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Editorial

Excessive Water and Drainage Management in Agriculture: Disaster, Facilities Operation and Pollution Control

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Floods and waterlogging are among the main natural disasters affecting agriculture, causing land inundation or excess soil water during and after extreme rainfall events, which drastically affects crop productivity and food security. The crop environment is affected by excess water through the depletion of oxygen, leading to reduced root respiration and photosynthetic capacity [1], ultimately affecting the yield and quality of crops [2]. With the impact of global climate change in recent years, the frequency of extreme rainfall events and flood events have been increasing [3], causing further damage to agriculture. At the same time, and with contribution from human activities, the regional underlying surface conditions have impacted the hydrological cycle [4]. Farmland drainage, the natural or artificial removal of surface water and sub-surface water from an area with excess water, is an effective method for eliminating floods and waterlogging threats and maintaining favorable unsaturated conditions in the crop root zone. Large-scale agricultural drainage has been practiced in many parts of the world, including the US, northwestern Europe, and Asia [5]. However, this drainage contributes to the conveyance of non-point source pollutants such as nutrients, pesticides, and sediments into the surface receiving waters [6]. Excessive water is discharged, which will also increase the pressure on downstream flooding [7,8]. Recently, considerable attention has been paid to the promotion of drainage water management (DWM) or controlled drainage as a potential best-management practice (BMP) to reduce nutrient loads in drainage water while maintaining profitable crop production [9]. Excess water conditions in the soil can be managed with the use of DWM to provide adequate drainage during critical planting and harvesting operations [10]. In addition, the optimal operation of drainage facilities is also an effective management method to improve the working efficiency of drainage facilities and reduce the yield loss caused by waterlogging.

To mitigate floods and waterlogging threats, it is necessary to fully understand their occurrences and evolution and provide better scientific methods or measures to minimize disaster losses. In view of this, the main goal of this Special Issue was to publish original, high-quality research papers addressing recent research advances in excess water removal and drainage management in agriculture. Five research articles from Chinese authors were published in this Special Issue, covering the evaluation of different combined drainage practices, waterlogging modelling, the optimization of drainage facilities' management, the evaluation of the drainage water detention efficiency of off-line ditch-pond systems, and controlled drainage in the main ditch.

Low-lying agricultural areas have been increasingly vulnerable to flood inundation disasters because of the increased runoff associated with urbanization and climate change. The accurate modeling of the waterlogging process in irrigated districts is essential for planning drainage works. Xiong et al. [11] developed a waterlogging process simulation model for paddy fields by using an improved tank model and hydrodynamic model. The model considered the interrelated and constrained relationship between the drainage of paddy fields and the river water level, and precisely predicted drainage and water-depth changes. Liu et al. [12] in turn established an optimal operation model of drainage

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facilities (including drainage sluices, ditches, and pumping stations) by incorporating the hydrological model of waterlogging processes and crop yield loss-estimation modelling to minimize the sum of the losses caused by waterlogging and the energy cost of drainage facilities by scheduling the operation of each pumping station. The yield loss was calculated under the condition of an inconstant inundated depth by linear interpolation. An adaptive generic algorithm with a global optimization function was selected to solve the model. With the extreme rainfall events in the Gaoyou irrigation district, China, as the topic of study, an optimized scheme was compared with the local practice and the result showed that the sum of the rice yield losses and operating costs under the optimization was decreased by 33.8%.

Different types of drainage practices have different characteristics and applicability. Ren et al. [13] tested combined drainage practices and evaluated their performance by an indoor experiment and a mathematical method. Combined drainage practices include the combination of conventional subsurface drainage with an open ditch, filter drainage, conventional, and improved subsurface drainage, under an equal and unequal drain depth. The paper quantified the drainage effect of different drainage practices and pointed out that open-ditch and improved subsurface drainage combined with conventional subsurface drainage have significant advantages for flooding and waterlogging drainage. Shen et al. [14] proposed an off-line ditch-pond system to temporarily divert a portion of drainage water into a pond and reduced the impact of agricultural drainage on downstream areas. The authors evaluated the drainage water detention efficiency of the system by using peak flow reduction rate (PFR) and drainage volume detention rate (DVD). The results showed that the PFR and DVD of the off-line ditch-pond system were significantly affected by three parameters: the weir depth (L_d), weir width (L_w), and pond area-to-drainage area ratio (K_{sp}). Adjusting the L_d and L_w could increase the PFR and DVD by up to 80%. When such a system is designed with an appropriate diversion weir, the impact of agricultural drainage water on the downstream areas can be reduced remarkably.

Controlled drainage is now classified as a best-management practice for agricultural production in many regions of Europe and the United States. The paper by Tang et al. [15] evaluated the effect of different controlled drainage schemes in the main ditch on groundwater to provide a basis for water management in alternating drought and waterlogging zones. The results showed that the study area was dominated by drought stress. It was important to control the drainage during the dry season and drain the excess water in a timely manner during the rainy season. The authors suggested that the water depth in the main drain ditch should be regulated by the zoning and season to alleviate crop droughts and waterlogging.

To conclude, this Special Issue provides a valuable contribution to improving field drainage efficiency, modelling waterlogging processes, optimizing the operation of drainage facilities to reduce yield losses and operation costs, reducing the pressure of agricultural drainage on downstream areas and alleviating crop drought and waterlogging by adopting controlled drainage. We want to thank all the authors for their contributions to the Special Issue. We also appreciate the efforts of both the Water editors and the publication team at MDPI, as well as the many anonymous reviewers.

We believe that the content of the published papers will receive a great deal of attention by the wider scientific community, and at the same time, contribute to a better understanding of excess water removal and drainage management in eliminating the threat of floods and waterlogging and promoting crop growth.

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