Two-dimensional flooding model using IBER software case Study: Saidia City North east of Morocco

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Abstract. In the last two decades, Morocco has suffered a lot from catastrophic flooding, resulting in enormous damage to materials and loss of human life. The Sadia City (northeast Morocco), in our case of this study, is the most urbanized area with a high concentration of socio-economic activities in the region. Sadia is located downstream of the Moulouya watershed known for its low topography, and high vulnerability to fluvial and torrential flooding. The study aims to simulate the flood hazard index in the city of Sadia and consists of developing a two-dimensional (2D) flooding model using IBER software, and then producing maps of water flow and water velocity based on a 1-meter DTM. Then, we use GIS to map the hazard index of the areas with a high risk of flooding over a return period of 50 years. These hydraulic models were used to elucidate the risk of the Moulouya River overflowing its catchment area and to assist the stakeholders in decision-making about adequate measures to protect human life in Saidia City.

1 Introduction

It is clear that the resolution of the topographic data has an impact on the flood simulation (1). Flood risk mapping needs exact data on the landscape elevation (2, 3, and 4). (5) Have verified the method to estimate flood phases based on flood boundary information and different types of DTM data. (6), and (7), mentioned DTM is deduced from observations of the terrain surface and characterize the bare earth at some level of detail. It provides a measure of water accumulation, saturation, and flood possibility for each pixel in a given watershed (8,9). In Morocco, (10) 2014 used a 30-meter resolution DTM to carry out a simulation and mapping of flood risk in the Ourika Valley. In addition, some flood studies have been piloted so far, while the susceptibility of the country to floods is in elevation (11).

The purpose of our study is too precise that knowledge of risks and their assessment is the basis for all decision-making in the areas that face higher risks. The studies on risk management in Morocco, pointed out, that Morocco is committed to strengthening its public risk management policies, and it is a very important tool for prevention and crisis management, as well as the necessary documents for the development of an awareness culture.

2 Study Area

The eastern region of Morocco has seen the achievement of major planning and development projects for ensuring a sustainable development compatible with national and international orientations. Saidia city located in the Northeast of Morocco, close to the Algerian borders, this city crossed by Oued Moulouya, one the biggest rivers in Morocco.

The main socio-economic activities in the region are based on Tourism and agriculture. This unique city faces a high vulnerability to torrential and fluvial flooding this could witnessed over the past two decades due the soil occupation of vulnerable areas and the climatic change’s impact. (Fig1)

Fig. 1. Saidia City and oriental region of Morocco

3 Methodology

The simulations focus on the return period of T=50 years, and carried out in several steps. The first of them, the generation of the numerical mesh, since it is the
processes that require more time and effort in developing a numerical simulation in rivers. Then, we use GIS to prepare other data, especially the land use of the study area and its Manning coefficient. The simulation using IBER needs an input data; especially the Hydrographs, which are used to study the temporal variation of the water flow rate, this hydrography, represent the limit condition should be affected in the chosen area. In our case study, the mono frequency Flood Hydrographs for return periods \( T = 50 \) Years, calculated by using the (QDF) model flow (12). Moreover, the generation of the Moulouya DTM watershed was based on the processing of WorldView-2 and Spot-6 satellite images, the georeferenced of altimetry was carried out using a network of high precision GPS levels. (Fig2)

![Contour lines and land use of our study area](image)

**Fig. 2.** Contour lines and land use of our study area

## 4 Results and discussion

### 4.1 Water Depth

Timely information escorted from water depth is essential for directing flood management, geolocation of the bridge and road accessibility, and post-event analysis of economic damages (13, 14). The water depth for the return period of \( T = 50 \) years, varies between 1.33m to 3.08m for the hydraulic step 48900s (Fig 3).

### 4.2 Water velocity

It accepted that the higher the water velocity, the greater probability of structural damage (15). The physical pressure caused by the high flow velocities lead into damage to the building (16). Generally, high velocities were recorded in the Oued Moulouya channel than the surroundings areas. The results of the return period \( T = 50 \) years, a minimum values of water velocity of 0.07 m/s, to a maximum of 1.74m/s (Fig4).

### 4.3 Classification of the hazard

Following the water depth and water velocity classification, the results are represented in the Figure (Fig5) for the return period \( T = 50 \) years, for the hydraulic steps (49800). Generally, the surface of flooded area is 14.46 Km² all the value represented on the table below. (Table1).

For the return period \( T = 50 \) years (Fig5), the hazard map show that the high flooded area, covers a surface of 7.78 Km² within the total flooded area of 14.46 Km² which corresponds to 53.8%.

<table>
<thead>
<tr>
<th>Hazard Level</th>
<th>Surface</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>3.33</td>
<td>23.029</td>
</tr>
<tr>
<td>Moderate</td>
<td>3.35</td>
<td>23.16</td>
</tr>
<tr>
<td>High</td>
<td>7.78</td>
<td>53.8</td>
</tr>
<tr>
<td>Total</td>
<td>14.46 Km²</td>
<td>99.989</td>
</tr>
</tbody>
</table>

**Table 1.** Hazard classification and flooded area
Fig. 3. Map of the water depth T=50 years

Fig. 4. Map of water velocity T=50 years
5 Conclusion

The Moulouya River crosses the study area; it is the major parameter that has highly influenced not only the study and analysis of the present paper but also the flood event in the region. The results above are representing the final hydraulic step of the return period $T=50$ years, which equal to a 50000 seconds (Approximately 14 Hours). The aim of the present paper is evaluating the impact of 1-meter DTM in the fluvial flood hazard in the Saidia city (N-E Morocco). The study aims to simulate the flood hazard index in the city of Saidia and consists of developing a two-dimensional (2D) flooding model using IBER software, one hand to improve the previous flooding studies and compare it with those who established on other simulation process. On the other hand, to calculate the hazard index based on the intersection of the water depth (m) and water velocity (m/s). Moreover, the underlying factors that affect how DTM resolution could affect the urban fluvial flood modelling.

Reference

1. Manoranjan Muthusamy, Monica Rivas Casado, David Butler, Paul Leinste Understanding the effects of Digital Elevation Model resolution in urban fluvial flood modelling 2021