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Assessment of Reservoir Sedimentation Induced by Extreme Flash Flood at Wadi System: Case Study Asarrin Upstream dam, Oman

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INTRODUCTION

Sedimentation is the most serious environmental problem in reservoirs management, especially in arid regions with increasing extreme flash floods. Monitoring the sediments coming from upstream reaches of Wadi basins during the flash floods is extremely difficult and scarce in arid regions (Saber, 2018). Huge quantity of sediments usually comes with the flash floods. Sediment quantities are controlled by serval factors, such as geological and topographical features of the basins, along with the land uses and soil types variability, as well as the intensity and frequency of extreme rainfall. Therefore, the aim of this study is to quantify the sediment yield and reservoir sedimentation in the upstream dam of Wadi Mijlas in Oman (Fig. 1) by using field investigation and remote sensing techniques, then to link the sediment yield with the discharge.

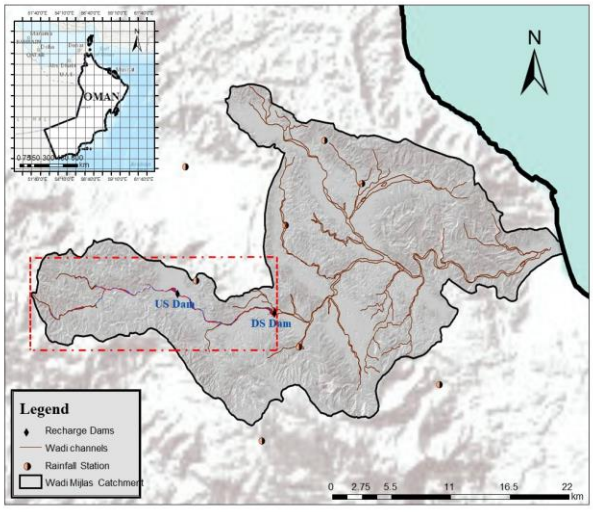

Fig.1 Study area, including dam locations

DATA AND METHODS

Four field surveys on Dec 2017, Sept 2018, Mar. 2019 and Aug. 2019 were conducted in order to study the sedimentation issues and its impacts on the reservoir capacity and identify the flash floods marks.

Several procedures have been implemented; such as sediments scale bars measurements, pedons to study the vertical layers of sedimentation at the reservoir and drone survey. The sedimentation volume at the reservoir along Wadi Mijlas was measured from the sedimentation scale bars installed in the reservoir before the dam constructions (Fig. 2).

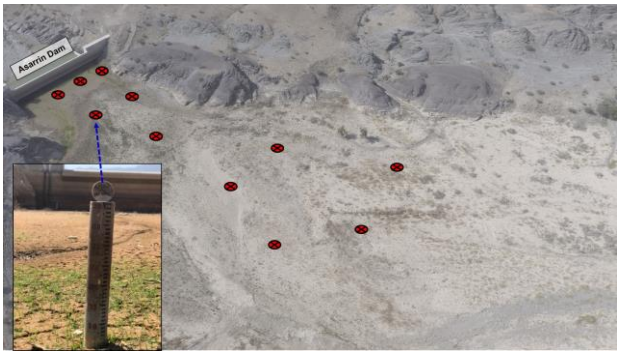

Fig.2 Sediments bars in the reservoir

Investigation of the morphological changes along Wadi channels is required to understand the sediment yield, transport and erodability at the basins. We have tried to assess and investigate the depositions and erosions along Wadi channel using remote sensing techniques. Previous works in remote sensing indicated that the DEM derived from Google Earth is relatively as acceptable as DEMs from other sources. Currently, several methods are available for obtaining the elevation data. El-Ashmawy, (2016), proved that Google Earth elevation data can be used for investigation and preliminary studies with low cost and acceptable accuracy.

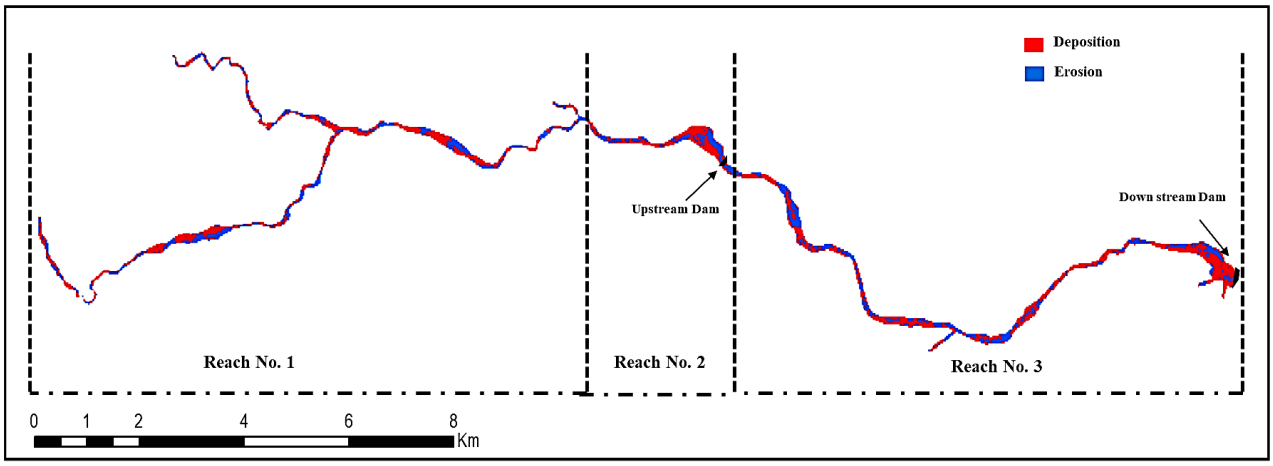

Fig. 3 Erosion and deposition polygons showing areas of sediment reworked for the period between 2017 and 2019.

The change in elevation at any point during a period of time (e.g. between i and j) can be calculated according to Ghoshal (2010), using the following formula:

$$\Delta D_{i,j} = DEM_j - DEM_i \qquad (1)$$

where $\Delta D_{i,j}$ is the change in elevations between i and j. While the change in the sediment volume ($\Delta S_{i,j}$) can be calculated using the following formula:

$$\Delta Si,j = [\Delta Di,j] \times [A] \qquad (2)$$

where A is the area of the reservoir.

In order to enhance the understanding of the sediments mechanism associated with rainfall and runoff, the deposition and erosion was studied along the Wadi channel.

RESULTS AND DISCUSSIONS

This study shows how remote sensing methods can be used to quantitatively document the deposition and erosions in the channel morphology and the extent of sediment reworking by extreme floods with an acceptable accuracy. The sedimentation volume at the reservoir along Wadi Mijlas was calculated from the sedimentation scale bars installed in the reservoir before the dam construction. It was found that the estimated accumulative sedimentation volume from 9 flash floods events over 8 years (From 2011 to 2019) is equal to 37,137 m^3 at the Upstream Dam.

Volumetric analysis of the changes in sediment deposited and eroded in the period from 2017 to 2019 was calculated from the derived DEM from Google Earth images (Fig.3).

The sediment volume calculated from the field measurements for the two last events between 2017 and 2019, was about 5,667m^3 (fig. 4), while the resulted volume from remote sensing method using Eq.2, was 4,129m^3 for the same two events which is around 75% of the observed volume. This study concluded that remote sensing method can give acceptable accuracy for calculating the sediment yield and reservoir sedimentation in Arid regions.

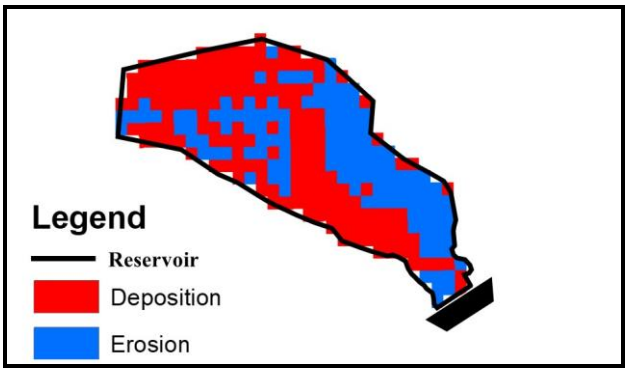

Fig.4 Sediments bars in the reservoir

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