

Reservoir sedimentation at Wadi System: Challenges and management strategies

○Mohamed SABER • Sameh KANTOUSH • Tetsuya SUMI • Yusuke OGISO • Tahani ALHARRASI

Introduction

Reservoir sedimentation is a global challenge, especially in arid regions when the monitoring and information are missing as well as the lack of effective management techniques. In arid and semi-arid regions, a large proportion of sediment yield and erosion are formed due to flash floods¹. However, a little attention paid to sedimentation impacts associated with flash floods in such regions, especially in the Arab regions (the most hyper aridity conditions). Sedimentation process is controlled by many factors including geological and topographical features of the basins, land uses and soil types variability, intensity and frequency of extreme storms, and climate change and human impacts.

Previous researches and studies have been concerning about Wadi flash floods modeling, forecasting and management^{2,3,4}, but addressing of sedimentation issues under the impact of climate changes are still missing in wadi basins. Therefore, in this study, the current challenges of sedimentation, approaches and management strategies are presented. The main objective is to answer the questions: How can we understand the current circumstances and impacts of reservoir sedimentation?, What are the current and available sedimentation management techniques? how can we overcome the current challenges for long-term sustainable management in arid regions.

Reservoir sedimentation challenges

There are several problems of sedimentation based on our field investigations and survey in wadi system (**Fig. 1**) including: 1) decreasing reservoir storage capacity (Fig. 1a), 2) affecting the groundwater

recharges (sediment clogging) (Fig. 1b&c), 3) increasing the disaster risk of flash floods, and 4) downstream environmental impacts. Due to the infrequent occurrence of flash floods in the past, the decision makers and planners did not take in their consideration the sedimentation issues. Therefore, currently, the flash floods become more frequent and devastating with huge sedimentation yield causes a real challenge of sediments in most of the reservoirs.

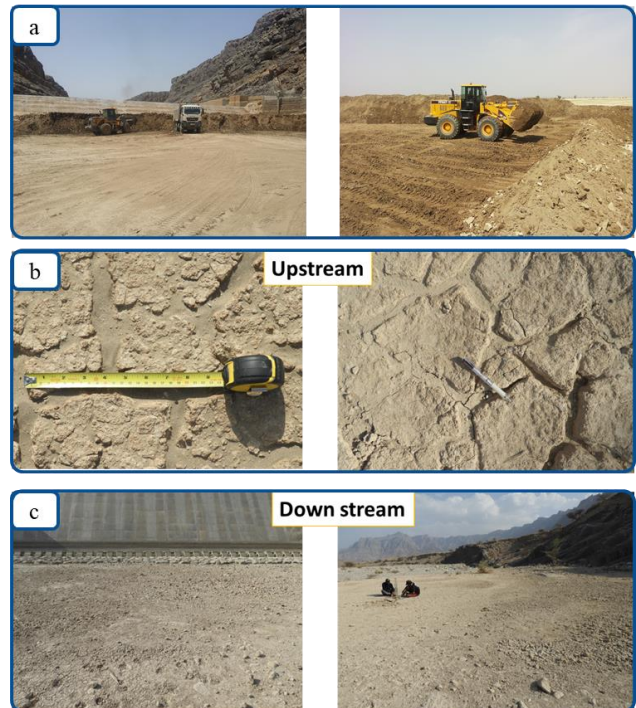


Fig. 1 (a) Reservoirs are full by sediments in some wadi in Oman, and Sediment clogging at upstream (b), and downstream (c).

Approach and methods

In order to come up with a sustainable long-term management of sediments and water. We propose the following integrated approach (**Fig. 2**) considering the climate change impacts, hydrological modeling of water and sediment, assessment of the sedimentation impacts on the reservoir capacity and infiltration

processes. This requires a comprehensive and an integrated study including developing models and monitoring along with field investigations.

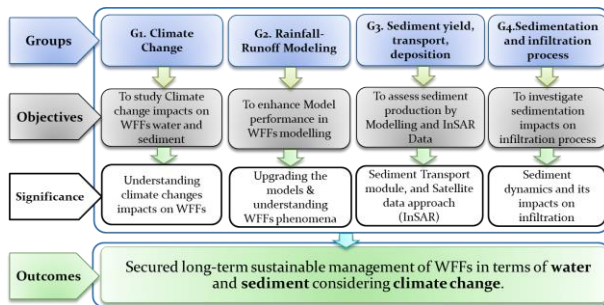


Fig. 2 An integrated Approach for sustainable management of water and sediment conceding the climate change.

Results and ongoing research

First, the hydrological models have been already developed for flash floods forecasting, and currently, developing sediment transport models are still in progress. Second, conducting detailed field investigations and sediment monitoring are the most important work for model validation and deep understanding for the physical process of sedimentation and its impacts. Two field investigations (**Fig. 3**) on Dec 2017 and Sept, 2018 were conducted at Wadi Mijlas and Samail in Oman. Some measures have been conducted including (wadi channel leveling, sedimentation Pedon analysis, detecting of flash floods marks, drone survey, infiltration tests, and field questionnaire about flash floods).

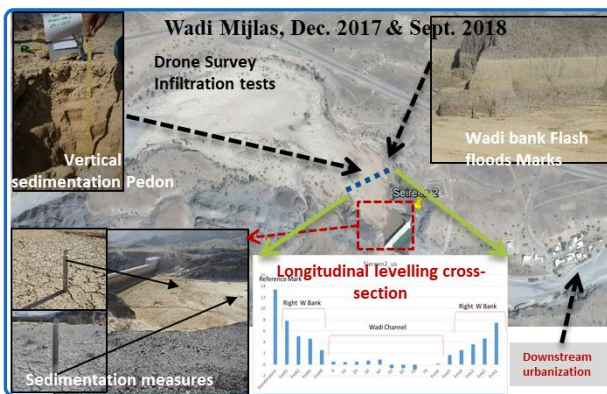


Fig. 3 Field survey at Wadi Mijlas, Oman (Dec. 2017, Sept. 2018).

Using satellite and radar high resolution data is still

being processing to assess the sedimentation changes and also numerical models to estimate the sediment transport, then all these outcomes will be compared and validated by the field investigation findings. Such integrated approach, is important to understand deeply the sedimentation impacts on the reservoirs as well as infiltration processes in arid regions.

Conclusion

In this paper, the current challenges of sedimentation in arid regions were discussed and reported. A comprehensive and integrated approach to understand the sediment dynamics coupled with water flow under the impacts of climate changes was proposed. The project is still running and several parts are still under progress. The expected final outcomes could be the way forward to a long-term sustainable management of sedimentation in wadi system based on deep understanding for sedimentation process during the flash floods.

Acknowledgment

This paper is based on achievements of the international collaborative research program of DPRI, Kyoto University, “Project 2018”

References

1. Walling, D.; Kleo, A. Sediment yields of rivers in areas of low precipitation: A global view. Proceedings... The Hydrology of areas of low precipitation 1979.
2. Saber, M. Hydrological approaches of wadi system considering flash floods in arid regions. 2010.
3. Saber, M.; Hamaguchi, T.; Kojiri, T.; Tanaka, K.; Sumi, T. A physically based distributed hydrological model of wadi system to simulate flash floods in arid regions. Arabian Journal of Geosciences 2013, 1-18.
4. Abdel-Fattah, M.; Saber, M.; Kantoush, S.A.; Khalil, M.F.; Sumi, T.; Sefelnasr, A.M. A hydrological and geomorphometric approach to understanding the generation of wadi flash floods. Water 2017, 9, 55.