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7th IAHR EUROPE CONGRESS

Innovative water management in a changing climate

SEPTEMBER 7-9, 2022

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Abstract Book

7th IAHR EUROPE CONGRESS

Proceedings of the 7th Europe Congress of the International Association for Hydro-environment Engineering and Research (IAHR), Athens, Greece, September 7 – 9, 2022.

International Association for Hydro-environment Engineering and Research 2022

Edited by
Anastasios I. Stamou, National Technical University of Athens, Greece
Vassilios Tsihrintzis, National Technical University of Athens, Greece

ISBN: 978-618-85675-3-5

Keynote Lectures

RLR Rivers, Lakes and Reservoirs

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ECS Estuaries, Coasts and Seas

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UHH Urban Hydrology and Hydraulics

FDCC Floods, Droughts and Climate Change

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TCEM Theoretical, Computational and Experimental Methods

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WREM Water Resources and Energy Management

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POSTER PRESENTATIONS

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Regional-Scale Modeling of Surface-Subsurface Flow: The Konya Closed Basin Case Study

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ABSTRACT

Basin-scale hydrological modeling is an essential tool for the management of water resources, particularly in arid and semi-arid regions. The development of such models is particularly challenging for large watersheds where the definition of the system parameters is associated with high levels of uncertainty. To address these challenges, we describe a geostatistical approach utilized to define the input parameters. The approach combines direct measurements as well as soft data to improve the reliability of the defined parameters. The focus is on the Konya Closed Basin case study, one of 5 case studies examined in the IntheMed project supported by the PRIMA programme.

1. Introduction

The Konya Closed Basin is one of the primary agricultural regions of Turkey. The basin, characterized by a semi-arid climate, is located in central Anatolia, covering an area of about 60,000 km^2 with no major flows into or out of the basin (Fig. 1). Agricultural is mostly concentration in the central part of the basin as shown in the 2018 Corine land cover map (Fig. 2). Because of the mismatch between precipitation, mostly in the wet season, and agricultural water needs which are concentrated in the dry season, the basin relies heavily on groundwater resources for irrigation (Ozbahce and Tari 2010, Bozdağ, 2015). As a result of the unsustainable exploitation of groundwater resources, the Konya plain aquifer system has experienced a drastic decline in groundwater levels in recent years (Yilmaz et al., 2021). The problem is exacerbated by the large number of unregulated wells, estimated to be as much as 100,000 wells.

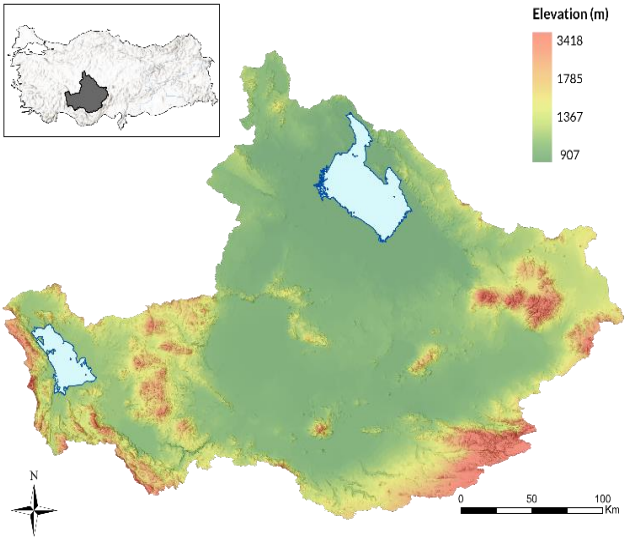

Fig. 1. Topographic map of the Konya Closed Basin.

2. Modeling Approach

To help manage this vital resource, a surface/subsurface flow model was developed. Covering the entire basin, the model is based the HYDRUS unsaturated flow package (Seo et al., 2006; Twarakawi et al., 2008) coupled to MODFLOW computer program (Harbaugh et al., 2000), thus allowing for the simulation of vertical water flow through the vadose zone and horizontal flow in the underlying aquifer system. The specific processes accounted for in the model include evapotranspiration, infiltration, irrigation, and groundwater extraction for

agricultural, domestic and industrial use. The purpose of the model is to reproduce the observed historical water level data and estimate the net recharge in the basin.

Given the vastness of the region being modeled, the unavoidable coarseness and simplifications of such large regional models, and the limited availability of detailed hydrogeological data, the model is associated with a relatively high level of uncertainty. To improve the reliability of the model, direct measurements, as well as soft data collected at different scales, are incorporated into the model. Specifically, the model combines point groundwater level data, meteorological data and pumping test data, geologic data, land cover data (Corine), surface topography, and water content (GRACE) satellite data. To account for the uncertainty in the definition of the input parameters, geostatistical techniques are used to define key parameters such as the hydraulic conductivity, precipitation, aquifer thickness, ground elevation, and groundwater extraction. Historical groundwater level data were used as the main calibration parameter.

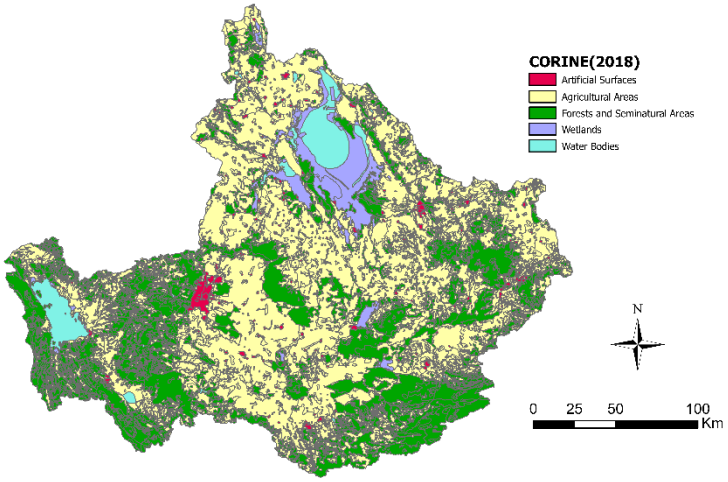

Fig. 2. Dominance of Agriculture in the Konya Closed Basin (map based on Corine Land Cover data).

3. Overview of Findings

Results show that the model was able to reproduce the observed groundwater level trends of the past two decades. Recharge areas are primarily located in the higher elevation regions of the basin with water flowing towards the central portions of the plain where intensive irrigation is located. The modeling results underscore the impacts of the expansion of irrigated lands and the switch towards more water-demanding crops on the basin's overall water deficits. As part of the efforts to move towards more sustainable use of the groundwater resources in the basin, there is a need to switch back to rain fed crops in the dryer portions of the basin. The model is used to predict the basin-wide long term water budget under various scenarios. The paper also highlights the challenges of modeling groundwater flow at the basin scale and discusses possible approaches to address these difficulties.

Acknowledgement

This research is part of the InTheMED project which is supported by the PRIMA programme under grant agreement No1923.

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