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Saline intrusion in coastal aquifers: Influence of climate change on the design of subsurface drainage systems in arid/semi-arid regions

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There's a growing awareness today about the effect of climate change on the availability and quality of surface- and ground-water resources. In particular, the mitigation of saline water intrusion mechanisms (SWI) in coastal aquifers is currently a recurrent environmental issue.
According to the Intergovernmental Panel on Climate Change (IPCC) (2013), in year 2100 about 95% of the coastal areas in the world will be considerably affected by sea level rise (SLR), hence increasing the risk of inundation in internal land and salt water intrusion (SWI) in coastal aquifers.
In the case of the Nile delta, the combination between SLR and other perspective human-induced stressors, such as the next operation of the GERD (Grand Ethiopian Renaissance Dam), represents a threat to be taken into account, in order to guarantee resilient agricultural practices to the next possible scenarios.
Subsurface draining systems (SD) can contribute to mitigate the vulnerability to climate change and to the increased anthropic pressure insofar they are capable to receive the incremented flow according to the foreseen scenarios of SLR, subsidence and recharge.
In general, subsurface drainage offers a practical solution to the problem of upward artesian water movement and the simultaneous downward flow of excess irrigation water, for mitigating the salinization of the soil in the root zone. Thus, the design objective of the drains is to keep the water table within specified limits, determining a flow of water through the soil to the drains.
The drain size and spacing need to be properly calculated to make the drainage system able to discharge the excess of irrigation water as well as the upward groundwater flow. In practice, subsurface drains must be designed to withstand the necessary water flow, which permits to tie the water table to the required depth, for any foreseen working condition that may happen within the lifetime of the hydraulic structure.
This work introduces a rational design of SD systems in coastal aquifers, taking into account the increment of flow due to future possible conditions of SLR, recharge and subsidence within a time horizon of about 50 years, which is compatible with the expected lifespan of a buried drainage system.
Our proposed approach is characterised by the assessment of the incremental flow through the drains as a function of various possible future scenarios at different times. Our calculations show that the impact of the new foreseen conditions on the discharge into the subsurface drainage system is anything but negligible. Thus, foreseen climate-related scenarios deeply impact the design of such hydraulic structures. This is a fundamental aspect that needs consideration in the frame of the future water management strategies for safeguarding agricultural activities, especially in arid/semi-arid regions. Finally, it must be noted that this necessity has been substantially underestimated until today.