Sentinel-1 data as operational tool for Flood Monitoring in Transboundary River Basins

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Abstract

Flood disaster is one of the heaviest disasters in the world. It is necessary to monitor and evaluate the flood disaster in order to mitigate the consequences. As floods do not recognize borders, transboundary flood monitoring and management is imperative in shared river basins. Flood risk management is highly dependent on early information and requires data from the whole river basin. The utility of Synthetic Aperture Radar (SAR) images for flood mapping, was demonstrated by previous studies but the SAR systems in orbit were not characterized by high operational capability. Copernicus system will fill this gap in operational service for risk management. The operational capabilities have been significantly improved by newly available satellite constellation, such as the Sentinel-1A&B mission, which is able to provide systematic acquisitions with a very high temporal resolution in a wide swath coverage. The present study deals with the monitoring of transboundary flood events occurred in Strymon and Evros river basins using free Sentinel-1 data and ESA's open source SNAP software.

Introduction

Floods are probably the most frequent and disastrous natural hazards of the world. Mapping their extension is fundamental to assess the damages[1]. Flood monitoring and management is complicated enough in river basins controlled by a single authority, and becomes even more challenging when dealing with transboundary floods[2]. Satellite Earth Observation (EO) are a unique source of synoptic information at global scale that can supply regular, detailed updates on the status of hazards[3]. The most common approaches making use of EO for flood mapping are based on SAR data. The potential of the data provided by SAR systems for large-scale flood detection has been demonstrated by several previous investigations. The synoptic view and the capability to operate during daytime and nighttime and in almost all weather conditions, contrary to visible/infrared sensors, are the key features that make SAR images useful for inundation mapping[4]. In addition, the great sensitivity to water of the microwave band permits SAR to distinguish between land and water. Near real-time (NRT) flood monitoring can be considered as a unique operational tool in the hand of authorities.

Objective

The objective of the present study is to create the "migration story" of the flooded areas on the basis of the evolution in time for flood events occurred in Strymon and Evros International River Basins IRB

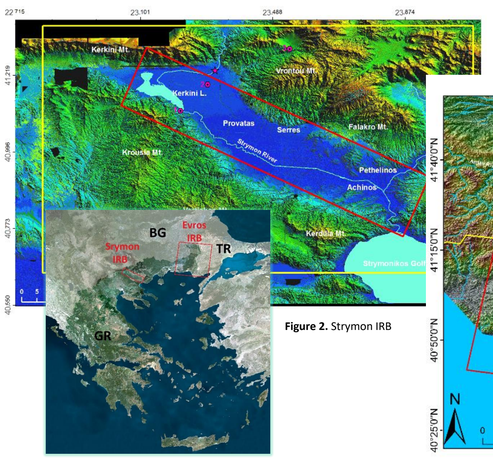


Figure 1. Location map

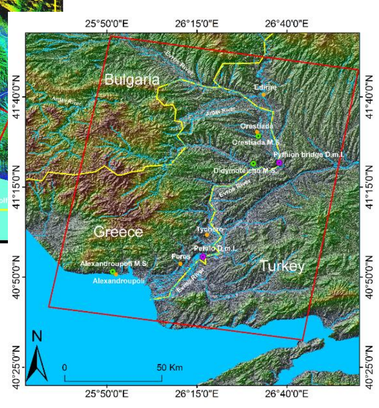


Figure 3. Evros IRB

Methods

The methodology for flood mapping/ monitoring of the affected areas is based on a change detection and thresholding procedure of radar satellite images. Binary water/non-water and RGB multitemporal products were generated and interpreted.

Kerkini lake-reservoir regulated in Strymon river basin

15 Level-1 GRD SAR scenes, in Descending Interferometric Wide swath (IW) mode, with polarization VV and VH were collected spanning the period from October 2014 to October 2015

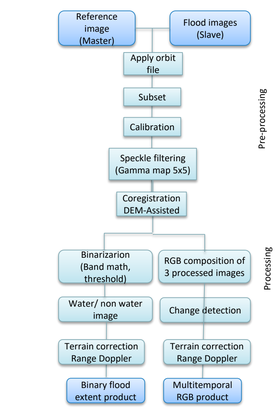


Figure 4. Methodology flowchart
Case study: Kerkini lake-reservoir in Strymon IRB

Transboundary Evros river basin

21 Level-1 GRD SAR scenes, in Descending Interferometric Wide swath (IW) mode, with polarization VV and VH and relative orbit 102 were collected spanning the period from October 2014 to May 2015

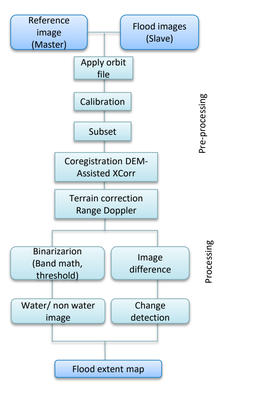


Figure 5. Methodology flowchart
Case study: Evros IRB

Results

Kerkini lake-reservoir regulated in Strymon RB (October 2014 – October 2015)

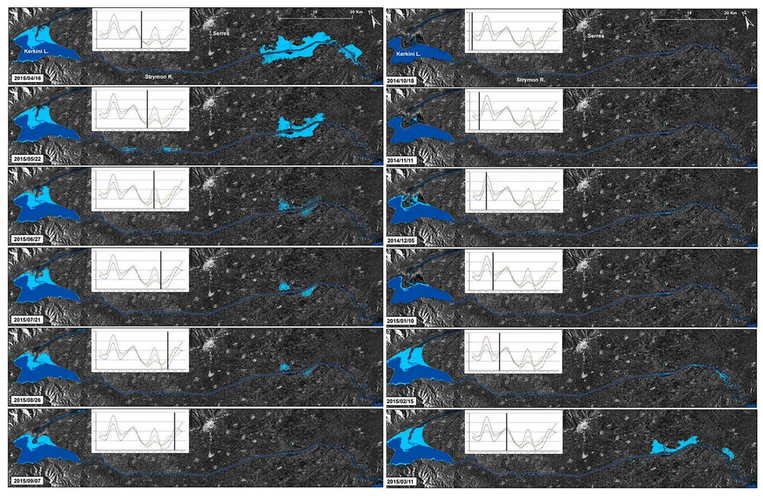


Figure 6. Binary images water/non water from October 2014 –October 2015

Chart 1. precipitation diagram

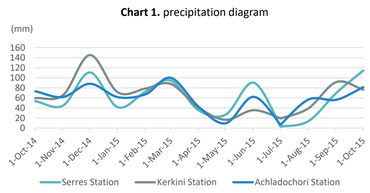
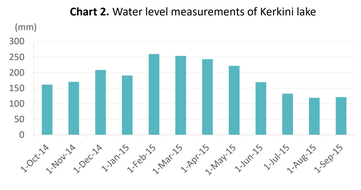


Chart 2. Water level measurements of Kerkini lake



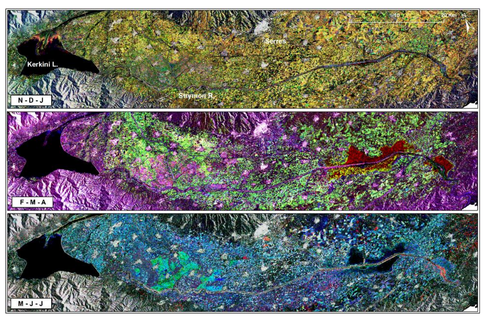


Figure 7. RGB Multitemporal SAR images

Transboundary Evros river basin (October 2014 – May 2015)

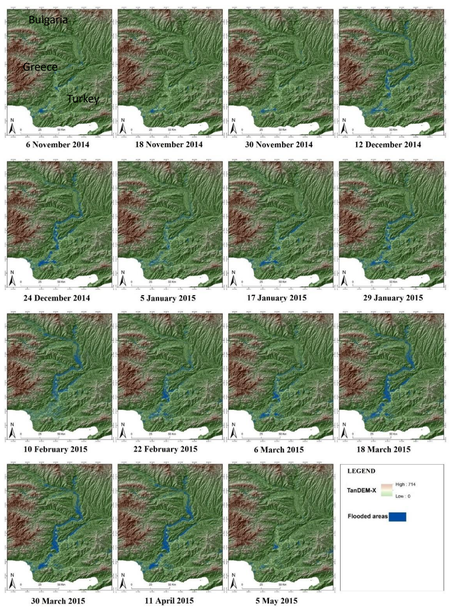


Figure 8. Flood extent maps in Evros IRB

Chart 3. Accumulated monthly precipitation

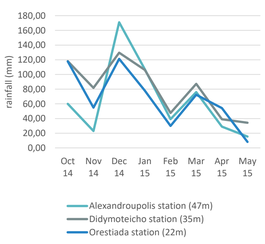
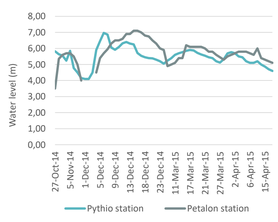


Chart 4. Water level measurements



Discussion

The significant contribution of the study in Kerkini-lake is the identification of the causes inducing the flood phenomenon in the downstream of the Strymon IRB using archive data and creating retrospective products based on Sentinel-1 free data. In combination with hydro-meteorological and topography data support the hypothesis that flood event was provoked mainly by the contribution of the increased water amount flow in the lake coming from the upstream part of Strymon river catchment. The increase of water level in the lake from upstream coincides with the start of the flood event in the downstream. The eventually inappropriate management of water release through the dam are the main reasons why the flood event could be attributed to. Sentinel-1 imagery provided excellent spatiotemporal dynamic flood hazard maps for the case of Evros IRB, offering the possibility of processing the entire transboundary area due to the wide spatial coverage of each image. The flood phenomenon occurred almost simultaneously in the Greek and Turkish territory. The affected areas extend north of the city of Edirne (Turkey) and south to the river's delta. There is no evidence for a specific spatiotemporal pattern of flood at least during this event.

Conclusions

- The Copernicus Sentinel-1 mission can be considered as a unique operational tool for flood monitoring.
- SAR's inherent capability to observe during cloud cover and Sentinel-1's frequent revisits makes it ideal for flood monitoring. It can be used to assess the extent of flooded areas and the impact on human, economic and environmental loss.
- Sentinel-1 repeat cycle of six days, and its systematic acquisition of dual-pol SAR data, provides an unprecedented chance to develop automatic, high frequency flood mapping algorithms for complex environments.
- NRT flood monitoring could support authorities especially during emergency response phase.
- In conclusion, the case of flood monitoring in a transboundary river basin became critical and an essential requirement to monitor the overall spatial catchment area. The needs revealed by this research are overall satisfied by Sentinel-1 mission in terms of revisit, wide coverage and systematic acquisition of free available data and open source software.

Acknowledgements

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Major References

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