Assessment of the Geomorphic Impacts of the Flash Flood Event of 15 November 2017 along the Shore of Eleusis Bay (Attica, Greece)

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Greece experiences a variety of catastrophic weather events that are frequently followed by severe consequences on social and economic activity. Flash floods have caused tremendous loss of life and property over the past decades (Papagiannaki et al., 2013). The most deadly flood in Greece in the last 40 years occurred on November 15th 2017 in the western part of the region of Attica. A high intensity convective storm with orographic effects reaching up to 300 mm in 8 hours (200mm in only 3 hours) locally in a small area (18 km x 4 km zone) of the western and southern slopes of Pateras mountain caused flash floods along the streams of Agia Aikaterini, Soures and Koulouriotiko with extensive damages in the towns of Mandra and Nea Peramos and the loss of 24 people. Basin-average precipitation rates reached 57 mm/h over Soures stream, 41 mm/h over Agia Aikaterini stream and 140 mm/h in the core of the storm. It is noteworthy that a hydrological simulation study resulted in discharge values about 115 m^3/s and water level values exceeding 3 m in Soures and Agia Aikaterini streams which caused the flash flooding around the Mandra area (Varlas et al., 2019).

The most severely affected by the extreme flash flood event area is the western part of the Thriassion plain in west Attica. Thriassion plain hosts one of the largest industrial units in Greece including refineries, metallurgical industries, factories, shipyards as well as the waste landfill of the Attica prefecture. It covers a total area of 812.95 km^2 and is bounded by Pateras Mountain (1016 m) to the west, Parnitha mountain (1413 m) to the north and Aigaleo Mountain (468 m) to the east while the southern border of the plain is the Eleusis Bay. The Bay of Eleusis is a small and deep basin between the north coast of Salamina Island and the mainland. It has a coastline of approximately 15 km and receives the sediment load of a series of streams that drain the surrounding mountainous area. The upper reaches of the streams have relatively steep slopes resulting in high stream erosion capacity and transfer ability. Due to very high water flow velocities during the event (since in certain areas the terrain was very steep) and bottom shear stresses, the flash flood caused significant soil erosion and carried away not only large quantities of solids (practically it was a mud-flow), but also extremely large and heavy objects, such as buses and cars. Additionally, debris flows occurred along the steep coastal fan of the Koulouriotiko Stream which passes through the settlement of Nea Peramos.

In this study images from Copernicus Sentinel 2 and Planetscope Dove microsatellites are used. For this purpose images before and after the flood event in the area have been collected also only one Planetscope image dated 15/11/2017 which is the only one in which a part of the coastal zone is displaced due to cloudiness.

Sentinel 2 is part of the Copernicus mission having in constellation A (lunch on 23 June 2015) & B (lunch on 7 March 2017) satellites, sharing the same orbital plane at an altitude of 786 km and featuring a short repeat cycle of 5 days at the equator optimized to mitigate the impact of clouds for science and applications. The Sentinel-2 mission includes 13-spectral band multispectral optical imager with different resolution (down to 10 m) and a swath width of 290km. The data of the constellation of two satellite units can support the build-up and frequent update of globally consistent background reference maps to be used for impact assessments.

Concerning Planetscope optical multispectral satellite images, LEO (low earth orbit) SSO (SunSynchrnous Orbit), with pixel size (after orthorectified) 3 meters, were used covering the study area. Ortho Scenes products (3B) are radiometrically-, sensor- and geometrically-corrected products that are projected to a cartographic map projection. These products are projected to UTM coordinates and orthorectified using GCPs and fine-scale DEMs to a positional accuracy of <10 m RMSE. PlanetScope is a constellation of 120 smaller CubeSats known as ‘doves’ (dimensions 10 cm × 10 cm × 30 cm) built and operated by Planet, and launched in groups called ‘flocks’. PlanetScope imagery has four bands, blue (Band 1, 455–515 nm), green (Band 2, 500–590 nm), red (Band 3, 590–670 nm) and near infrared (Band 4, 780–860 nm) and a ground spatial resolution of 3.7 m, having a field-ofviewontheEarthsurfaceof20-30kilometer (Altena et al. 2017).

Research based on optical satellite images are simple to interpret and easily or free obtainable. Furthermore, absorption of infrared wavelength region by water and its strong reflectance by vegetation and soil make such images an ideal combination for mapping the spatial distribution of land and water. These characteristics of water, vegetation and soil make the use of the images that contain visible and infrared bands widely used for coastline mapping (DeWitt, et al., 2002). All images are georeferenced and spectral processing techniques (radiometric indices) have been applied in order to delineate the boundary land-water and then detect coastal changes producing multitemporal thematic maps based on the above optical data. In addition the Idepix ((Identification of Pixels) processor, integrated in the SNAP s/w, has been used which provides a pixel classification into properties such as clear/cloudy, land/water, snow, ice etc. although some limitations and weaknesses are presented. Finally Sentinel 1 OCeaN (OCN) data have been used dated 19-11-2017 (morning and night records) in order to collect knowledge about wind velocity and direction. The OCN product (OWI component) is a gridded estimate of the surface wind speed and direction at a height of 10 m above the ocean surface.
In order to process of Sentinel 2 Sentinel 1 (OCN) and Planetscope images the open ESA’s software SNAP, the ENVI and the open software QGIS were used.

The main objective of this study is to identify the effects of the 15 November 2017 flash flood event along the north shore of Eleusis Bay using remote-sensing observations. These effects concern mainly the deposition of large amounts of sediments transported by the streams that flow into the Eleusis Bay.

References

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