A dynamic model for salinity and sodicity management on agricultural lands: interactive simulation approach

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In this research, a dynamic simulation model, SAMIMI (**Sa**linity/Sodicity **M**anagement with an **I**nteractive **M**odel **I**nterface) is developed to simulate soil salinization and sodification to test the long-term impact of alternative agricultural water management practices on soil degradation and crop yields on farmlands. Soil salinity and sodicity are processes which pose threats to agricultural production and farmer livelihoods through soil degradation and crop yield reduction. The accumulation of salts may take place through natural processes and through human-induced practices which are mostly related to inappropriate irrigation applications. While irrigation facilitates the agricultural production, it may lead to soil salinization especially in semi-arid and arid regions. Irrigation water quantity, quality and irrigation method are crucial in management and control of salt related problems in farmlands which require knowledge and expertise crafted through appropriate experiments and models. Sub-surface hydraulic flow, solute transport, the accumulation of salt minerals, soil sodification and crop growth are interconnected dynamically complex processes. To better understand and analyze salt-related problems on farmlands, comprehensive numeric models are built to integrate these different dimensions as simultaneous dynamic processes. The characteristics and capabilities of available comprehensive models differ with respect to their specific purposes. Existing long-established models offer miscellaneous simulation abilities in high spatial and temporal resolutions, yet they may not be suitable for long-term simulations with seasonal variations and not appeal to large audience due to highly parametric interfaces. On the other hand, several models with user friendly interfaces may be less comprehensive for this problem or needs to be further improvement to be used as a management purposes. Therefore, among the available simulation models with similar purposes, our model/simulator contributes to the existing literature with both its holistic

perspective and its user-friendly, accessible on-line simulation platform. The SAMIMI model is capable of making fast simulations over long-term based on the computational convenience delivered by its simplistic structure. The SAMIMI consists of interacting modules of hydraulic model and solute model. The former simulates the sub-surface hydraulic flow in vertical soil compartments on daily basis while the latter represents the solute transport via only advection process. Yield response evaluates the end of crop yields and is received through incorporating the impacts of water and salt stress on the crop. The model implements the system dynamic method and the theoretical knowledge in soil physics, crop yield response to water and salt stresses and empirical and field data on environmental conditions and farmers' irrigation practice in a semi-arid agricultural basin of Turkey (Konya). The credibility of the model outputs is confirmed through direct and indirect structural tests as well as through two behavioral validation tests. The first behavioral validation test is performed against a long-established Hydrus 1-D model which is capable of simulating the water flow and solute transport model accurately especially in small spatial and temporal resolution. The second behavioral validation test is set to represent the conditions of soil-column experiments that were conducted as part of the SAMIMI (**Sa**linity/Sodicity **M**anagement **I**nterdisciplinary **M**ulti-**I**nstitutional Network) project, which bears the same name with the simulator. Over these various behavioral validation tests, the outputs of SAMIMI model are assessed and confirmed. Through the interface available on an online platform (ISEE Exchange Website) introduced in this research, the model offers capabilities for long-term simulations, appealing to not only the experts but to a large community of users to experiment on the impact of agricultural water management on soil quality and crop yields. The interface provides essential information about the problem, model structure and smoothly guides user to operate the simulator. Users can select among various options for environmental conditions and for irrigation water quality initially. Thereafter, they set parameters for seasonal decisions to specify crop type, irrigation amount and efficiency. Users can observe visual demonstrations for seasonal outputs for many parameters that are in concern. They can proceed for fifteen seasons through regarding the outputs and making new seasonal decisions. It is novel as an open-access simulator as it does not require much prior knowledge on soil salinity and sodicity. Users are expected learn about soil salinization, its relevance to soil degradation and crop yield loss while they decide on options to control this problem through simulation experiments. In that regard, the simulator is intended for use as a learning platform for soil conservation against salt-induced problems.

Link for simulator: https://exchange.iseesystems.com/public/mehmet-can-tunca/samimi-model-interface

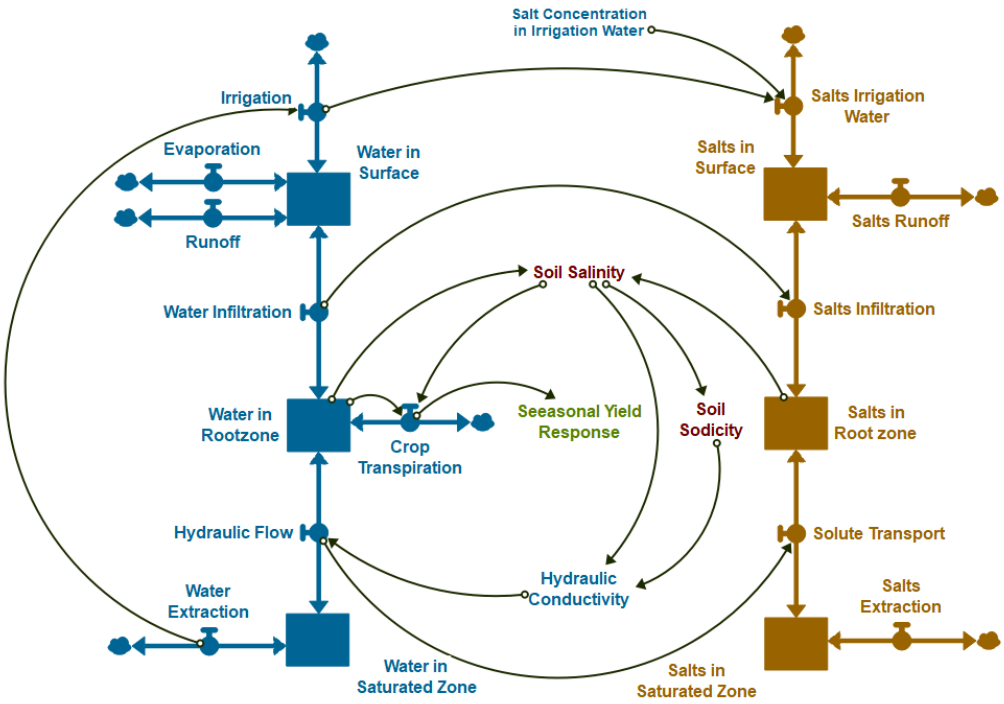

Figure 1: Simplified stock-flow structure of the model

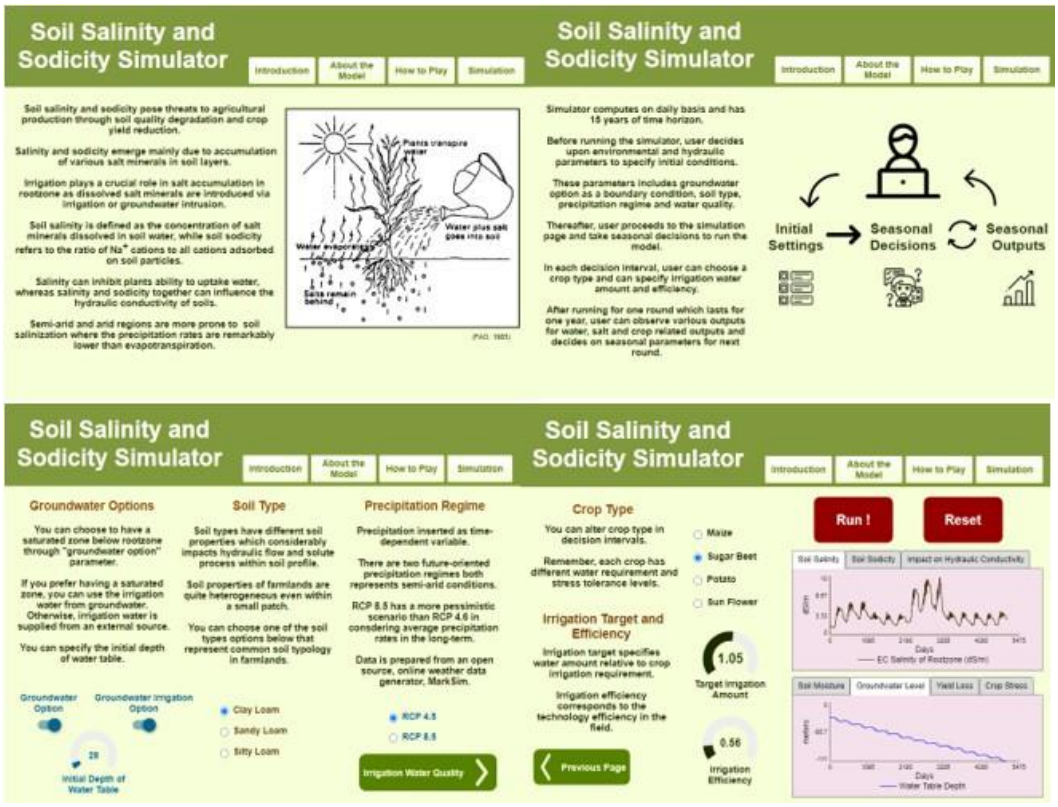

Figure 2: Model Interface

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