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BEYOND Center of Excellence: flood mapping and modelling

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Abstract

Flood is defined as '*a covering by water of land not normally covered by water*' in the European Union Floods Directive 2007/60/EC. Human activities, such as agriculture, urban development, industry and tourism, contribute to an increase in the likelihood and adverse impacts of flood events. It is thus important to establish flood risk management plans focused on prevention, protection and preparedness. The ultimate goal of the Flood Hazard activities in the BEYOND Center of Excellence is to reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity. In this direction, we select river basins at high risk of flooding, we study the hydraulic behaviour of the river, and we proceed to the flood modelling validation and enhancement with the integration of satellite and radar data. In the context of the implementation of BEYOND by the National Observatory of Athens, we have launched the Floods Observatory in Greece where we register the major flood events in Greece and we publish the results we produce following process of satellite and radar images. Our first area of interest is Arachthos river basin, a river with several flood events, very close to the city of Arta, where the Public Power Corporation S.A. is operating two hydroelectric plants.

Keywords: Floods; natural disasters; remote sensing; mapping; modelling

1. INTRODUCTION

EU Directive 2007/60/EC [1] on the assessment and management of flood risks entered into force on 26 November 2007. It defines flood as *'a covering by water of land not normally covered by water'*, and, obviously, human activities, such as agriculture, urban development, industry and tourism, contribute to an increase in the likelihood and adverse impacts of flood events. The Directive requires Member States to first carry out a preliminary assessment by 2011 to identify the river basins and associated coastal areas at risk of flooding. For such zones they would then need to draw up flood risk maps by 2013 and establish flood risk management plans focused on prevention, protection and preparedness by 2015. The Directive applies to inland waters as well as all coastal waters across the whole territory of the EU. The Directive shall be carried out in coordination with the EU Water Framework Directive [2], notably by flood risk management plans and river basin management plans being coordinated, and through coordination of the public participation procedures in the preparation of these plans. All assessments, maps and plans prepared shall be made available to the public.

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The Directive has been incorporated into Greek law by the Joint Ministerial Decision H.P. 31822/1542/E103/2010 (GG B 1108/21.07.2010) [3], where the concept of flooding includes flooding caused by disasters of large hydraulic works, such as dams and levees breaks, which are not mentioned in the Directive.

In December 2012 the Special Secretariat for Water of the Ministry of Environment, Energy and Climate Change published the preliminary flood risk assessment for the 14 water districts in Greece [4]. It was based on 1627 floods events at 1076 sites all over Greece. It also provides the database for the registration of flood events, configured to meet the requirements of the Directive 2007/60/EC.

2. BEYOND CENTER OF EXCELLENCE FOR FLOOD MONITORING

The recently established Centre of Excellence for Earth Observation based monitoring of Natural Disasters in south-eastern Europe, BEYOND [5], run by the National Observatory of Athens, aims to maintain and expand the existing state-of-the-art and interdisciplinary research potential, configures innovative integrated observational solutions, and operates space borne and ground-based monitoring networks in a complementary, unified and coordinated manner. The research portfolio covers a broad spectrum of phenomena, addressed under the three research domains of BEYOND: meteorological and human induced hazards, geophysical hazards, and atmospheric pollution and air quality. BEYOND starts in south-eastern Europe, with a prospect to increase its access range to the wider Mediterranean region through the integrated cooperation with twining organizations.

The ultimate goal of the Flood Hazard activities in BEYOND is to reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity. In this direction, we select river basins at high risk of flooding, we study the hydraulic behaviour of the river, and we proceed to the flood modelling validation and enhancement with the integration of satellite optical and radar data.

3. PRODUCTS AND SERVICES

This section contains a series of indicative products that have been generated by the BEYOND Center of Excellence on floods and provides a brief presentation of the main services which become available in the same context.

3.1 The Floods Observatory

In the context of the implementation of BEYOND, we have established the Floods Observatory (Figure 1) [6] where we register and maintain information on the major flood events in Greece. Moreover, the Floods Observatory publishes the flood mapping results produced through the process of satellite optical and radar images.

A case study presented is the flood event of the Arachthos river on 24 October 2003, with one casualty. Arachthos river in western Greece, is the river where the Public Power Corporation S.A. operates two dams upstream of the city of Arta. Our area of interest for studying the flood event of 24/10/2003 is depicted in red in Figure 2. LANDSAT-5 images were available before and after the flood, so the best suited pair of images has been selected, one image acquired before the flood on 10/10/2003, and one after the flood on 26/10/2003. Following image processing and photointerpretation, we estimated the water surface at 85 ha on 10/10/2003 (Figure 3), and at 202 ha on 26/10/2003 (Figure 4). Figure 5 is the result of overlapping the flood extends depicted on Figure 3 and Figure 4.

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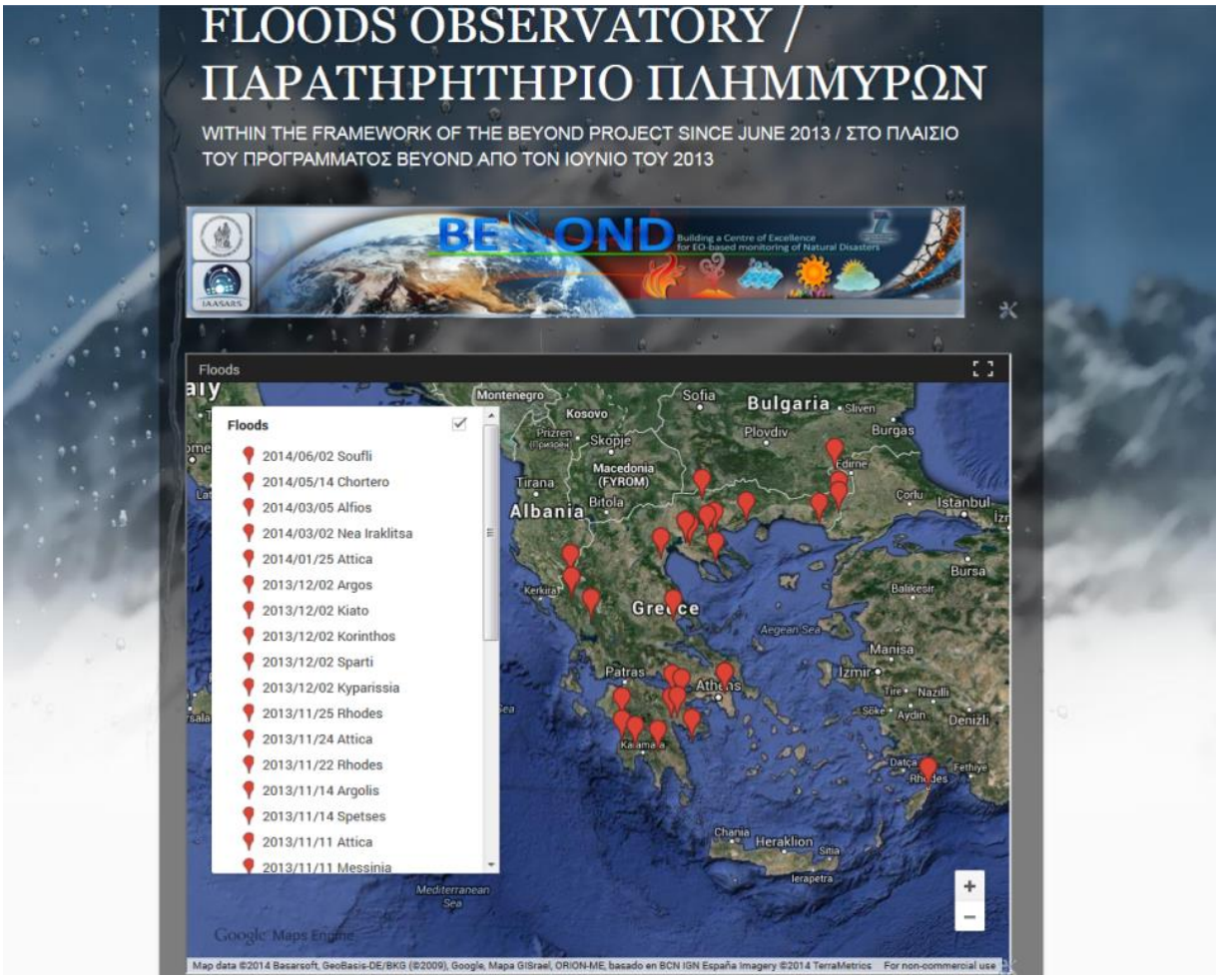

Figure 1. The Floods Observatory within the framework of the BEYOND project.

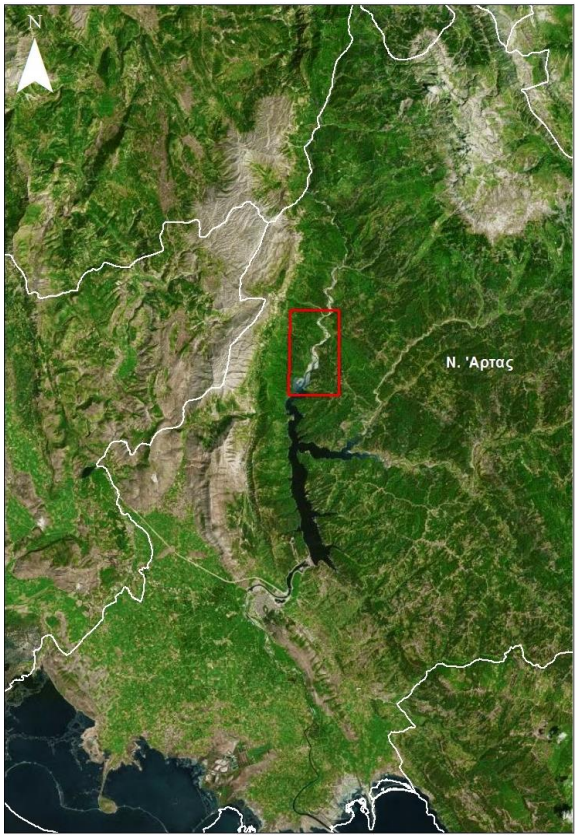

Figure 2. Area of interest in the Arachthos river basin.

Figure 3. LANDSAT-5 image acquired on 10/10/2003 before the flood event (water in light blue).

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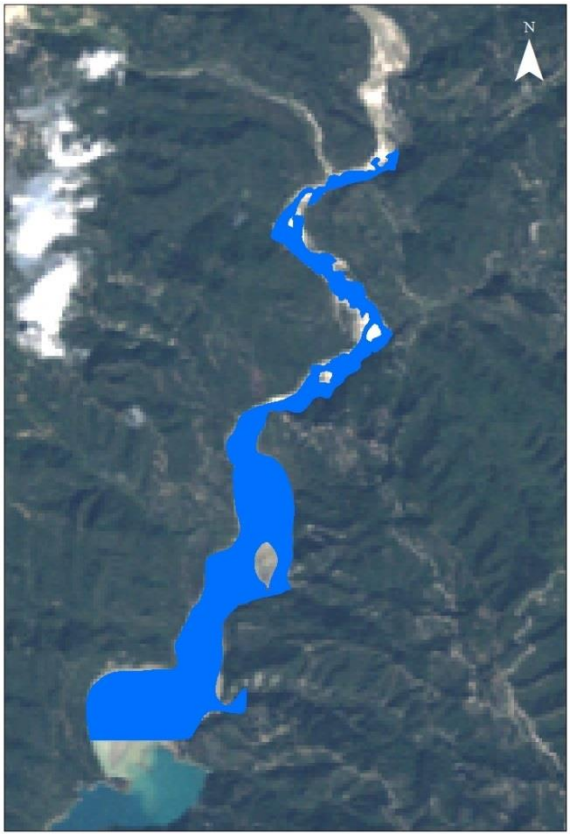

Figure 4. LANDSAT-5 image acquired on 26/10/2003 after the flood event (water in dark blue).

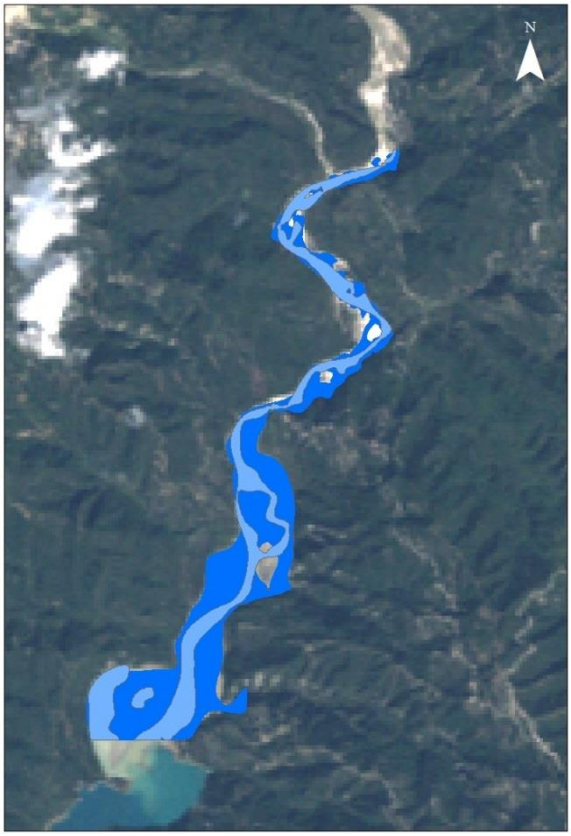

Figure 5. Overlap of flood extends depicted in Figure 3 and Figure 4.

3.2 The Early Warning System

In the framework of the BEYOND project, NOA has established cooperation with the Public Power Corporation S.A. (PPC S.A.), as there is a mutual interest in the field of studying floods and developing a methodology for the assessment of flood risks, ultimately by creating an early warning system for floods. The contribution of PPC S.A. covers the provision of relevant expertise and information derived from the processing of the in-situ collected data of the hydrometeorological network operated by PPC S.A., and/or data relating to the management of the hydrological basins under study. This cooperation will allow the improved adjustment and calibration of the hydrologic and hydraulic models which are operated by the IAASARS/NOA, as well as the development of a methodology that will provide reliable observations to the services of PPC S.A in the future.

The area of interest for the specific study is the river basin of Arachthos, a river with several flood events, very close to the city of Arta, where PPC S.A. is operating two hydroelectric plants, a large one known as Pournari I (effective capacity of reservoir 303 million m^3) and a smaller one known as Pournari II (effective capacity of reservoir 4 million m^3), respectively (Figure 6).

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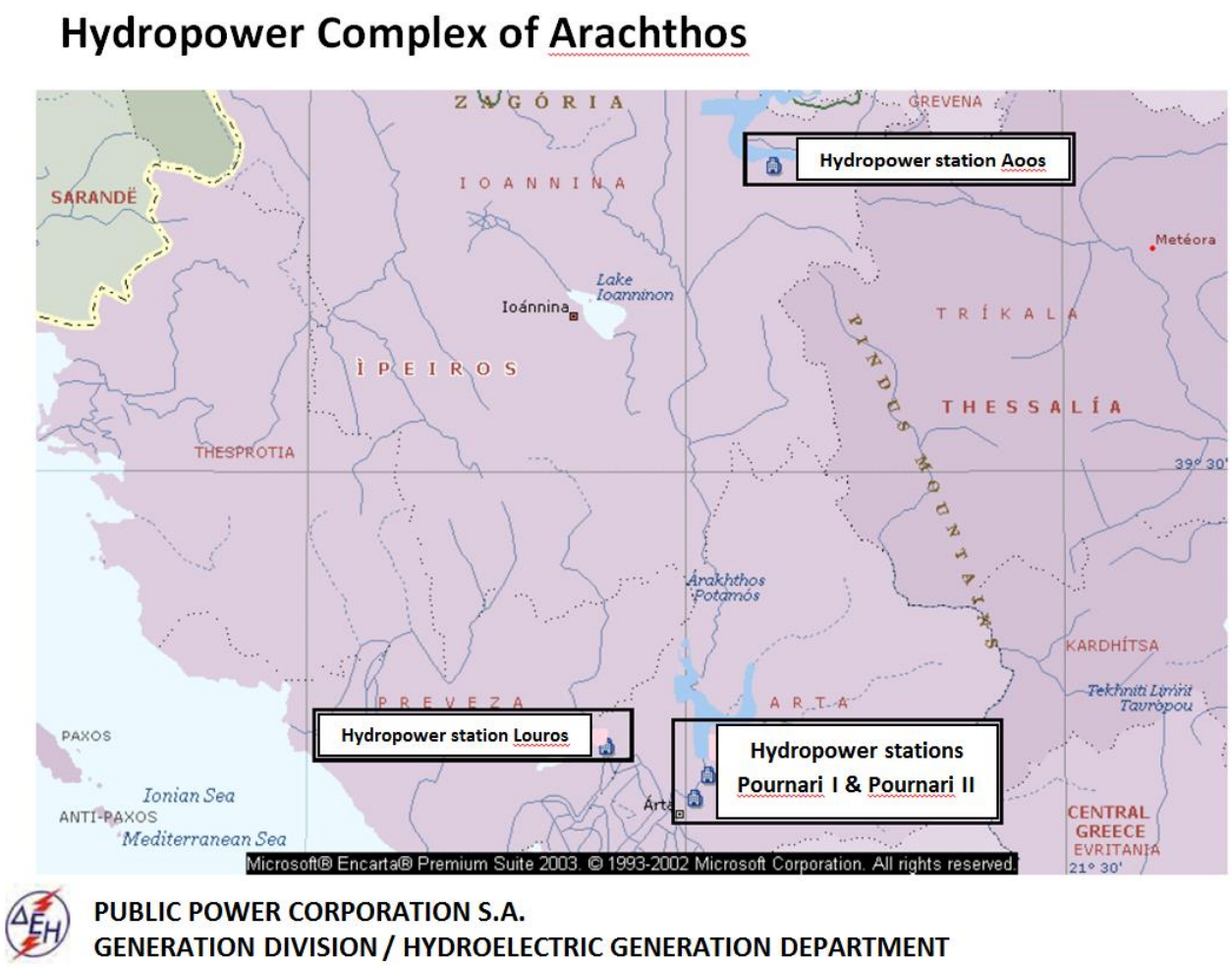

Figure 6. Map showing Arachthos river and the city of Arta in western Greece, as well as the location of the two hydroelectric plants of the Public Power Corporation S.A.: Pournari I and Pournari II.

NOA has also established cooperation with the National Technical University of Athens, School of Civil Engineering, Department of Water Resources and Environmental Engineering, providing expertise in the hydrologic and hydraulic modelling.

The following hydrological and hydraulic models are used in BEYOND:

- HYDROGNOMON [7], a free software application for the analysis and processing of hydrological data, mainly in the form of time series.
- LISFLOOD [8], a GIS-based hydrological rainfall-runoff-routing model that is capable of simulating the hydrological processes that occur in a catchment.

4. CONCLUSIONS

Flood forecasting is crucial to flood risk management, especially in reducing the impact of floods. The European Floods Awareness System [9] is an early flood warning system on European level, but it can only be complimentary to national and regional systems. Flood warning is a Member State responsibility, and, anyway, Member States are committed by the Floods Directive 2007/60/EC. Flood mapping and modelling are essential in this direction and earth observation offers increasing possibilities. BEYOND develops products and services for monitoring and mapping floods, based on the use of satellite and radar data, efficient earth observation technologies and long-term expertise in the field. In addition, the National Observatory of Athens will soon launch a European Space Agency Mirror Site at its premises in Penteli, for the collection, management, distribution and processing of SAR data and derivation of added value products from

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the Sentinel family of Copernicus satellites, on a real-time basis. This mirror site will definitely boost the remote sensing research on flood monitoring, mapping, and forecasting in the framework of BEYOND. The massive flow of satellite data, in combination with the in-situ hydrometeorological measurements provided by the PPC S.A. partner, will result to high quality products and services, through elaborated algorithms and processing chains which are under development in BEYOND.

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