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The irrigation module

Aiming at a highly efficient but nonetheless sustainable agriculture in an arid region requires not only exploiting the potentials hidden in planning and operation procedures by advanced technologies but also incorporate the (somehow uncertain) impacts of climate change.

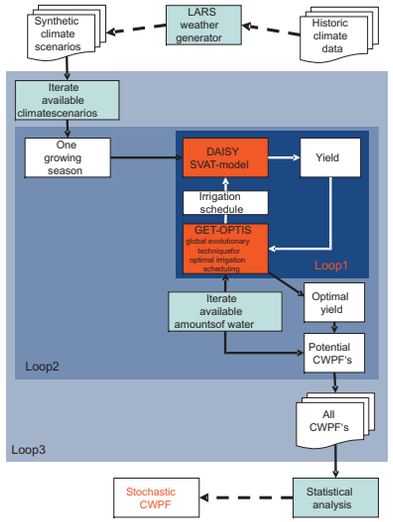


Fig. 3: The APPM irrigation planing tool

The irrigation module offers

- rigorous process models for reliable irrigation scenarios
- new tools for optimizing irrigation efficiency
- a quantification of the risk regarding the success of selected irrigation management scenarios under climate change
- analysis of saline water use for specific irrigation purposes
- customized Artificial Neural Networks for an easy application
- a weather generator for simulating regional impacts of climate change
- a new tailor-made evolutionary optimization algorithm for optimal irrigation scheduling with limited water supply
- process models for simulating water transport and crop growth.

A system of water distribution

The innovative technical system realizing the water allocation and distribution consists of a pipeline-system (water backbone) which connects different aquifer systems and water consumers. The back bone technology allows for a spatial and temporal compensation of the differences between the local water resources availability and the demands for water. This includes

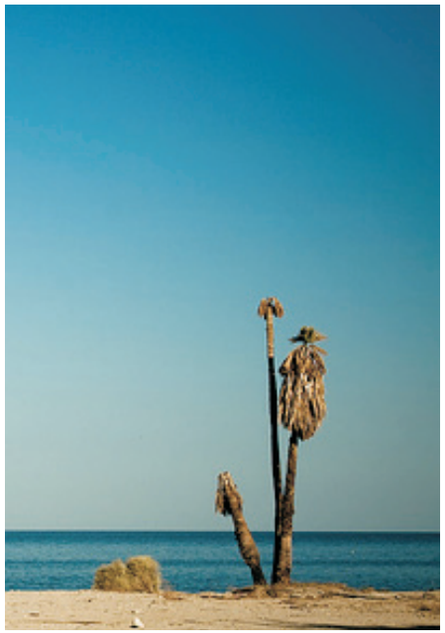
- the withdrawal of groundwater at the most suitable sites due to the actual groundwater situation
- the water delivered to the consumers is always of the most adequate quality
- the system additionally contributes to artificial recharge by reallocation of water resources

The design criteria for the technical system will be elaborated on the basis of expected future water yield and demands.

4 The APPM

The APPM software clearly shows the consequences of planning options and management decisions including the impact of climate change. The APPM incorporates three major steps:

- analysis and modeling of actual and future water resources availability and demands,
- estimation of optimal and sustainable agricultural management strategies,
- operative control of the technical systems of water allocation and distribution.



A new approach for improving water resources management in arid coastal areas

IHM Institute of Hydrology and Meteorology

1 Background

Within the frame of promoting scientific excellence, the German Ministry of Education and Research funds the research network IWAS (International Water Research Alliance Saxony).The research venture focuses on water management in arid regions incorporating the present view on expected climate change development.

In arid areas more than 80% of the limited water resources are used for irrigated agriculture. Convective rainfall storms which generate the well known flash floods are a major source of water resources which replenish the aquifers. As a result water resources are heterogeneously distributed in time and space.

Thus, the project envisages developing an innovative **water management and long-term planning tool**. It unites optimal solutions for water allocation, groundwater storage and withdrawal including saline water management with alternative, most beneficial irrigation strategies. This tool shall also provide options for evaluating the adequacy of proposed locations for additional groundwater recharge and flood protection systems. The optimal design of a problem orientated, modern water pipeline system (backbone) will open new horizons as regards optimal management for problem solving in the field of water resources. It will also be part of our project development.

2 The multidisciplinary research project

For ensuring a reliable basis as regards both optimal sustainable water resources management and long-term planning in a changing environment, the envisaged APPM (Assessment-, Prognoses-, Planning- and Management tool) integrates the complex interactions of the strongly nonlinear meteorological, hydrological and agricultural phenomena, taking into account at a later stage the socio-economic growth. The task demands a rethinking of current research strategies: Instead of straightforwardly applying currently available hydrological, hydrogeological, meteorological and socio-economic models and concepts we will design a fully customized tool which is based upon comprehensive problem specific process models and considers the nonlinear interactions and feedbacks between the different submodels. In the light of climate, land use and population change this actually represents a precondition for obtaining reliable information on benefits or losses with respect to selected planning and management scenarios.

In order to satisfy the contradictory requirements

- reliable but intricate process modeling
- consideration of the stochastic nature of meteorological data for realistically incorporating the impact of climate change
- sound rigorous multicriterial and multidimensional optimization
- straightforward operation without numerical inconvenience

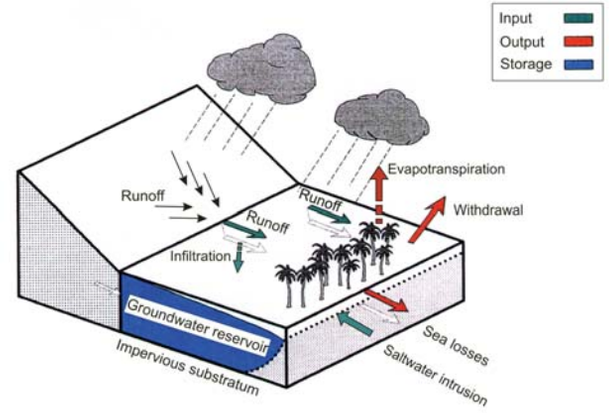


Fig. 1: Interacting hydrological processes in arid coastal regions

We adapt as another innovative feature hybrids of process models and artificial neural networks as well as other customized artificial intelligence tools for efficiently solving the complex optimization problems.

Apart from the meteorological and socio-economic regional analysis, the GIS-based APPM consists of three major hydrologic components:

- a water resources module for artificial groundwater recharge and management as well as flash flood modeling
- a module for irrigation control, scheduling and planning
- a technical system (water backbone) for water allocation and distribution.

3 Methodology

Water resources module

This module deals with the analysis and the assessment of the water resources availability. It forms the basis for evaluating the renewable water resources and saltwater intrusion phenomena as well as for managing the groundwater reservoirs in an optimal sense. Including climate change scenarios, results will yield a prognosis of the short and long term water availability. For this purpose, a meteorological regional model for estimating climate development on the basis of (the continuously improving) knowledge as regards global climate development (IPCC) will be established. As well, process models which consider the most relevant data uncertainties shall portray the relevant hydrologic surface and subsurface flow processes in the catchment in order to yield a reliable prognosis of the advantages/disadvantages of selected water resources development options. Furthermore, this module will also take care of assessing the efficiency of the artificial recharge schemes and their optimal operation (with respect to locations for underground water storage)

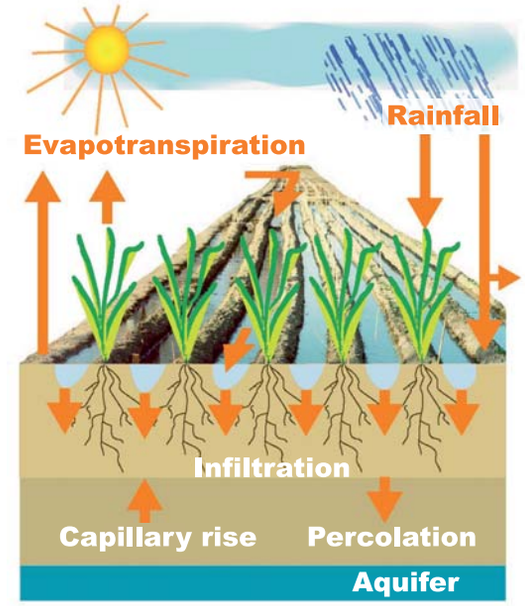


Fig. 2: Interacting processes in irrigation