

Assessment of Flood Mitigation Strategies: A Case Study of the Aït Athmane Center in the Errachidia Region

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Abstract. The development of impoverished and marginalized communities is being increasingly jeopardized by the risks associated with climate change. Extreme weather events, like floods, can impact infrastructure, ecosystems, agriculture, water, and other vital sectors. Our study focuses on the flood risk in Aït Athmane, located 28 kilometres north of Errachidia, Morocco. This area is particularly vulnerable to flooding and overflows from the Ziz Wadi tributary, which passes through the territory of Aït Athmane. The specific objectives of this study are to assess the effects of flooding in this area and to propose various adaptation strategies. The methodology involved processing GIS data for the basin's hydrological study, statistically analyzing the maximum daily rainfall at the "Foum Tillich" rainfall station using HyfranPlus software, and estimating peak flow using various empirical formulas. We then used the 'HEC-RAS' hydraulic modeling program to perform a hydraulic simulation, an essential step in understanding these values for Aït Athmane Wadi, a tributary of Ziz Wadi. GIS software was used to create the maps, which were superimposed to identify locations vulnerable to flooding. The findings indicate that, for varying return periods, flows range from 60.13 m³/s to 92.69 m³/s, with a concentration-time of 125.55 minutes. The hydraulic study indicates an overflow risk, endangering nearby residents and their crops. In certain areas, these floods can reach three meters. Numerous strategies have been identified and proposed to mitigate the effects of this significant risk. These primarily involve simple mechanical adjustments such as constructing gabion weirs, raising retaining walls along the Wadi's banks, and creating crossing structures.

Keywords: Climate Change, Flooding, Aït Athmane, Hydraulic Modelling.

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Introduction

Floods are one of the world's most devastating natural disasters, causing considerable economic losses and extensive damage to infrastructure and livelihoods [3, 9, 6]. In Morocco, rural areas are particularly vulnerable due to a lack of preparedness and adequate protective measures [4]. The Aït Athmane center, in particular, regularly suffers from floods that compromise the safety and well-being of its inhabitants. This study aims to assess flood risk in the Aït Athmane region using a rigorous methodology based on geospatial and hydrological analyses. By processing the Digital Terrain Model (DTM) with GIS tools and analyzing rainfall data [5, 1], this research identifies high-risk areas and proposes concrete adaptation measures. These measures include infrastructure strategies and risk management plans to minimize the impacts of future flooding and improve the resilience of the local community.

1. Study area

The Aït Athmane region is located in the Drâa-Tafilalet area of Morocco. It is characterized by an arid climate and irregular rainfall [2, 7]. The region's geology, composed mainly of sedimentary formations [8], plays a crucial role in flood dynamics. Climatological variations, with episodes of heavy rainfall followed by periods of drought, aggravate the risk of flooding.

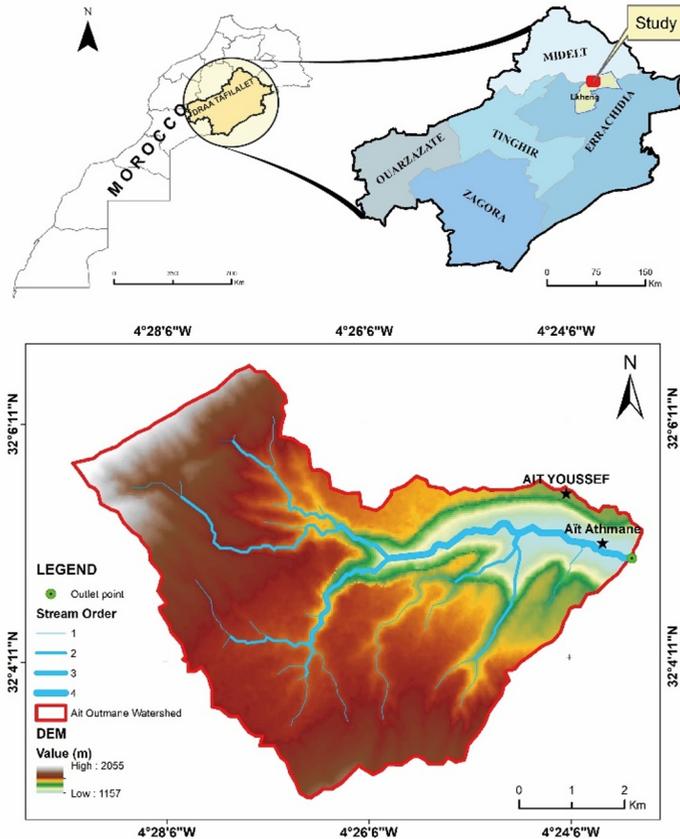


Fig. 1: Geographical location of the study area

2. Methodology

To achieve these objectives, a rigorous methodology was adopted in this study. It began with GIS processing of the Digital Terrain Model (DTM) to delimit the watershed and extract its geomorphological characteristics [1]. Next, daily maximum precipitation data were statistically analyzed using HyfranPlus [5]. The concentration-time was estimated by various empirical methods, peak flow by empirical formulas, and the SCS method with HEC-HMS 4.1.1. Hydraulic modeling was performed with HEC-RAS 6.4.1. Finally, development strategies were proposed to minimize the risk of flooding.

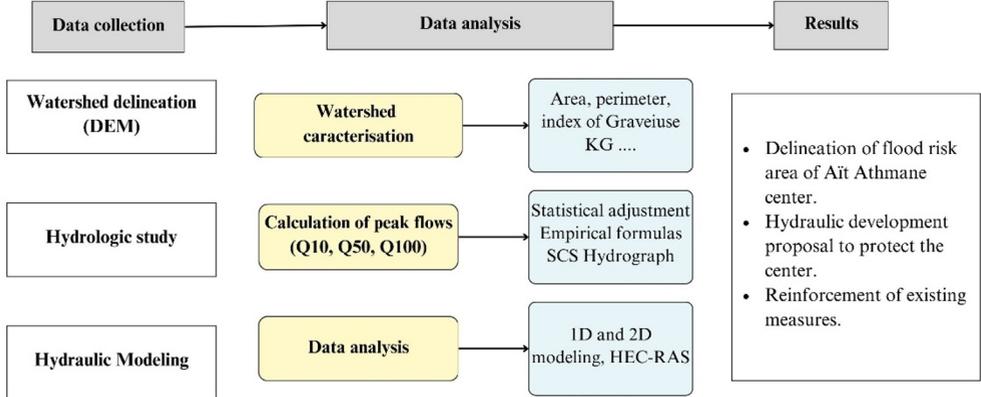


Fig. 2: Overall diagram of the methodology adopted

3. Results and Discussion

The results of the hydrological analysis for the center of Aït Athmane indicate a high propensity for flooding, with flows ranging from 60.13 m³/s to 92.69 m³/s for return periods from 10 to 100 years and a time of concentration of 125.55 minutes.

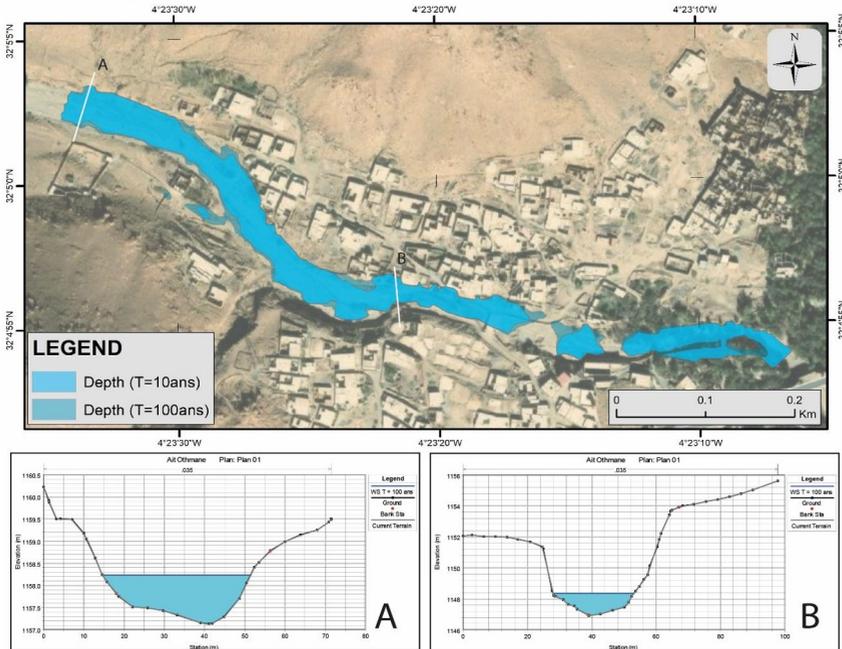


Fig. 3: Flood risk modelling map based on the return period of Aït Athmane Wadi

This situation exposes the region to a significant risk of flooding, particularly along watercourses characterized by complex topography and increasing urbanization. The consequences could be severe, potentially impacting nearby infrastructure, housing, and farmland.

Homes are likely to be submerged, endangering the lives of residents and causing considerable property damage. Agricultural land, crucial to the local economy, could also suffer significant economic losses, affecting the region's food security. To meet this challenge, urgent measures are needed, such as strengthening drainage systems and flood protection infrastructure and raising local awareness of adaptation strategies and emergency evacuation plans. Coordination between local authorities, risk management experts, and the community is essential to build resilience to future hydrological hazards.

4. Conclusion

This study highlights the vulnerability of the Aït Athmane region to flooding and proposes concrete measures to reduce the risks. The results underline the importance of an integrated approach combining hydrological and hydraulic analyses to develop effective risk management strategies. Further research is needed to refine these measures and ensure their successful implementation.

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Author Contribution

All author (Abdelhakim Kadiri, Badre Essaфраoui, Messaoudi Badre, Ait Lahssaine Ismail, Ait Said Brahim, El Ouali Mohamed and Lahcen Kabiri) reviewed and approved the final manuscript. With Abdelhakim Kadiri, a significant contributor to the manuscript conceptualized the research reported in this paper. The methodology was suggested by Messaoudi Badre, Ait Lahssaine Ismail, Ait Said Brahim and El Ouali Mohamed. Badre Essaфраoui, Lahcen Kabiri contributed to developing the ideas in the article and provided follow-up and supervision of the work.

Ethics approval and consent to participate

Not applicable.

Consent for publication

All the authors have agreed to publish this article.

Competing interests

The authors declare that they have no competing interests.

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