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Editorial

Ecohydrological Developments For The Optimization Of Water Resources In Arid And Semi-Arid Regions.

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Abstract

Water resource conservation is a present issue that will only get worse in the future as a result of climate change. Changes in the availability of water are anticipated to have a particularly significant impact on the arid and semi-arid regions of the world. Advances in ecohydrology sciences, that is, the interaction between hydrological and biological processes is required to improve knowledge of the critical zone, maximize the use of water resources in dry and semi-arid regions, and slow down climate change. The ten original papers in this Special Issue (SI) focused on optimizing water resources and managing land sustainably in delicate areas that are more vulnerable as a result of climate change. The primary subjects in this context include deep percolation, groundwater recharge, transpiration, evapotranspiration, and associated problems. The selection of publications included in this SI reflects ecohydrology knowledge. Ecohydrology is predicted to see a rise in its uses in the future. As a result, it is reasonable to believe that initiatives focusing on water as a key issue to promote environmental sustainability and socioeconomic development will have a higher probability of success.

Keywords : *runoff, gully erosion, evapotranspiration, transpiration, groundwater, soil water retention, compost, silicon, and forest restoration.*

INTRODUCTION

The majority of surveys pertaining to soil physics and hydrology have moved from the lab to the field in recent decades. They have also evolved from a narrow perspective that only takes into account one aspect, such as the physical properties of hydrology, to a broad perspective that engages with the fields of related disciplines, including ecology, geochemistry, engineering, pedology, meteorology, and climatology [1].

The multidisciplinary scientific area of ecohydrology examines the relationships between ecological systems and water. It is regarded as a branch of hydrology with an emphasis on ecology. Rivers, lakes, and other bodies of water may be the sites of these interactions, as well as forests, deserts, and other terrestrial habitats. Ecohydrology research focuses on the following topics: how plants and vegetation use water, how organisms adapt to their aquatic environments, how vegetation and benthic plants affect stream flow and function, and how ecological processes, the soil carbon sponge, and the hydrological cycle interact with one another [2].

The issue of conserving water resources is one that will only get worse in the future because of climate change [3]. Variations in the availability of freshwater are predicted to have a particularly significant impact on the world's arid and semi-arid regions [4,5]. To improve knowledge of the critical zone hydrology, maximize the use of water resources in dry and semi-arid regions, and slow down climate change, ecohydrology studies must therefore progress [6, 7].

Presenting cutting-edge ecohydrological research and applications with an emphasis on optimizing water resources in arid and semi-arid regions was the primary objective of this Special Issue (SI). All things considered, the contributions collected in this SI cover the ecohydrology of (i) cultivated areas, such as orchards [13] or arable lands [14], (ii) natural areas, such as deserts [8,9], wetlands [10], grasslands–rangelands [11], and forests [12], or (iii) areas that do not specifically focus on the environment–vegetation interaction [15–17]. Studies on transpiration-evapotranspiration and groundwater were the most often submitted.

A work [15] was added to the Editor's choice articles—that is, studies judged to be particularly significant in their field or of great interest to readers—based on suggestions made by the scientific editors of MDPI publications.

The next part is a summary of the key findings compiled from the gathered investigations.

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OVERVIEW OF THIS SPECIAL ISSUE

Ten original ecohydrology-focused contributions were gathered for this special issue. Only one field study examined the optimization of water resources in a controlled laboratory setting [17], while the majority of the relevant studies were conducted in dry and semi-arid regions [8–11,13–16], albeit some came from more humid conditions [12]. Additionally, China created half of them [8–11,14], with the remaining ones coming from the United States [15], Korea [16], Brazil [12], Kansas, and Mediterranean Europe (Italy and Portugal) [13,17].

The papers are arranged according to three basic themes for the convenience of the reader: (1) transpiration/evapotranspiration, (2) groundwater/deep percolation, and (3) miscellaneous.

There are four papers in Topic 1. In two Mediterranean vineyards—one in southern Portugal in a level region with irrigation, and one in northern Italy with a sloping, rainfed crop—Darouich et al. [13] calculated the evapotranspiration fluxes and water consumption. For both research scenarios, the SIMDualKc model was effectively used to represent soil-water balance, crop evapotranspiration, and water use.

In a natural region in the Eurasian interior and along China's northwest border (Xinjiang), Tang et al. [14] examined the spatiotemporal variability in evapotranspiration as well as the impact of heat and water on water-use efficiency (WUE). The findings demonstrated that WUE trended upward in the majority of locations and that regional variability in WUE across various hydrological processes were considerable. Additionally, they discovered that precipitation has a negative influence on WUE in arid regions, whereas temperature has a favorable effect.

In their study of the environmental regulation of desert ecosystem transpiration within an oasis–desert ecotone, Xu and Yu [9] measured the sap flow from three prominent shrub species and concomitant environmental factors over the course of two growing seasons. Their research had ramifications for diurnal hydrology modeling, particularly diurnal transpiration and water stress modeling, as well as insights into ecosystem-scale environmental constraints on the water flux of dry and semi-arid regions.

The study findings for an area in Inner Mongolia, northwest China, that is under risk of desertification were published by Jia et al. [10]. Using estimates from several observation wells and soil moisture fluctuations at various locations, they examined the following topics: (i) the evapotranspiration of groundwater (ETG); (ii) the temporal and spatial variations in ETG; and (iii) the sensitivity of ETG to water table depth for various vegetation types (i.e., Phreatophytes).

There are three papers in Topic 2. In Midwestern states like Kansas, Ternes [15] investigated the impact of private water wells on the preservation of a high Plains aquifer and the over-exploitation of this groundwater resource.

contrasting well-owners' irrigation technology with those of non-owners throughout the state made it easier to evaluate the connections between water conservation and infrastructure issues by looking at well ownership.

Park et al. [16] measured the various silicon fractions in volcanic ash soils on the southern Korean island of Jeju that might influence the silicon content of groundwater and contrasted them with those in forest soils on the Korean mainland. The concept is based on the possibility that silicon will breakdown and seep into the groundwater through the soil profile. Together with calcium and potassium, a high silicon content in drinking water enhances its flavor and is good for human health. According to their findings, silicon is more soluble in Andisols found in areas with high precipitation, and the Andisols on Jeju Island may have an impact on the concentration of silicon in groundwater.

Because delicate ecosystems in arid sandy locations are particularly vulnerable to water deficiencies, Cheng et al.'s paper [8] sought to investigate the redistribution process of precipitation moisture in shallow soil in an arid sandy region (Ulanbuh desert, northern China). In the dry region of the Ulanbuh Desert, the authors distinguished the features of water dynamics and change. The quantitative evaluation of water resources in dry sandy environments can be guided by their findings.

Three papers outlining additional significant research concerns make up Topic 3.

Li et al. [11] addressed the broad topic of arid rangeland's sustainable development in Central Asia, focusing on how droughts, flooding, and gully erosion all work together to impede this growth. This study demonstrates how a rainwater harvesting (RWH) system installed in a gully proved a versatile solution to challenging environmental issues. In order to restore damaged grassland and foster community development, the authors suggested a few appropriate low-cost RWH strategies. Their research may offer recommendations for pasture management and ecological restoration in Central Asia's arid regions.

Because of the restoration of forests in damaged areas, secondary tropical forests have grown in number in recent years. However, the existence of a healthy soil environment that allows for the successful development of seedlings and trees is essential to the success of forest restoration activities. Pereira et al.'s study [12] sought to address the following research question: may passive restoration enhance the physical characteristics of the soil superficial horizon and soil-saturated hydraulic conductivity (Ks)? Thus, in Rio Claro (São Paulo State, Southeast Brazil), they examined the behavior of Ks and certain soil physical characteristics in forests of various ages that were undergoing passive restoration by natural

regeneration, a pasture, a sugarcane field, and a degraded forest fragment. The authors supported the literature's suggestion that soil hydro-physical functioning recovery is a gradual process that varies depending on the kind of soil attribute, past land use, and the legacy of degradation.
The efficiency of compost amendment on hysteretic water retention curves in a sandy loam soil was lastly evaluated by Bondì et al. [17], who looked into the dependability of markers of soil physical quality, such as pore-size distribution parameters. Hysteresis is a phenomena related to the soil in which, for a certain pressure head, the water content of the soil is larger during drying than during wetting. Given that water infiltration was preferred during wetting and water storage during drying, the authors found that the addition of compost could have a positive impact on soil hydrological processes and agronomic services.

CONCLUSION

In fragile or endangered habitats, experimental results for sustainable land management and water resource optimization have been presented in the ten original publications included in this SI. Overall, a variety of contexts were examined from the standpoint of ecohydrology, including South American forests, Asian arid regions, European vineyards, and delicate ecosystems. Due to comparatively modest levels of economic interest, the majority of them have not yet been thoroughly studied. Nonetheless, research efforts may increase as a result of the growing recognition of the urgent need to protect marginal or delicate habitats, or rehabilitate degraded ones, for future generations.To demonstrate research advancements in particular disciplines, the gathered publications were compiled into three primary topics: (1) transpiration/evapotranspiration [9,10,13,14], (2) groundwater or deep percolation [8,15,16], and (3) miscellaneous [11,12,17]. A summary of the study's objectives and key findings was also provided.Results from particular ecosystems around the world were presented in the SI-collected publications, but each one emphasized the potential for extrapolating the findings to comparable situations. More generally, the gathered data contribute to our knowledge of critical zone hydrology, the efficient use of water resources in arid and semi-arid regions, and the reduction of climate change's effects.

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