On the Use of Gee for Management and Monitoring of Flood Events

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Abstract. *This work analyzes the phenomenon of the dynamic variation of thewater bodies surface under extreme climatic events. The Apollo hurricane, that affected the Mediterranean Area in 2021 was considered as input condition for the delineation of flood area in Simeto Basin in Sicily. The studywas conducted through the use of SAR (Synthetic Aperture Radar) satellite remote sensing systems treated with the aid of the online platform Google Earth Engine, and can be considered as a contribution in the field of monitoring tools and techniques, management and protection of the territory.*

Keywords. Flood events, remote sensing, sentinel 1, SAR, Google Earth Engine, surface of water bodies, Medicane Apollo, EMS Copernicus, PAI

University of Maribor Press

DOI https://doi.org/10.18690/um.4.2023.26
ISBN 978-961-286-783-6

1 Introduction

The management and monitoring of flood events is a topical issue due to the systematic interchange between flood phenomena periods and extreme drought events, leading to further aggravate the hydrogeological instability and the water crises of territory.

The identification of solutions dedicated to land protection, management and preventionof flood events is crucial to mitigate damage to both economic and cultural/environmental heritage and to reduce the risks associated with loss of life. Hydraulic monitoring activitiescarried out with remote sensed data can make a significant contribution to this issue.

The research is focused on the potential role of satellite remote sensing systems in the field of monitoring, management and protection of territory.

Specifically, an attempt was made to define a methodological and applicative approach which would allow the monitoring of catastrophic events, such as floods, in conditions of absent solar irradiation or insufficient (night hours or cloud cover).

The procedure foresee the use of Synthetic Aperture Radar (SAR) images classifying the different surfaces on the basis of the values deriving from the difference in reflection of thesignal towards the sensor and in particular the recognition of water [1]. For this purpose, the COPERNICUS Earth observation program (promoted by ESA - European Space Agency) Copernicus was taken into consideration.

The Sentinel-1 satellite is a Copernicus mission including a constellation of two satellites (sentinel-1A and sentinel-1B) placed in the same sun-synchronous and near-polar orbit at amean altitude of 693 km, phased at 180° to each other.

Both Sentinel-1 platforms are equipped with SAR providing continuous all-weather, day-and-night imagery at C-band.

2 Methods

The remote sensed data processing was performed using Google Earth Engine environment, with the purpose of identifying the pixels covered by water in a SAR-type satellite image.

The code, implemented in Javascript, has the following structure:

a) Selection of ROI and reference time interval
b) Uploading the SAR Sentinel 1 image collection
c) Application of anti-noise filters (speckle) of the focal median type
d) Classification of pixels by identification of suitable backscattering thresholds
e) Creation of an interactive graph with a callback function of the SAR image corresponding to the point clicked on the graph itself

A complex problem is the calibration and tuning of the application, to determine correct parameters of polarization, back scattering and speckle effect for the evaluation of the surfaces covered by water. It is conditioned by many variables, thus we adopted a heuristic approach, based on 2 consecutive phases:

a) Changes to the speckle effect of the images
b) classification method of water pixels (identification of the threshold value)

3 Case study

Between October 24 and 25, 2021 a Mediterranean hurricane called "Apollo " had a significant impact on the territory, causing victims and extensive damage to infrastructure and productive activities located in the catchment area of the Simeto river and Gornalunga stream (eastern Sicily, Italy).

The flood event is reconstructed in GEE environment [2] by considering sentinel 1 datain the Reference period (14/10/2021-31/10/2021) with the following characteristic Polarization: VV Backscattering threshold: -14 Focal_median filter: Radius: 45m, Proximity: circle

The Sentinel-1images analyzed are:

- image acquired on 10/19/2021, 16:56:28 (fig.1a) represents the situation few daysbefore the storm event;
- image acquired on 10/25/2021 at 05:05:02 in the morning. (fig 1b) represents the situation d a few hours after the storm event.
- Image acquired on 10/25/2021 at 16:55:44, (fig.1c) the situation detectable in thearea several hours after the event.

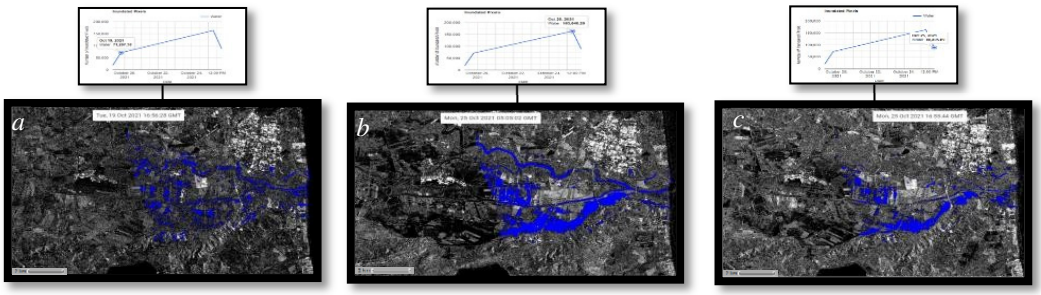

Figure 1. Sentinel-1 images elaborations

The surface covered by water, due to the storm event on the ROI, was approximately 1,400 Ha. This value, after about 12 hours, reduces significantly as is evident from the comparison between the two calculations of 10/25/2021 (05:05 - 16:55 approx.)

From a rough estimate, it can be deduced that, during the day, the outflow of water affected approximately 50% of the surfaces, leaving a residue of surfaces covered by water, equal to approximately 700 hectares compared to normal conditions

The results obtained from the modeling were compared with PAI data from the Simeto Basin [3]. Most of the flooded areas fall into medium and moderate risk zones (R1 and R2),

i.e. with low impact on infrastructure and anthropic settlements. From the analysis of the images it also emerges that the event can be classified with a medium-high probability level (P3/P2) which can be approximated with $50 \leq TR \leq 100$ years (Figure 2).

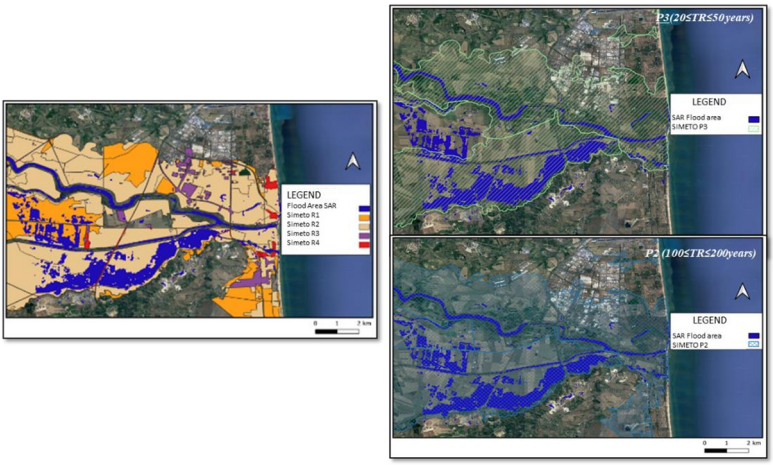

Figure 2. Comparison between risk maps and flood areas

4 Conclusions

The SAR remote sensing is able to ensure the relief of the land in any environmental andirradiance condition and is therefore, in certain contexts and for certain types of event, a discriminating factor of primary importance. The GEE platform constitutes a tool extremelyinteresting thanks to the free and unlimited access to a large catalog of satellite images and the possibility of implementing applications for the treatment and processing The procedureimplemented on the Google Earth Engine platform, with appropriate adjustments and calibrations, has shown an overall validity for the recognition of water bodies. It can be considered a support tool for the evaluation and validation of the effects of a catastrophic flood event, for the ex-post monitoring phases, the estimation of damage to production activities and the impact on infrastructures and anthropic activities.

References

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