Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 162 (2016) 277 – 283

Procedia Engineering

www.elsevier.com/locate/procedia

International Conference on Efficient & Sustainable Water Systems Management toward Worth Living Development, 2nd EWaS 2016

Sustainable agricultural water management in Pinios river basin using remote sensing and hydrologic modeling

Alexander Psomas[a,*], Vasiliki Dagalaki[a], Yiannis Panagopoulos[a], Dimitra Konsta[a], Maria Mimikou[a]

[a]*Laboratory of Hydrology and Water Resources Management, Department of Water Resources and Environmental Engineering, School of Civil Engineering, National Technical University of Athens (NTUA), 5, Iroon Polytechneiou Street, 15780, Zografou, Greece.*

Abstract

The Pinios river basin is a major agricultural area in Greece, which faces environmental issues with water scarcity and nutrient pollution. Recent Earth Observation satellite data and ground truth information were combined to produce an updated land use map, focusing on irrigated crop areas. A process-based hydrological model (SWAT) was set up using the produced land use map. The model was calibrated and validated using observed streamflows and nutrient concentrations at selected gauging stations. Four irrigation and nutrient management practices related to resource efficiency (i.e. deficit irrigation, reduced fertilization, combination of deficit irrigation and fertilization, precision agriculture) were modelled and simulated. The sustainability of the management practices was assessed using indicators to quantify their impacts on the water-energy-land-food nexus of the river basin.

Peer-review under responsibility of the organizing committee of the EWaS2 International Conference on Efficient & Sustainable Water Systems Management toward Worth Living Development

Keywords: agricultural water management; Pinios; remote sensing; SWAT; water efficiency; nexus;

* Corresponding author. Tel.: +30-210-772-2829; fax: +30-210-772-2416.
E-mail address: alexpsomas@chi.civil.ntua.gr

Peer-review under responsibility of the organizing committee of the EWaS2 International Conference on Efficient & Sustainable Water Systems Management toward Worth Living Development
doi:10.1016/j.proeng.2016.11.059

1. Introduction

Agriculture is a major water user for Europe accounting for 22.5% of total freshwater abstractions. In southern Europe agricultural abstractions account for 46% on average, while in certain southern river basin districts they reach up to 80%, causing serious water quantity issues [1]. Furthermore, areas with intensive agricultural activity suffer from water quality degradation, which is associated with N and P emissions from fertilizers [2]. As a result, irrigated agriculture is considered a key driver for both water scarcity and drought and nutrient pollution. Climate change is expected to deteriorate the situation, unless mitigation and adaptation measures are implemented [3, 4]. Several European policies support the effort to increase resource efficiency of water and fertilizers to alleviate these environmental pressures. The EU 2020 Strategy [5] for smart, sustainable and inclusive growth and the Roadmap to a Resource Efficient Europe [6] frame the vision for a low-carbon, innovative and sustainable economy through the promotion of resource efficiency. In addition, water saving and water protection measures are required to be integrated in the Programmes of Measures (PoMs) of the national River Basin Management Plans (RBMPs) in line with the Water Framework Directive (WFD) [7], with the ultimate goal of achieving good status for surface and groundwater bodies.

However, decisions about farming practices may influence not only water quantity and quality status, but also other environmental components in a catchment, as well as societies and the economy. Designing and implementing measures for sustainable management of water resources in agriculture requires an integrated approach addressing the water-energy-land-food nexus [8, 9] and also taking into account rural development, economic growth and social cohesion. Especially in the Mediterranean, agriculture is considered a significant economic sector, because of its traditionally high contribution to growth and employment. For example, the gross added value of crop production in EU is estimated at 1.6% of the total economy, whereas in Spain and Greece it reaches 2.5% and 3.8% respectively [10]. In addition, the agricultural sector accounts for 5.2% of the total EU labour force on average, whereas this share rises up to 9% in Italy and Spain or even 20% in Poland [11].

The Soil and Water Assessment Tool (SWAT) is considered a prominent process-based model, which serves as a robust and interdisciplinary tool for the simulation of agricultural catchment management [12]. It has been used in a broad range of studies for designing water-related measures in agricultural catchments [13, 14, 15]. Recent studies have also focused on coupling remote sensed products and SWAT to analyse the impacts of land use change or agricultural management practices [16, 17, 18, 19].

The Pinios river basin is a key agricultural area in central Greece facing issues with both water scarcity and nutrient pollution. The current study focuses on the assessment of the sustainability of alternative agricultural management practices to deal with these issues. The methodology that is followed combines remote sensing and image interpretation, GIS processing, hydrologic modeling and simulation of agricultural management practices using SWAT, analysis of impacts on the water-energy-land-food nexus and development of nexus-related indicators.

2. Methodology

2.1. Study area

The Pinios river basin (~10600 km^2) lies in central Greece, covering most of the area of the Thessaly River Basin District (RBD). The central part of the river basin is covered by a large fertile plain, where cotton, winter wheat, maize and alfalfa are mainly cultivated. The average annual rainfall and reference evapotranspiration are approximately 700 mm and 1400 mm respectively, while the observed average annual streamflow at the catchment outlet is approximately 80 m^3/s. Irrigated agriculture takes up 90-95% of the total water use and approximately 50% of the total agricultural land. Taking into account the official and unauthorised abstractions from illegal boreholes, the primary water source is groundwater by far. Overexploitation of groundwater has led to higher costs for pumping from greater depths and seawater intrusion in coastal aquifers. Surface water is mainly abstracted from the Plastiras reservoir, which is considered an outside source because it collects water from the RBD of Western Greece, the Smokovo reservoir and Karla, which is a lake restored in recent years. Irrigation infrastructure includes collective systems with open trenches and canals, which are responsible for very high conveyance losses (30-50%). The conveyance efficiency of the urban distribution network is also very low, as losses reach up to 40%. Since the 1980s, payments to the farmers under the