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DISCUSSION

EVALUATING THE EFFECTIVENESS OF THE EXISTING FLOOD RISK PROTECTION MEASURES ALONG WADI DEFFA IN EL-BAYADH CITY, ALGERIA

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Discusser

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This discussion aims to offer more importance to the original work carried out by Ben Said et al. (2024). The article entitled "Evaluating the Effectiveness of the Existing Flood Risk Protection Measures Along Wadi Deffa in El-Bayadh City, Algeria" focuses on the floods in the wilaya of El Bayadh notably the overflowing from the wadis into nearby urban areas. The prolonged lack of rainfall has increased human activities encroaching upon the dry areas near the wadis. This paper focuses on the October 1, 2011, event in El Bayadh. The event was numerically replicated through hydrological and hydraulic modelling using HEC-HMS and HEC-RAS software. The integration of the influence of key structures such as protective walls, channels, and buildings as determinant factors shows the originality of the modelling process. This enhanced model incorporates real-world complexities, leading to a more accurate representation of the flood scenario. Utilizing the calibrated model, the performance and capacity of the channel and protective structures in safeguarding the city's nearest buildings were assessed. The obtained results demonstrated that the October 1, 2011 occurrence, with a peak discharge of 425 m^3/s, greatly exceeded the channel's capacity, which can only handle a peak discharge of 180m^3/s.

During the 2000s, a drought was recorded in the Algerian territory due to lack of rainfall, as the result of climate change. In the Saharan areas, torrential floods were marked, including Adrar, Ghardaia, Béchar, Naama and El Bayadh. In these areas, floods appear periodically where the periodicity changes in time and space. In addition, the flood depends on various factors: part of it runs off, part evaporates, and part infiltrates the ground. The amount of infiltrated water depends on the nature of the soil, in particular its

permeability, its slope and its vegetation cover, which can slow down the flow of water and promote its infiltration. However, vegetation can be neglected in large parts of the wadis in the Sahara. In addition, slope variation and rainfall intensity will also play a role in the proportion of infiltrated water to runoff water. The flow in the watercourse over an extended period depends on the volume of water following a significant inflow, particularly heavy rains in the upstream areas of the wadi.

Saharan environments play a role in the storage of water due to the sandy material nature. During exceptional floods, these environments have a hydrological role when quantities of water exceed the usual quantities. The areas on the edge according to the surrounding topography play a role in the animation of the flow and its overflow. The overflow of water in neighbouring urban areas is done in a direction of urban growth to the detriment of the natural environment of the Oued without taking into account the limits not to be crossed, in particular the areas supplying the Oued. The morphology of the watercourse also depends on the sediments that it carries and the geology of the region, affecting in particular the slopes of the banks and the shape of the flood zones. A good understanding of the change in time and space of fluvial forms and sediment flows is very useful as a preventive measure when carrying out urban area expansion projects. For this, the study of aerial photographs allows, for example, to quickly observe geomorphological adjustments of a watercourse over time and thus it can offer more indication about vulnerable zones that can be affected by the sediment flows. Consequentially, analysis of sedimentary flows transiting through the Saharan system, from the source zone of a watercourse, through the transit zone, then finally in the accumulation zone becomes necessary for vulnerability mapping.

In the Saharan zones, the absence of vegetation on the banks helps to maintain the flow speed where the flow speed is much higher in the centre of the wadi bed compared to that of the edges. It is important to mention that the application of hydrology and hydraulics concepts alone does not allow us to fully understand all the physical parameters that govern floods. For this, the integration of the simple practical technique of the trinity of Leeder in the flooding modeling can offer more significance to the deduced scenario. Leeder's technique is a model that aims to represent river dynamics (Taylor, 2014; AGRCQ, 2024). It includes the interrelations between three main components: the structure of the flow, the transport of sediments, and the development of the forms of the bed.

Concerning the flooding evolution in time and space, the sediment transport component can also be described at several scales in the Saharan region. On an annual scale, we can compare the volumes of sediment transported as bed load compared to the volume transported in suspension by a watercourse. We can determine the morphological change caused by the transported sediment. On an event scale, we can look at the volume of sediment transported during a flood and, above all, at the time during the flood when the maximum transport occurs. On a sediment scale, we can look at the role of sediment size in terms of their probability of being carried as bed load or in suspension.

The management of urban extensions depends on the geomorphology of the wadi bed. Management recommendations vary according to the scale of the spatial analysis, in particular the scale of the watershed (profile along the Oued), the scale of a section (main channel), the scale of the bed, and therefore the shape created by the sediments. The increase in speed causes an increase in the size and volume of sediments and has a direct implication on the agglomerations, which are built along the wadi and/or sometimes in the beds of the wadi. The sediments transported create either erosion forms or accumulation forms that cause changes in the geomorphology of the wadi and its course over time and consequentially have a direct impact on current or future extensions. For this, the hydrogeomorphological diagnosis based on hydrosedimentary dynamics, the geomorphological trajectory, and the dynamism of a watercourse over time becomes primordial for a flooding modelling study.

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REPLY BY THE AUTHORS

The authors sincerely thank Dr. Khebizi H. for the valuable and constructive comments regarding the integration of geomorphological and sediment transport dynamics in flood risk assessments. We fully recognize the importance of these elements in broader flood risk studies. However, we would like to clarify the primary objective and scope of our current work.

In fact, the current study was specifically aimed at evaluating the effectiveness of the existing flood protection measures along Wadi Deffa, with a particular emphasis on assessing the channel's capacity to manage extreme flood events, such as the one that occurred on October 1, 2011. The primary goal was to replicate this event using hydrological and hydraulic modeling, allowing us to analyze the performance of the protective infrastructure. Given this focus on the capacity related to a specific historical flood event, an evaluation of changes due to sedimentation was not considered critical for achieving the study's objectives.

Although the physical characteristics and other attributes of the study region were integral to the hydrologic and hydraulic analyses, it's important to recognize that morphological changes caused by sediment transport, particularly at large scales in impacted areas,

typically occur slowly and gradually. These changes can take a significant amount of time before they visibly alter the landscape. Understanding this gradual transformation is essential for evaluating long-term environmental impacts and formulating sustainable land and water management strategies. While these processes may not yield immediate effects, their eventual repercussions on terrain and watercourses can be considerable, particularly in relation to flood risk assessment, hazard mapping, long-term mitigation strategies, and future urban development planning. Therefore, including these factors in our analysis of short-term structural performance may not significantly improve the immediate assessment of flood protection measures.

While our current study concentrated on immediate flood risk through hydrological and hydraulic modelling, we greatly respect Dr. Khebizi's viewpoint and recognize that future studies, particularly those aimed at urban flood risk management and the development of flood maps, will benefit greatly from these broader considerations.