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Modelling the water-agricultural sector in Rosetta, Egypt: exploring the interaction between water and food

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An integrated System Dynamics Model for the Rosetta region, Egypt, assessing local water balance and agricultural yield to 2050, is presented. Fifty-seven simulations are analysed to better understand potential impacts on water and food security resulting from climate and social change and local/regional policy decisions related to the agricultural sector. Water limitation is a national issue: Egypt relies on the Nile for >95% of supply, and the flow of which is regulated by the Aswan High Dam. Egypt's share water of Aswan water is limited to 55 x 19 m3 yr-1. Any reduction in supply to the reservoir or increase in demand (e.g. from an expanding agricultural sector), has the potential to lead to a serious food and water supply situation.

Results show current water resource over-exploitation. The remaining suite of 56 simulations, divided into seven scenarios, also mostly show resource overexploitation. Only under significant increases to Nile flow volumes was the trend reversed. Despite this, by threading together multiple local policies to reduce demand and improve/maintain supply, water resource exploitation can be mitigated while allowing for agricultural development. By changing cropping patterns, it is possible to improve yield and revenue, while using up to 21% less water in 2050 when compared with today. The results are useful in highlighting pathways to improving future water resource availability. Many policies should be considered in parallel, introducing redundancy into the policy framework. We do not suggest actual policy measures; this was beyond the scope of the work.

This work highlights the utility of systems modelling of complex systems such as the water-food nexus, with the potential to extend the methodology to other studies and scales. In particular, the benefit of being able to easily modify and extend existing models in light of results from initial modelling efforts is cited. Analysis of initial results led to the hypothesis that by producing excess crop as a result of cropping pattern changes, international markets could be exploited, leading to further local improvements to the water balance, food yield and revenue. An extension 'module' was added onto the initial model which aimed to simulate this exploitation of international markets. Despite the promising results, any improvements would probably manifest after a number of years, have to be managed carefully, and would increase reliance on other countries, something that would need to be considered at the national level. It would also be prudent to implement such a policy in parallel with others aimed at mitigating potential future drought scenarios.

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