ESTABLISHING LONG-TERM ECOLOGICAL RESEARCH INFRASTRUCTURE AT THE RIVER PINIOS HYDROLOGIC OBSERVATORY

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ABSTRACT

Pinios River basin (RPB), located in central Greece, has a spatial extent of ca 11,000km^2 and is one of the largest productive basins of the country. Alpine tectonics gives rise to a rather complex hydrodynamic evolution context. Lateral crossflows from the aquifer units of the mountainous regions to the aquifer systems of the plains control the recharge mechanism of the latter. Excessive groundwater abstractions from the thick alluvial groundwater system of the basin to sustain expanding irrigated agriculture have triggered continuous decline of hydraulic heads and quality deterioration since mid 1980's. To assess the evolution of water resources in the basin and provide a sustainable water management scenario in the context of climate change, the hydrologic model mGROWA (Herrmann et al., 2015) has been compiled and run for the entire RPB. Agia basin, a 44.5km^2 marginal sub-basin to RPB, has been selected in 2015 as a field laboratory. In Agia basin, the so-called "Pinios Hydrologic Observatory" was established in the same year (https://data.lter-europe.net/deims/site/LTER_EU_GR_004), following a well-coordinated effort between the Hellenic Agricultural Organisation-Soil and Water Resources Institute and the Forschungszentrum Jülich-Agrosphere Institute. Main purpose of Pinios Hydrologic Observatory is the identification and quantification of the major controlling hydrodynamic evolution processes and their transfer at the RPB scale to enable better simulation of hydrodynamics at regional scale, thus enhance modelling capabilities and accuracy.

Being a rural agricultural area where agro- and eco-tourism progressively expands, Agia bases its socio-economic growth and resilience on water resources sufficiency for high quality and low cost agricultural production, whilst preserving the environmental features of the basin. Scattered low potential springs at the southern slopes of Mt Ossa (northern margin of the basin), and numerous creeks and torrents occur; these account for water demands of remoted fruit orchards at the mountainous part of the basin, and also cover the needs of livestock and wild fauna species inhabiting the basin. Groundwater systems are by far the most important source of water to the basin, at least for major water demanding activities.

Pinios Hydrologic Observatory comprises 3 fully equipped telemetric and energy self-sufficient climate stations fully covering the altitudinal zones in the basin. A set of 11 autographic groundwater level and temperature instruments, water meters and discharge loggers have been installed, some additionally equipped with an electric conductivity sensor. Groundwater quality monitoring is performed quarterly covering a wide spectrum of parameters. Water balance calculations are enhanced through the installation of 2 soil-net clusters within the observatory domain, that provide data on soil water content at 3 different depths and 3 different points per cluster. A cosmic ray device is installed and operates to provide averaged soil water content fluctuation at a larger area compared to the soil nets. The observatory will be further equipped in 2018 with a denser soil moisture network and autographic instruments for key water quality parameters monitoring. A full-scale soil properties study is due, as are geophysical campaigns to improve understanding on the geometry of the groundwater systems. Operation of Pinios Hydrologic Observatory will be supported by an integrated system of farm management data collection, so that the on-site measurements will be assessed within a real-life context as to their importance. The data collection system will involve the recording of technical and economic indicators describing main cropping activities, use of resources (land, labor, capital), main products, producer prices, marketing (short and mainstream supply chains) etc.

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Climate change projections for Greece indicate considerable increase of mean annual temperature and decrement in future precipitation amount and wet day's occurrence (Tolika et al. 2012). Subsequently, the frequency of prolonged and severe drought episodes is expected to increase. The frequency and magnitude of extreme precipitation events is also expected to increase, especially during winter (Tolika et al. 2008). It is therefore important to develop a well-structured and substantiated set of adaptation measures in time. Through the collection and analysis of the high-frequency environmental data collected in Agia basin, such measures may be based on the study and analysis of the field-lab system. These data sets shall be augmented by conventionally collected environmental data and data on socio-economics and market trends. Indeed, such an integrated approach will be crucial in order to support the development and adaptation of an overall resilient (environmentally, socially, economically) agricultural production paradigm. Data based analyses and multi-discipline approaches may lead to optimization of well-adapted agricultural practices that will make wise use of soil and water resources minimizing production costs, environmental impact and maintaining yields whilst improving revenue. Historical data, tacit knowledge and traditional know-how will be important elements of an assessment framework of proposed outcomes.

Data measured in Pinios Hydrologic Observatory are already intensively explored by the regional population for a number purposes. Climate data measured by the 3 fully equipped telemetric and energy self-sufficient climate stations of Pinios Hydrologic Observatory are already being made publicly available to local farmers as a means to support their agricultural activities. Additionally, this climatic data is offered to upgrade the efficiency of the regional forest-fire protection system. The observed groundwater level, discharge and water quality data of Pinios Hydrologic Observatory will be used to support management of the collective irrigation networks operated by the local municipality. Calculation of key hydraulic parameters of the aquifer system is enabled as a prelude to deepen understanding of the hydrodynamics and the potential of the system, thus a valuable service to the regional water authorities. Last not least, Pinios Hydrologic Observatory shall act as a live field school for environmental education at all levels, thus contributing to the information and sensitization of the general public and the specialization of higher education students and scientists on state of the art instrumented monitoring and analysis. On the long run, the identified and quantified hydrologic mechanisms may be appropriately and proportionally transformed to the entire RPB contributing to accurate forecasts and thus manage the water resources of RPB, i.e. in a very sensitive and socio-economically critical region of the country. Moreover, successfully applied management and governance practices tried at Pinios hydrologic observatory, may be transferred to regions and basins sharing the same physiographic and socio-economic conditions in Greece and beyond.

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