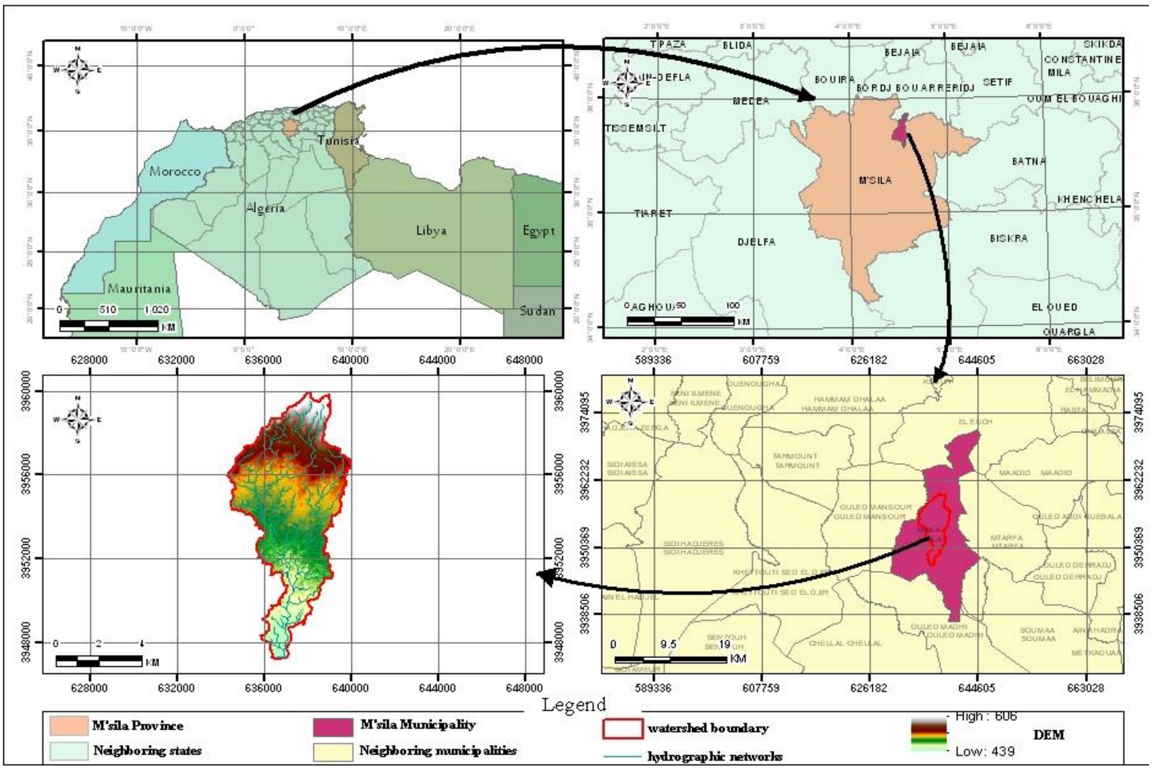

Figure 1: M’sila city location and catchment river Portem

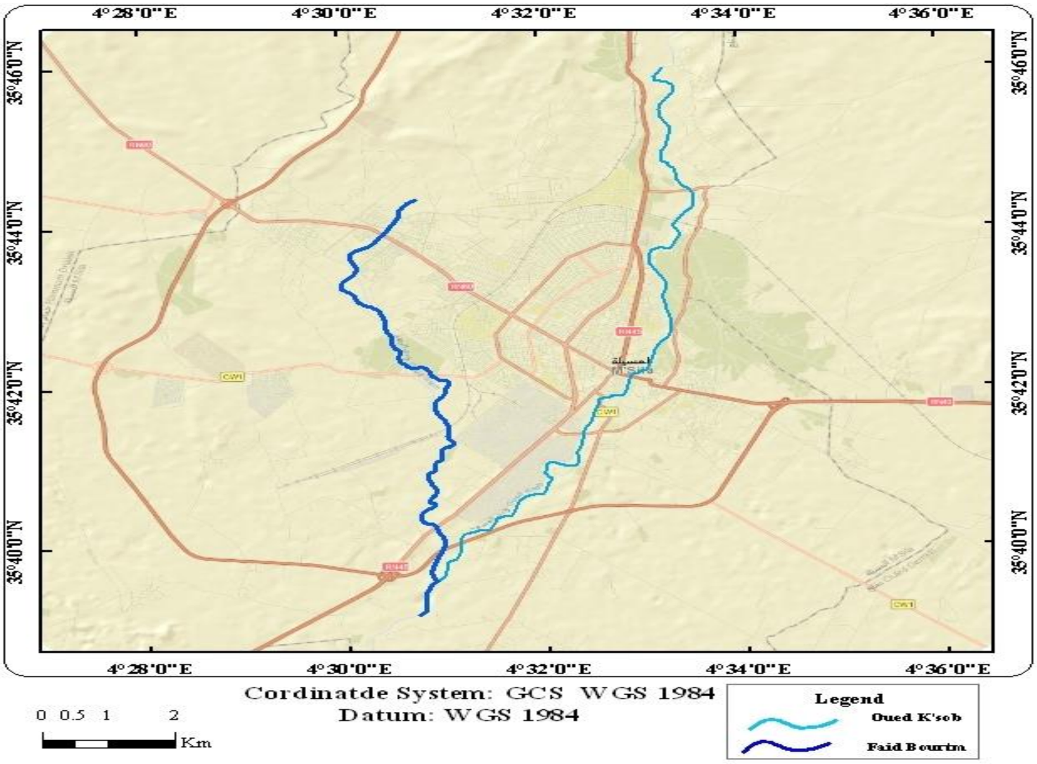

Figure 2: Location of the River K’sob and River Portem

3. Materials and methods

3.1 Data Collection

Data is an essential element in any study related to the hydrological model simulation process. This information is for the sub-water catchment basin of the river Portem from ANRH (National Agency for Water Resources) in an excel file that includes maximum rainfall data and maps showing the major catchment basins. In parallel, the digital elevation model (MNT) of the study area is downloaded from the USGS website, and then the morphological characteristics of the sub-water catchment basin are extracted. The exl files of the maximum precipitation data values are processed with Confirming and correcting all missing rainfall data and values, as rainfall data was obtained for a period of 37 years (1973-2009) with the calculation of the maximum flow $Q_{maxm}{}^3$/s for return periods of 10-50-10.0 year (Table 2).

In the first stage, the data of the Earth Digital Elevation Model (MNT) were relied on and processed using the Geographic Information Systems (SIG) program, and the collection basin of the Portem valley was identified, with the extracting of the morphometric characteristics of the basin (area, perimeter, length of the main stream, ...) (Table No. 01)

As for the second stage, it depends mainly on working with the HEC- RAS 2D river simulation program: for return periods of 10, 50, 100 year, to draw areas at risk of flooding, assessing the effectiveness of the canal, knowing the role it plays in reducing or contributing to the occurrence of floods, and then relying on Maximum flow value data for return periods.

As the flow system has been worked on and is in steady state with respect to the covered channel, the solution convergence of the covered channel cannot be obtained, this is due to the complexity of the corresponding model. In fact, the channel starts with three exposed and then covered sections, which are affected by the basic hydrodynamic models. To homogenize the results between the two types of channels, open and covered, we had to choose the steady state, where the solution converges

Table 1. Morphological Characteristics Of the Portem catchment

Aria (Km^2)		36.45
Perimeter (Km)		39.23
Equivalent rectangle or Gravilus rectangle	l(km)	2.10
	L(km)	17.38
Concentration time (Tc) (heures)		4.33
Elongation coefficient (Ca)		7.81
Compactness coefficient		1.82
Length of main Thalweg		16.87

Table 2. Table showing the maximum flow by return period

Repetition time	10an	50an	100an
Q_{MAXm}3/s	47.75	64.87	76.88

Table 3. Station coordinates in terms of altitude

Station Pluviometry	Z	Y	X	code
Barrage of K'sob	600	282,65	668,7	051005

Source; ANRH: Algerian National Water Resources Agency

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The table shows the location of the station for recording rain values according to the geographical coordinates, as it is located near the K'sob Barrage and is the nearest station for the partial catchment of Portem Valley (Fig No.3).

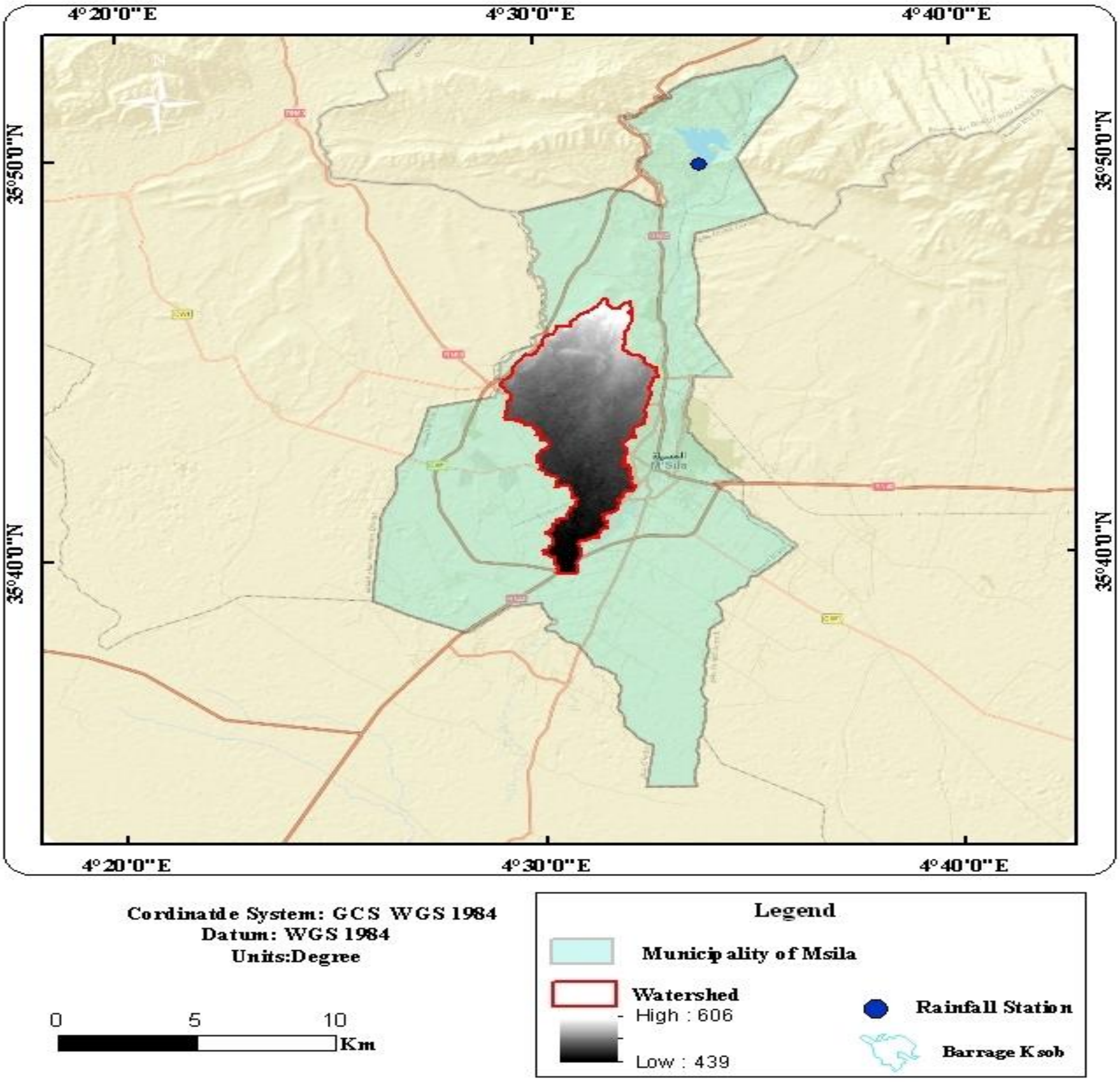


Figure 3. Rain fall Data Recording Station, Ksob Dam

3.2 Introducing the channel

The canal was completed in 2010 by the Water Resources Directorate of the city of M'sila, based on a study previously prepared by a technical consultant. The total length of the canal is 2.08 km divided into several sections, 1.55 km of which, with dimensions of 5.00 m in width and 1.80 m in height, have been completed in one section 0.48 km wide, completed in reinforced concrete, along the Portem. The path of the valley, in the middle of the urban area of the urban expansion area of the city of M'sila (plot of land occupancy of Hammam Al-Dhal'a and plot No. 05) from north to south along the canal, a concrete wall with a width of 25 cm. There is also a 150-meter manifold from the top of the canal for periodic monitoring and maintenance (Figure 5) The study area is also a populated urban area and contains several types of individual and collective housing, public facilities and equipment (Figure 6), and the slope factor plays an important role in the speed of flood flow, as the study area has a relatively weak slope It can contribute to flood formation (Figure 7).

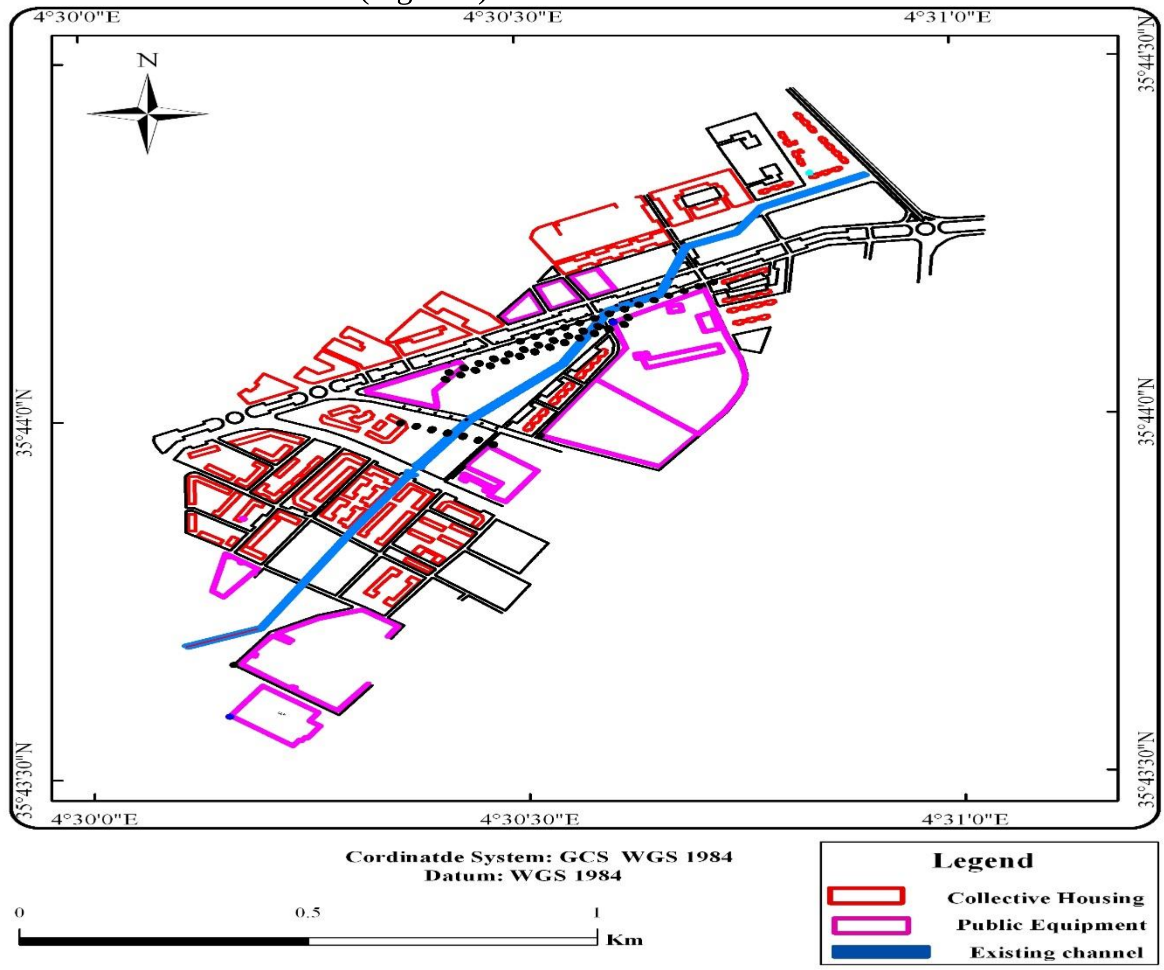


Figure 4. location of the channel

Picture. 1 the channel

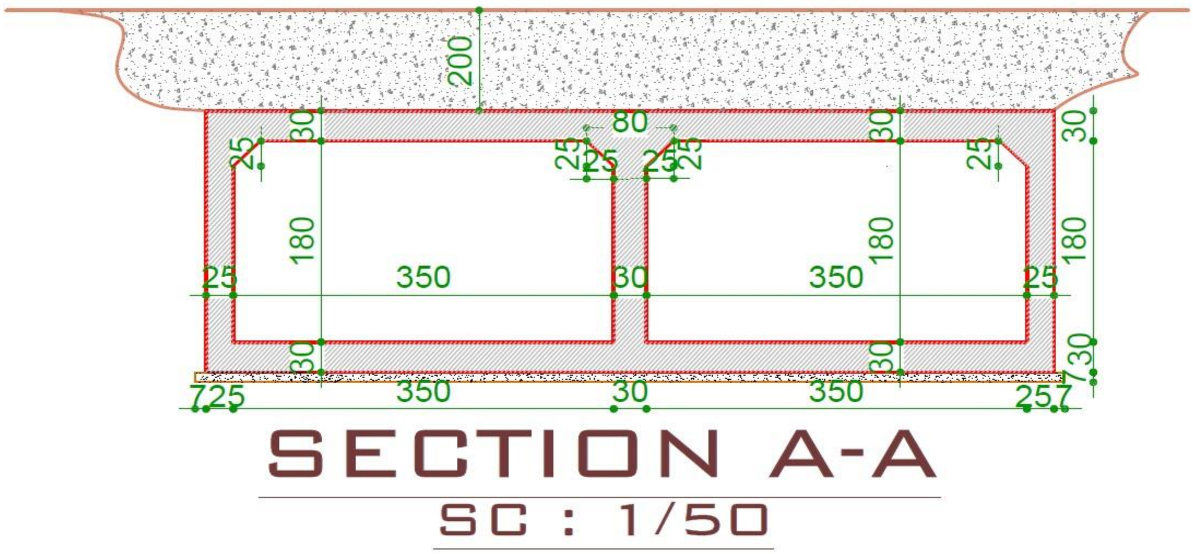
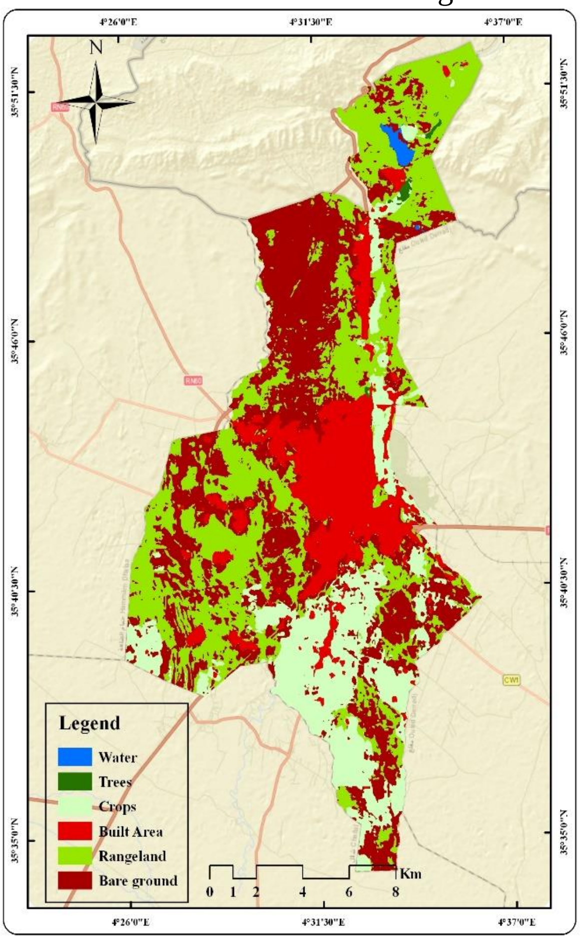


Figure 5. Channel dimensions



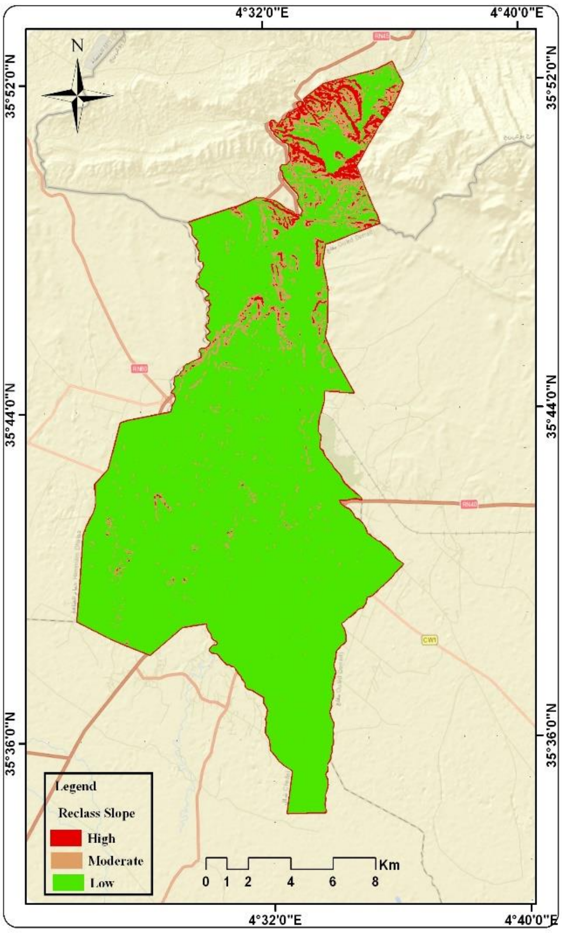


Figure 6. Land uses municipality of M'silaFigure 7. Regression map of the municipality of M'sila

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3.3 Simulation

HEC-RAS 2D river simulation software is widely used open source software that implements 2D hydraulic applications and calculations for an entire network of natural and constructed canals, riparian and floodplain areas, and protected areas; etc. (Ackerman, 2002)

Hydraulic modeling in HEC-RAS 2D requires user input to determine channel geometry and cross section geometry including clearances, spacing, and flow bank stations by a viewer and must be based on field measurements.

To proceed to the collection of geometric input data, transverse cross-sections were installed and measured along the channel. A total of 13 cross-sections were modeled (fig 5).

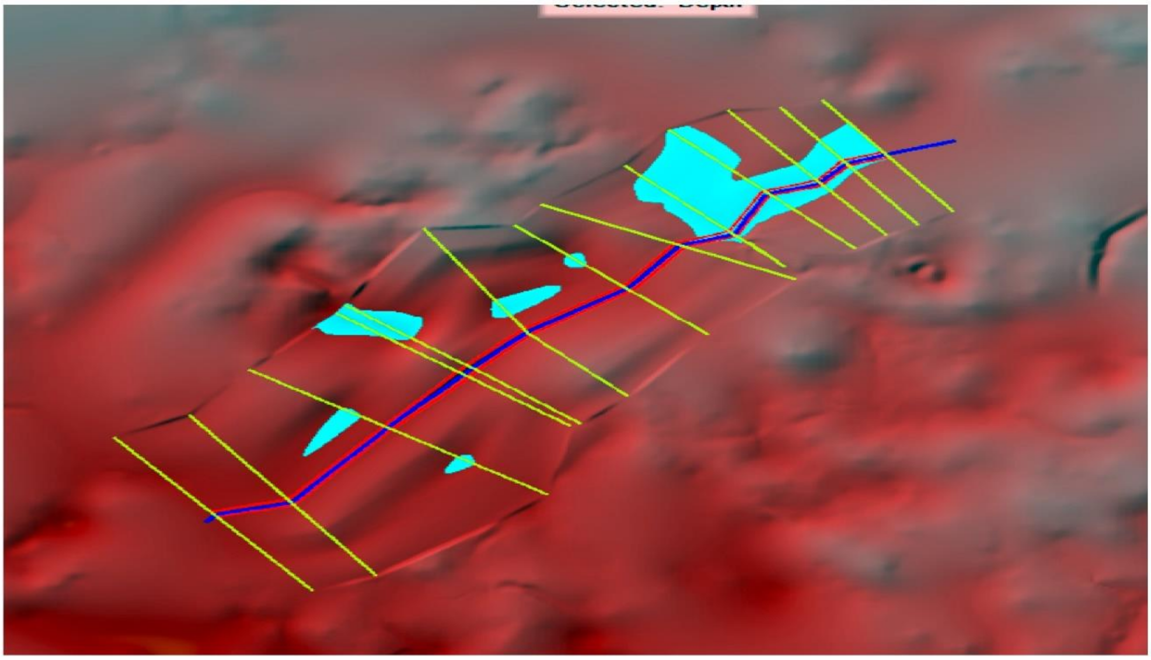

Figure 8. Channel cross sections

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4. Results and discussion

Hydraulic modeling was performed on the maximum flow values for the three return periods of 10, 50, and 100 year.

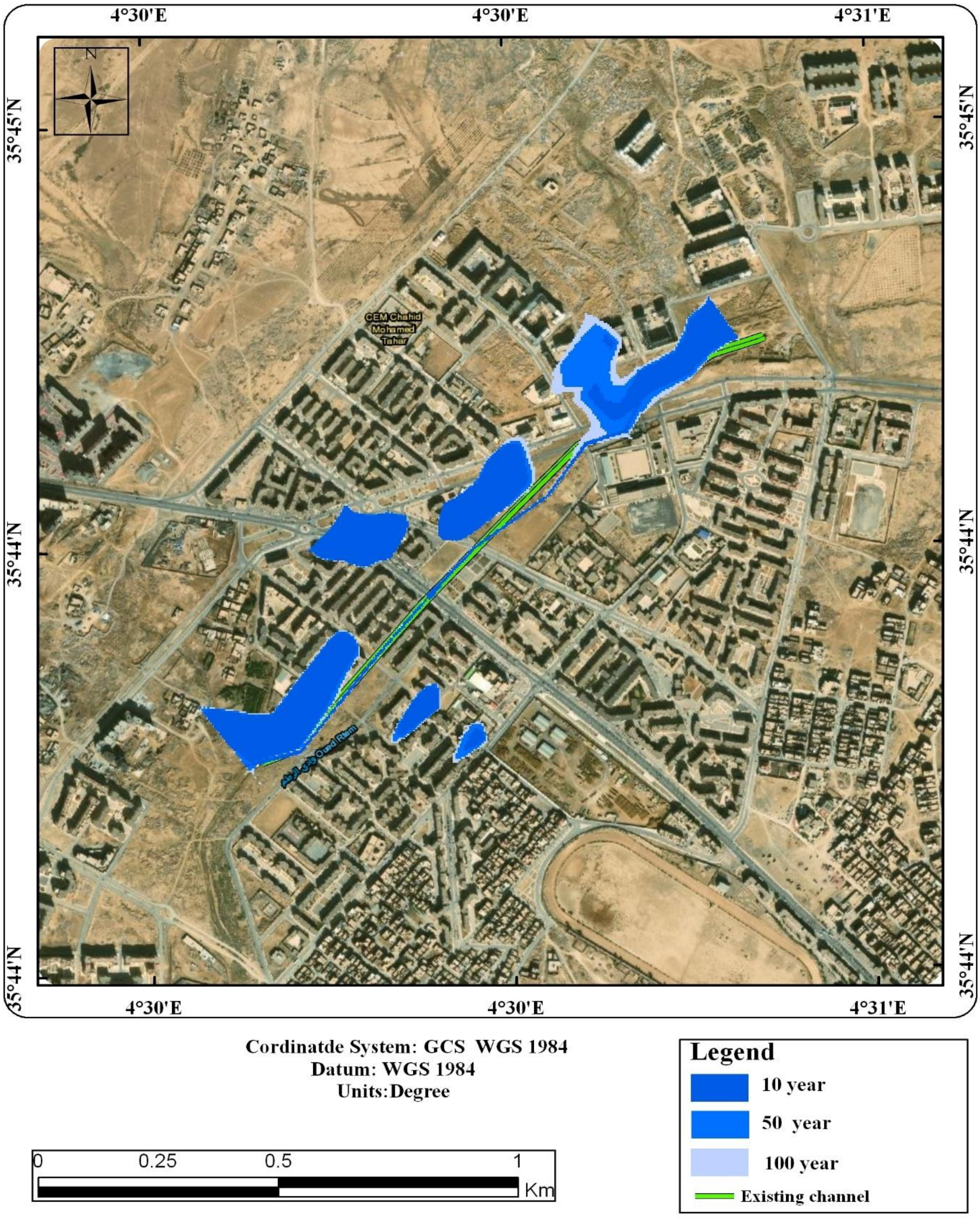

Figure 9. Areas at risk of flooding in the return periods of 10, 50, 100 year

Table 4. Table showing areas at risk of flooding in terms of return time

return period	Area flood risk (Ha)	Area Percentage (%)
10an	9.98	27.37
50an	12.72	34.89
100an	14.31	39.25

5. Discussion

Through the maps that show the areas affected by the risk of flooding and exposed to flooding, represented by social housing, public equipment, roads and sidewalks in the case of a closed canal, it becomes clear that there is an increase in the areas exposed to the risk of flooding from the time of return 10 years to 50 years to 100 years, As for the social housing, where it was recorded in the time of return 10 years 5182.74 mm while in 50 years 6,856.47 m 2 with an increase in the immersion area estimated at: 1673.73 m 2, while in the period of return 100 years it was recorded 7868.36 m 2, an increase estimated at 1,011.89 m 2 and the same for public equipment, roads and The sidewalks are the same and this is due to the location of the dwellings near the valley and near the beginning of the canal. The same is true with the public equipment. We note that the longer the return time, the greater the area exposed to flooding and the risk of flooding. This is due to the location of the public equipment, and it is also noticeable on the road network and sidewalks. The return period increased the area of inundation and the area exposed to the risk of flooding.

6. Conclusion

The risk of flooding remains a threat to urban life if the latter is not taken into account in urban planning and during the preparation of the preparation and reconstruction tools. Two-dimensional and by integrating the SIG geographic information system with the two-dimensional river simulation program HEC-RAS 2D to determine the areas at risk of flooding on two assumptions, the first hypothesis that the channel is open and the second closed, which is actually effective, and to assess the role of the channel in reducing or limiting the occurrence of floods by applying the flow The maximum return periods are 10, 50 and 100 years. The final maps show the areas of immersion.

The study concluded that the canal when it is open is better as it reduces the occurrence of floods and reverses in the case of the open channel, and this is what the plans show the areas exposed to the risk of flooding.

The decision-makers and managers of the state, and through the results we reached in this paper, can rely on it as a reference in proposing future solutions, especially during the preparation of the preparation and reconstruction tools, by proposing solutions to avoid the occurrence of floods.

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