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EDITORIAL

Irrigation challenges in the COVID-19 scenario

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Water is a limited resource and global water demand for irrigation is about 70%. Estimations for 2050 highlight that world population will be over 9 billion, and 45% will live in countries facing water scarcity. Likewise, if irrigation efficiency is not improved, the demand for irrigation will have to increase by 20% to guarantee food security. In addition, projected climate change predictions indicate warmer temperatures and drastic changes in precipitation patterns worldwide thus, soil productivity and crop production could be considerably reduced. Consequently, competition among water users will be enhanced in many areas of the world.

These aforementioned issues highlight the role of water and natural resources management for the sustainability of irrigated agriculture and the need to improve the resilience of productive systems under uncertain conditions. Irrigation has to face the challenge of how irrigated agriculture, across the scales, will adapt to water scarcity scenarios since it will directly affect the future and sustainability of the sector. Particularly, it will be of interest the application of technology and the advance in knowledge to increase water use efficiency and to better estimate crop water requirements.

This special issue compiles research results regarding the above-mentioned issues based on the contributions to the European Geosciences Union sessions: "Irrigation for a resilient and sustainable food–energy–water nexus: science, technology and innovation", held in 2020, and "The challenges of irrigation in the COVID19 scenario", held in 2021. The special issue contains 12 papers with the research topics, regarding the challenges of irrigation at different scales, listed below.

Application of technology to estimate crop water requirements and irrigation efficiency

1. Estimating crop coefficients and actual evapotranspiration in citrus orchards with sporadic cover weeds based on ground and remote sensing data (Ippolito et al. 2022)
2. Irrigation efficiency optimization at multiple stakeholders' levels based on remote sensing data and energy water balance modelling (Corbari and Mancini 2022).
3. Sensitivity to water deficit of the second stage of fruit growth in late mandarin trees (Berrios et al. 2022).

Optimal irrigation scheduling can boost water efficiency. Thus, it is a need to better estimate crop water requirements. Ippolito et al. (2022) suggest a procedure to obtain highly accurate results on dynamics of soil water content and actual crop evapotranspiration under the investigated field conditions. Moreover, it highlights that site-specific crop coefficients, accounting for local and time-variable conditions in the field, can improve crop water requirement predictions, irrigation scheduling and thus, can also forward the implementation of precision irrigation strategies. Likewise, Corbari and Mancini (2022) developed a methodology for optimizing irrigation volumes at the field and at the irrigation consortium scales. It highlights the potential for the combined use of satellite data and a distributed energy water balance model to estimate soil moisture as a direct regulator of irrigation triggering with respect to crop stress thresholds.

Berrios et al. (2022) determine the time and dose of the irrigation water deficit to be applied to adult mandarin trees in semi-arid conditions. Wavelengths in the short-wave infrared region, between 1540 and 1740 nm, allowed differentiation of non-stressed, moderately, and severely water-stressed trees. Therefore, these results can be considered as an initial basis for determining the water status of mandarin trees at various stress intensities by remote sensing.

Prof. Guiseppe Provenzano died in a car crash on November 29th, 2022.

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Irrigation strategies to increase water use efficiency

4. Deficit irrigation of cool and warm season turfgrass varieties under sprinkler irrigation method (Halim Orta and Kuyumcu 2022).
5. Assessing different methodologies for irrigation scheduling in protected environment: a case study of green bell pepper (de Almeida et al. 2022).
6. Modelling water fluxes to improve banana irrigation scheduling and management in Magdalena, Colombia (Zubelzu et al. 2022).
7. An analysis framework to evaluate irrigation decisions using short-term ensemble weather forecasts (Guo et al. 2022).

   Impact of irrigation regime on morpho-physiological and biochemical attributes and centelloside content in Indian pennywort (Centella asiatica) (Theerawitaya et al. 2022).
8. Optimizing the allocation of irrigation water for multiple crops based on the crop water allocation priority (Gong et al. 2022).

Irrigation scheduling in agriculture is a key factor for saving water while guaranteeing maximum crop yields in arid regions as well as in future areas affected by climate change and water scarcity. However, irrigation scheduling is typically conducted based on simple water requirement calculations without accounting for the strong link between water movement in the root zone, crop yields, and irrigation expenses.

Guo et al. (2022) addresses the knowledge gap in providing decision support information and provides an alternative view compared with previous work on irrigation scheduling optimization. An uncertainty-based analysis framework for evaluating irrigation scheduling decisions is developed with focus on the uncertainty arising from short-term rainfall forecasts. Thus, it fosters operational irrigation scheduling by presenting the uncertainty in the outcomes of different irrigation management, while allowing flexibility for individual farmers to make their own decisions.

Halim Orta and Kuyumcu (2022) highlighted that cool-season turf types are very sensitive to water deficit. Warm-season turf (Bermuda grass) is very tolerant to water shortage and can survive with deficit irrigation. To save water and if retaining a permanent green condition is not necessary during the entire year, it is better to grow in warm-season turf instead of cool-season turf grass.

The water use efficiency and the commercial productivity of green bell peppers, cultivated in pots under a protected environment, were affected by the techniques to define the daily irrigation depth (de Almeida et al. 2022).

The results from Theerawitaya et al. (2022) provide a better understanding of the optimum growth conditions required for Indian pennywort for irrigation scheduling by the assessment of its growth and physiological responses. An alternative is proposed to promote total centelloside yield using water supply by maintaining soil water content at 75% field capacity.

Zubelzu et al. (2022) developed a tailored modelling approach to account for the temporal variability in banana crop development. It also addresses common issues regarding: poor data availability on soils and crop management, a lack of knowledge on irrigation system and management and guidance on water demand for ratoon crops.

Gong et al. (2022) develop an irrigation water optimization model that applies a crop water allocation priority model (validated in the field) to quantify the changes in three indicators: yield, economic benefits, and irrigation water productivity. The model, supplemented with real-time data (e.g., weather forecasts, crop, growth monitoring data), can be used to expeditiously develop irrigation schemes to become a real-time optimization platform for irrigation systems. This will facilitate more precise agricultural management and promote digital agriculture to further sustainable development.

Water–food–environment nexus

9. A proposal of an Irrigation Sustainability Index for agricultural basins: application in a semi-arid river basin (Cánovas-Molina et al. 2022).
10. Optimal agricultural plan for minimizing ecological impacts on river ecosystems (Sedighkia et al. 2022).

Irrigation sustainability has become a major concern as water scarcity threatens sustainable development. Cánovas-Molina et al. (2022) develop and propose an Irrigation Sustainability Index for application in agricultural basins. It uses indicators of four dimensions of sustainability: economic, social, institutional, and environmental, that were tested in the Segura River Basin agroecosystems in southeastern Spain. It can be applied to identify, among agricultural practices, the ones with have the largest environmental impact—and their location—and it can support decisions when planning for sustainability. A novel framework to improve agricultural planning in river basins is developed by Sedighkia et al. (2022) which considers ecological impacts on the river. It is based on fuzzy physical habitat simulation to assess the environmental flow regime in the river ecosystem.

Water allocation and redistribution within the soil

Numerical model for the simulation of soil water flow under root absorption conditions. Application to tomato plant crop (Del Vigo et al. 2022).

The evolution of emitter wetting patterns is an important factor to design and manage surface and subsurface drip irrigation systems. Del Vigo et al. (2022) developed a numerical model for the simulation of soil water flow under trickle irrigation conditions with included the root absorption effect. It is potentially useful for designing trickle irrigation water systems, and for irrigation scheduling.

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