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Editorial: Hydro-Informatics for Sustainable Water Management in Agrosystems

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Editorial on the Research Topic

Hydro-Informatics for Sustainable Water Management in Agrosystems

Future food security is increasingly being challenged by climate change and the ever-growing global population and migration. These factors have already intensified the competition for water resources between agriculture and urban areas. They will probably exacerbate rather than relieve the major water challenges in the future (Flörke et al., 2018). This situation has led to widespread discussion and consensus on the urgent need to implement sustainability-oriented water management practices in agriculture. The remediation of this situation requires transformative investments on several fronts to, for example, alleviate the impacts of climate change, preserve land and conserving water, and modernize irrigation and drainage practices (Hanjra and Qureshi, 2010).

Water use and management for agricultural purposes are often influenced by a number of highly complex economic, engineering, social, hydrologic, environmental, and even political factors (Zomorodian et al., 2018; Bjornlund and Bjornlund, 2019). The intricate and interwoven nature of these factors makes it more challenging to cope with them in light of the anticipated increase in agricultural water demand due to climate change impacts and global population growth. Accordingly, there is an urgent need to move beyond the technocratic or techno-centric nature of current practical and research effort on water management (Vojinovic and Abbott, 2017). Therefore, a holistic approach that interweaves technological, social, and institutional innovations represents a promising pathway to underpin major transformations around agricultural water harvesting, supply and demand management.

The field of Hydroinformatics has evolved from computational hydraulics, a techno-centric endeavor, to currently focus on a whole socio-technical dimension of water resources management. It aims at transforming the social environment around water resources and infrastructures from an individualistically reactive one into an altruistically interactive one. However, much of the current developments and benefits of Hydroinformatics have been focused on and highlighted in urban water systems management (Urban Hydroinformatics; Vojinovic and Abbott, 2017; Makropoulos and Savić, 2019). However, owing to the multifaceted water resources use in crop and livestock production, agricultural systems represent a domain of paramount importance for the application of Hydroinformatics. Thus, this Research Topic aimed at highlighting state-of-the-art technological and institutional innovations toward improved agricultural water management practices. It has resulted in six (6) papers which we summarize as follows.

Guedessou et al. use HYDRUS-2D to study the behavior of subsurface drainage systems in cultivated organic soils (histosoils) in the Montérégie region (Québec, Canada).

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The objective of this study was to: (a) evaluate the effect of soil compaction on drain depth and spacing, and (b) determine the combinations of the thickness of compaction layer and saturated hydraulic conductivity (Ksat) that can improve the performance of subsurface drainage systems. The end goal is to increase water infiltration, thereby making irrigation more efficient and increasing crop yield and water productivity. They found that soil management methods for improving Ksat are more effective strategy when compared to deepening the drains and/or reducing the spacing between drains. Poon et al. develop an upgraded version of the Soil Water Assessment Tool (SWAT) model named SWAT-MAC. This later integrates a new percolation algorithm that partitions subsurface water into a macropore and a matrix flow pathway. The objective was to more accurately predict subsurface water flows and chemical (phosphorus) transport to tile drainage systems through soil macropores in an agricultural subwatershed of southern Quebec, Canada. They found that the percolation algorithm provided an improved framework to simulate the macropore flow pathway while improving the description of water movement through agricultural soils under subsurface drainage systems. The work presented in these two papers is of particular importance to understand how agricultural practices influence subsurface flows and nutrients pathways. Subsequently, these papers contribute to our understanding of the extent and severity of agricultural practices (soil and water management) on water bodies which often present a substantial risk to human and environmental health.

Two other featured papers deal with efficiency-based strategies for water management in irrigated agriculture in view of future predictions of increased demand in global food production and climate change effects. Camporese et al. introduce a modeling and experimental framework for efficient sprinkler irrigation of maize, a widespread crop in Italy. The framework incorporates field monitoring of soil moisture dynamics using time domain reflectometry sensors integrated with a parsimonious hydrological model for the estimation of the water balance terms at the daily time scale. They compare two sites: an "Uninformed Site" irrigated based on farmer's experience, and an "Informed Site" irrigated based on soil moisture monitoring. The study demonstrates that soil moisture monitoring during agriculture activities leads to economic and environmental advantages in terms of irrigation water volumes requirements and cost, without compromising farm productivity. Shahnazari and Akbarzade discuss the effect of deficit irrigation techniques on water productivity in the water supply and utilization chain (fresh herbage yield, dried yield, leaves and aerial parts, and essential oil) of peppermint plants. In their experimental study, two different irrigation strategies (regulated deficit irrigation and partial root-zone drying) as varying fractions of the plant evaporation demand were inflicted to the plants. The results indicate that irrigation treatments had a significant effect on all yield components except leaves and aerial parts and partial root-zone drying treatments outperformed regulated deficit irrigation treatments in term of fresh herbage yield. Furthermore, the leaves and aerial parts from dried yield were identified as the step with the lowest efficiency. They suggest that additional strategies such as change in plant density and optimization of fertilization use rate are necessary to improve the efficiency of this least-efficient step.

The four papers introduced above apply a technical approach to agricultural water management. Two additional papers by Celicourt et al. and Biazin et al. rather promote a sociotechnical approach to agricultural water management. Biazin et al. examine the effect of deficit and supplementary irrigation for staggered production of potato driven by market opportunities at different periods in northeastern Ethiopia using the AQUACrop model. The study found that the number of rainfall days was more important than the amount of rainfall during the growing period. The social aspect of this effort includes the engagement of water users' associations to apply the results of the model and assess their behavior toward water saving techniques. The study further revealed that institutional settings and associated market incentives are the major adoption drivers of improved irrigation water management practices. In line with the spirit of the Research Topic, Celicourt et al. propose a new research field called *agricultural hydroinformatics* through an overview of the intersection between hydroinformatics and agriculture. A general conceptual framework taking into account the distinctive features associated with the sociotechnical dimension of hydroinformatics when applied in agriculture was introduced as the cornerstone of this nascent field. Several facets of the framework applicability, or purposes of the framework, as new paradigms on data flows consideration, and information and simulation model engineering for a holistic approach to water resources management in agriculture are highlighted.

Overall, the papers featured in this Research Topic highlight the relevance of the emerging field of *agricultural hydroinformatics* and are certainly an impetus to propel this nascent field of research. They further highlight subsurface drainage systems performance improvement, efficient irrigation strategies and sociotechnical approach and studies of agricultural water management as three major research areas.

AUTHOR CONTRIBUTIONS

PC wrote the first draft of the manuscript. AR, SG, and MC reviewed and edited the manuscript. All authors contributed to the article and approved the submitted version.

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