Flash Floods in the Arid Arabian Wadis: Processes, Hydrological Modeling and Mitigation

○Mohammed ABDEL-FATTAH, Sameh KANTOUSH, Mohamed SABER, Tetsuya SUMI

Regional extreme flash floods events (e.g. Jan. 2010, Mar. 2014 and Oct. 2015) have been frequently happened in the Arabic Region where flash floods are considered among the most severe disasters in terms of fatalities and economical loss. These destructive flash floods usually happens in the arid wadi drainage systems. Wadi is an Arabic term, which refers to valley and usually its channel is dry except during heavy rain events.

Wadi Flash Floods (WFFs) threat frequency has been increased in the recent decade. Meanwhile, these floods are vital source of water for such arid regions. For instance, Egypt and Oman are arid Arabian countries, that facing raising challenges to manage the devastating WFFs risk. The extremist flash flood event occurred in Oman are due to Gonu-2007 tropical cyclones, causing 50 fatalities with 4 billion USD of economic losses, while Egypt faced large scale flood in Jan. 2010 causing 10 fatalities and hundreds of destroyed homes. Until today, no proper integrated basin scale management for most of the Arabian wadis.

Flash flood process understanding is the first step to assess and manage the WFF`s risk and water resources. To achieve this, hydrological modeling tools are indispensable. However, flash flood modeling in arid region is hindered by lack of suitable hydrological

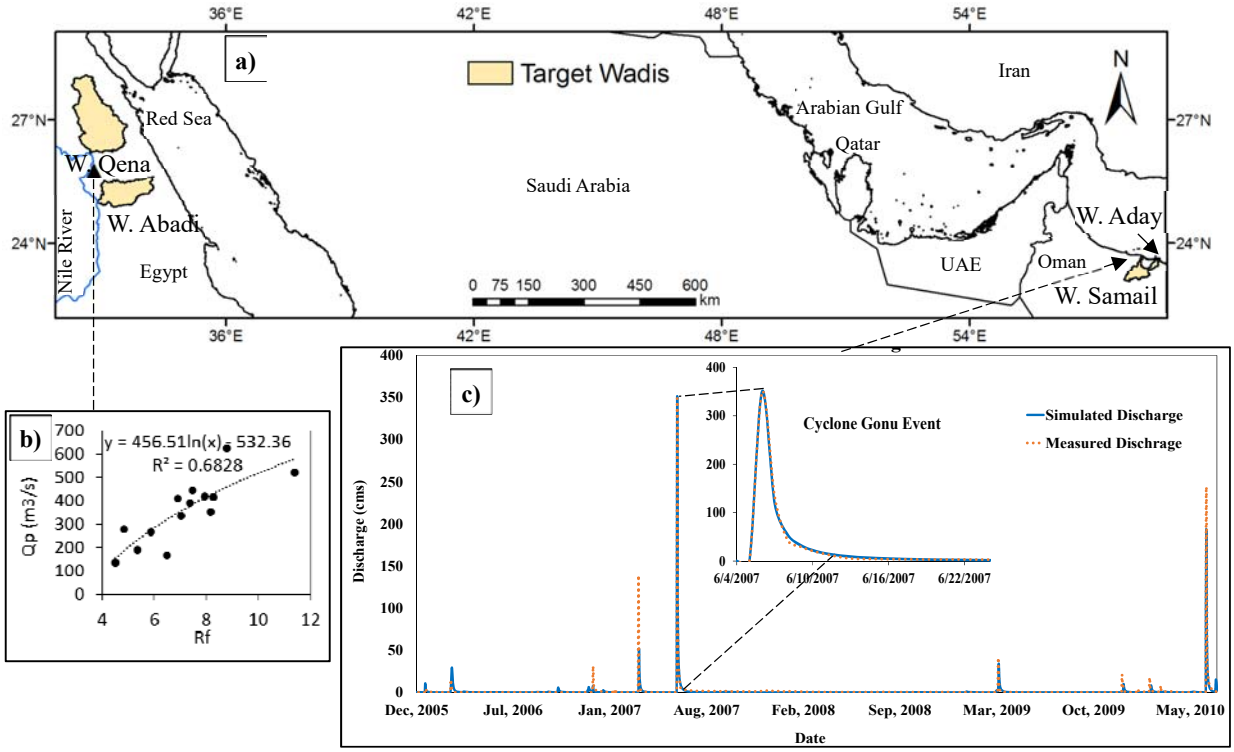

Fig.1 a) Target wadis location map, b) correlation between the maximum discharge and fitness ratio morphometric parameter for W. Qena sub basins and c) WFFs long time series simulation (2005-2010) in W. Samail using RRI model, showing the unique features of WFFs.

models and data.

Four typical wadi systems in Egypt and Oman have been selected (Fig.1-a) to study WFFs issues with area ranging from 300 km^2 to 16,000 km^2 and average annual rainfall from 20mm to 90mm. Furthermore, hydrological River Basin Environmental Assessment Model (Hydro-BEAM) and Rainfall Runoff Inundation model (RRI) were calibrated, validated and modified for efficient representation of the unique wadi system characteristics.

Wadi geomorphologic characteristics have major impact on the hydrologic response. For instance, the fitness ratio (total stream length per unit basin perimeter length) has good correlation with outlet peak discharge in W. Qena sub-basin as indicated in Fig.1-b using high resolution DEM and Hydro-BEAM model. Establishment of such relationships could be useful for flash flood risk assessment and highlighting the main factors of flood`s generation and magnitude.

Fig. 1-c. indicates long-term flash flood simulation in W. Samail, Oman using RRI model. It can be noticed that wadi channel is usually under dry condition with absence of base flow, but sometimes it is exposed to flash flood events every one or two years. These WFFs have sharp hydrograph, where it takes a few hours to reach to the peak discharge and then gradually decreasing until it coming back to its dry condition.

Once the flash flood has been simulated and evaluated and factors that control its risk have been identified, management strategies selection will be more efficient. For the structural WFFs mitigation, Fig.1-a summarizes useful guidelines for planning. In that regard, W. Abadi in the Eastern Desert of Egypt that has high potential for development especially for land reclamation activities, selected as case study for WFFs mitigation and to compare between different scenarios as distributed and concentrated dams application (Fig. 1-b). Both of the proposed strategies could be efficient in downstream risk mitigation as depicted in Fig. 1-c. The distributed dams scenario has merit of distributed development and water use, while the concentrated dam could has lower cost.

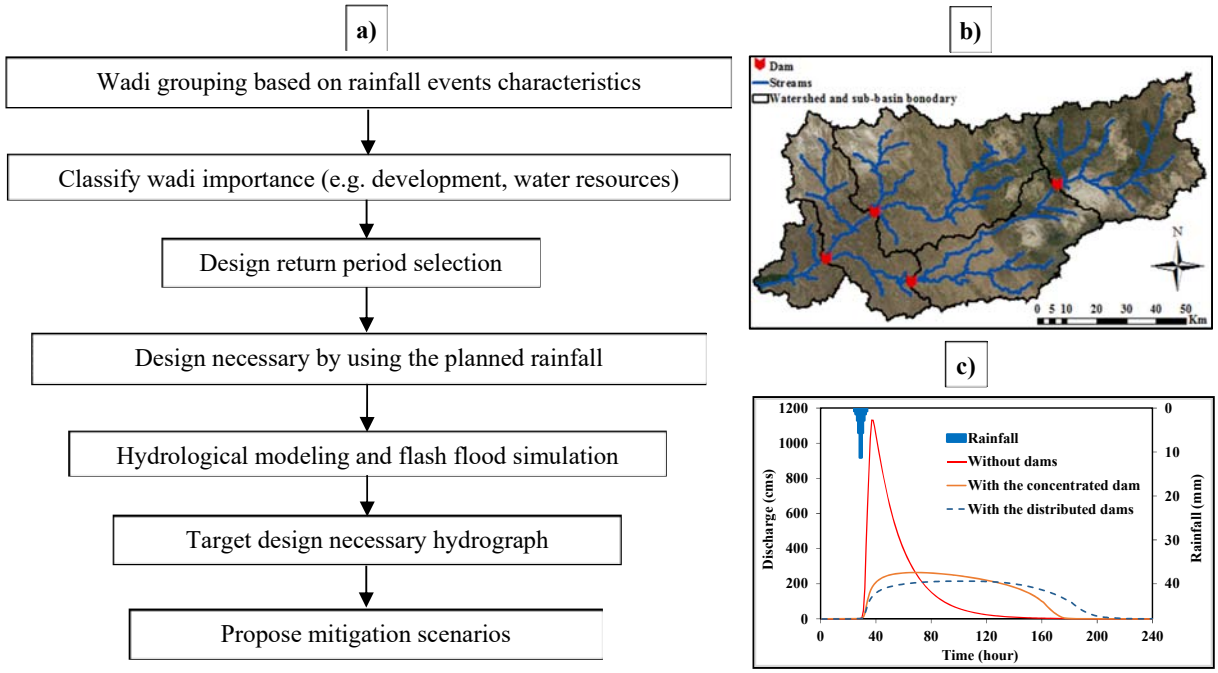

Fig. 2 a) Wadi flash floods mitigation structure measures design guidelines, b) W. Abadi watershed delineation with the proposed dam location and c) Simulated hydrographs before and after mitigation scenarios application in W. Abadi (100 yr. return period storm)