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Hydrological Modelling of Flash Flood at Wadi Samail, Oman

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1-Introduction

Recently, flash floods are frequently occurring in the arid region as Oman, which counter with various challenges to the management of wadi flash floods. In the past Oman hit by cyclone Gonu in June 2007 causing torrential flooding and severe damages where the economic loss about 4 billion USD, as well as nearly 50 deaths. Mitigation measures and warning system have become more critical given the expected increased extreme events due to climate changes. Oman is an arid country, where the average annual rainfall, in its capital Muscat, is only 100 mm, while the average of the whole country is only 51 mm/yr varying from less than 20 mm/yr in the internal desert regions to over 350 mm/yr in the mountain areas. Wadi Samail at the coastal area of Oman is selected as case study for flash flood hydrological modelling. Available data are 9 rainfall measurement stations, 2 flow rate gauge, 70 groundwater monitoring well levels. So wadi Al-Samail has good data measurments comparing to other wadis at the the arabic countries.

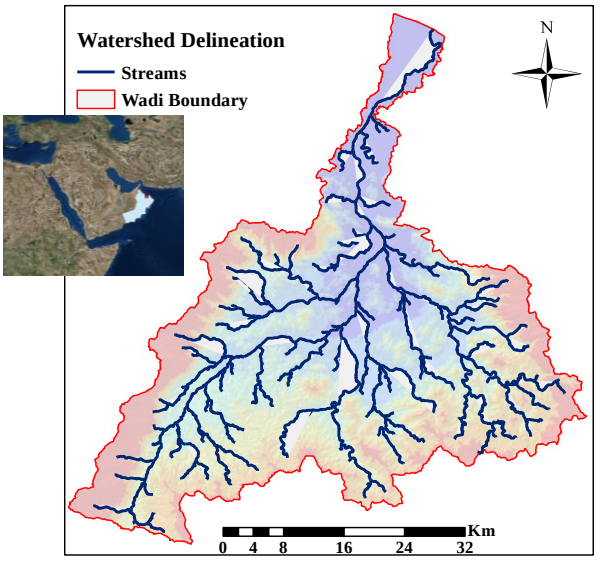

Figure 1 Location map of wadi Samail and Oman

Rainfall–runoff responses predictions in arid climate as wadi system always presents unique challenges. One of the main challenges beside data limitation is the hydrological models themselves, where the majority of models developed for catchments that have different characteristic other wadi system. Hence, the need to evaluate the suitability of alternative modelling approaches for wadi system and its scarce dataset arises. In that regard, two hydrological models are selected in this study. The first one is the Hydrological River Basin Environmental Assessment Model (Hydro-BEAM) and the other is the Rainfall-Runoff-Inundation (RRI) Model.

Another aspect of this paper is to focus on both structural measures for flash flood retention as dry dams, and water harvesting. The location of such mitigation structures must be carefully designed to avoid transferring the problems to the developed downstream area of the wadi.

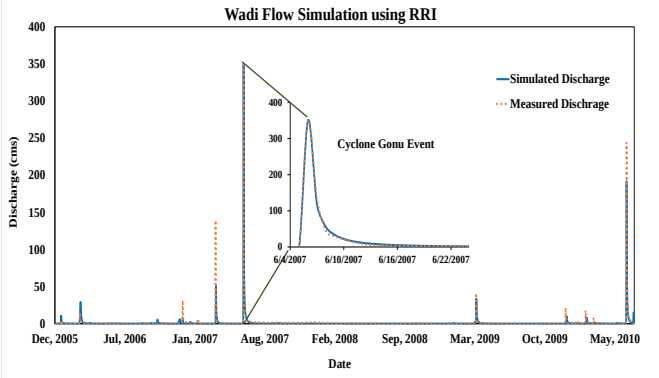

Figure 2 Flash flood simulation at wadi Samail from 2005 to 2010 using RRI model

Moreover, mitigation structures should be designed in a coordinated manner, to assess their overall effect. This study analyzes the wadi flash flood mitigation for three cases: 1) no dams, 2) distributed small dams allover over the catchment in the upstream, and 3) proposed large dam in the middle or downstream area of the wadi. The effect must be quantified through a comparison of the consequences with and without mitigation structures over the whole wadi. Various factors are considered to study and improve the assessment methodologies. The simulated scenarios highlighted significant differences in calculated hydrographs when using either distributed or concentrated dams scenarios for wadi Samail.

2-Methodologies

Hydrological modelling was used to determine the most vulnerable areas in wadi Samail, leading to the development of a mitigation plan aiming to reduce flood damages. Remote sensing data as well as GIS technique have been utilized for data input, preprocessing and visualization of the results. Hydro-BEAM which was developed by Kojiri, et al., (1998), and enhanced to Hydro-BEAM-WaS (Hydro-BEAM Incorporating Wadi System) by Saber et al. (2010), to be applicable for wadi system in arid regions. The other model is RRI, which is a two-dimensional model, simulate rainfall-runoff and flood inundation simultaneously. A Sensitivity analysis is used to evaluate the weight of different parameters in both models. The performance of the alternative methods, for predicting flow volumes and peaks at the catchment outlet, are inter-compared.

3-Conclusion

This study is expected to conclude recommendations for hydrological modelling and management at wadi system in arid environments. The next questions address how to the define dam height and reservoir volume. For better assessment of several dams options, clear quantification of evaluation factors and cost-benefit approaches should be included in future. Small dry dams are effective structures. Both, Hydro-BEAM and RRI models are efficient, and emphasizes the importance of taking into account the variability and spatial properties of rainfall patterns.

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