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Incorporation of SVAT models and efficient optimization strategies into water resources management tools for improving crop water productivity from field to regional scale

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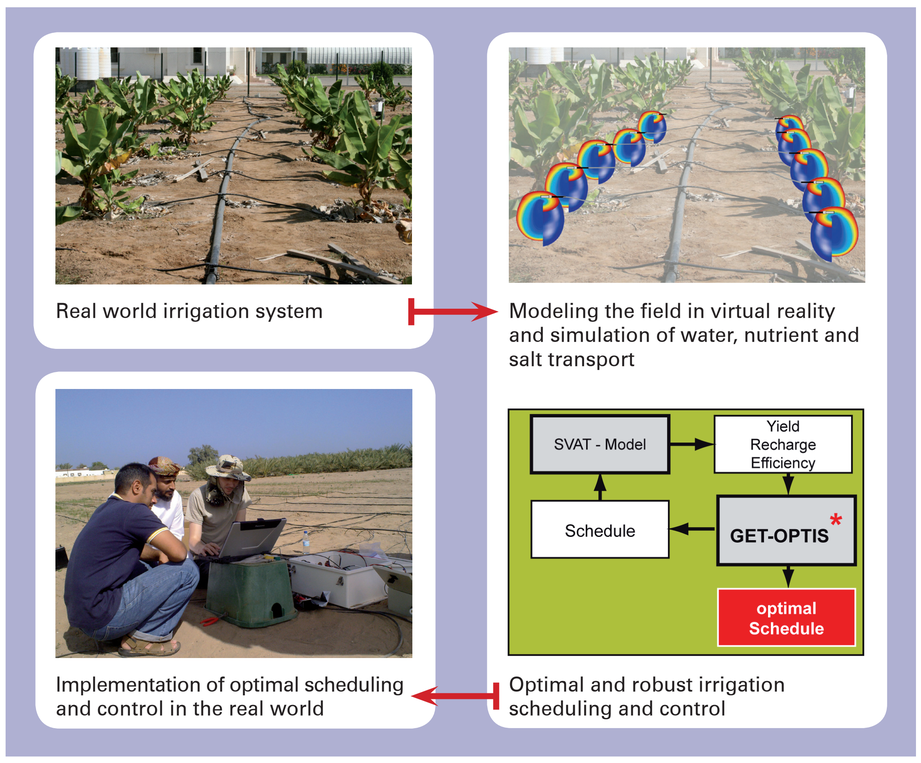


Simulation-optimization framework for optimal irrigation management

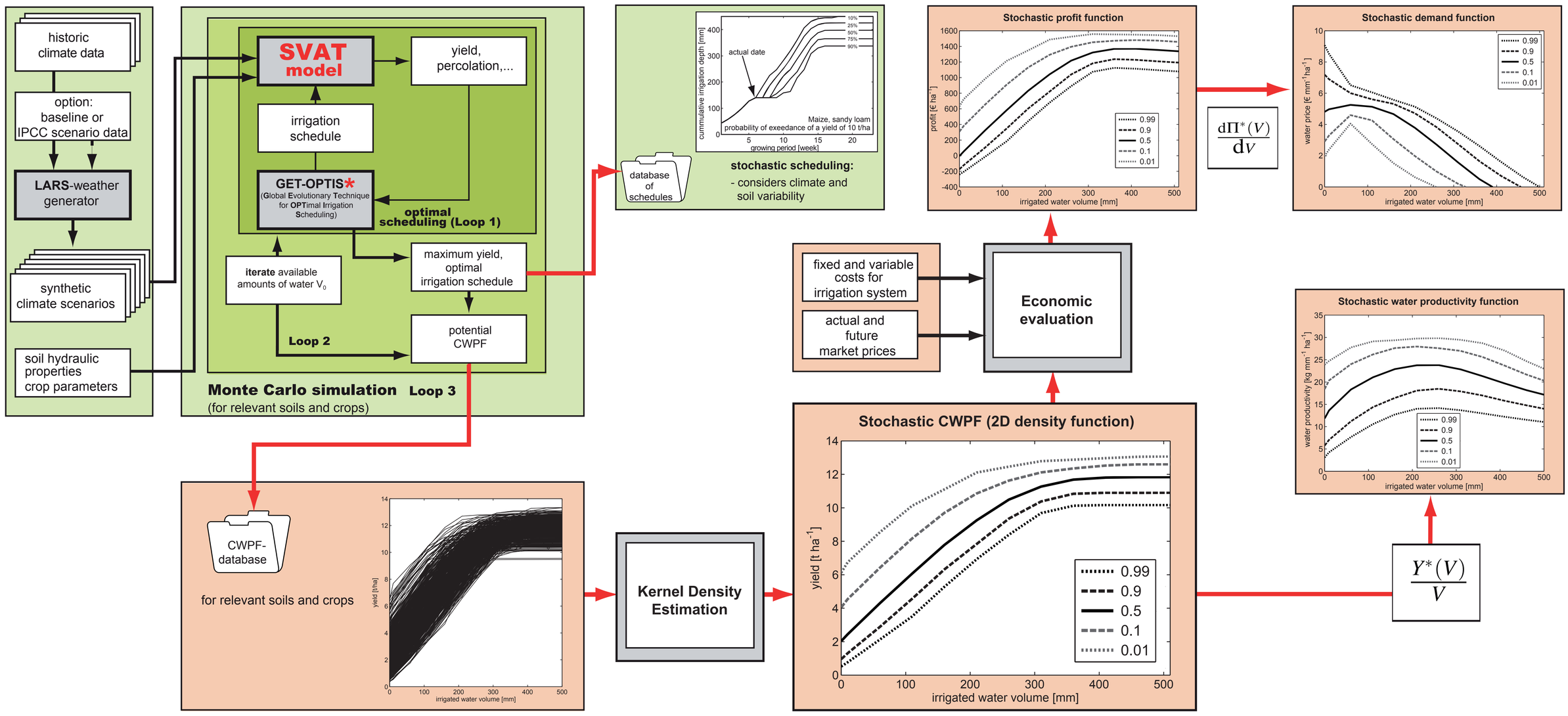
Introduction

Arid and semi-arid areas that are intensively used for agriculture, are facing water shortage which is often intensified by an overexploitation of existing water resources. Accordingly, they show an increased sensitivity to water stress and a high vulnerability that can only be reduced by highly efficient and foresighted water resource management practices.

Therefore, we introduce a stochastic framework for decision support for optimal planning and operation of water supply in irrigation. This consists of (i) a weather generator for simulating regional impacts of climate change on the basis of IPCC scenarios; (ii) a tailor-made evolutionary optimization algorithm for optimal irrigation scheduling with limited water supply; (iii) mechanistic Soil-Vegetation-Atmosphere Transfer (SVAT) models for simulating water transport and crop growth in a sound manner; and (iv) a kernel density estimator for estimating stochastic productivity, profit and demand functions by a nonparametric method.

As a result of several simulation-optimization runs within the framework, we present stochastic crop-water production functions (SCWPF) for different crops which can be used as a basic tool for assessing the impact of climate variability on the risk for the potential yield or, furthermore for generating maps of uncertainty of yield for specifc crops and specific agricultural areas.

Stochastic framework for the estimation of potential SCWPF and its derivatives



Conclusions

The proposed strategy for an application of SCWPF in water resources planning is to perform the majority of the computational effort during a first preparatory phase. On this basis it becomes possible to quickly access to potential yield or water demand data - including the corresponding probabilities – and to combine it with spatial information in a GIS.

Thus, an appropriate database of SCWPF's can help to evaluate and assess management, mitigation and adaption measures for ensuring food security through an analysis of multiple irrigation sites in a considered basin.

If the user is only interested in a specific quantile a recent developed stack ordering procedure yields considerable computational savings by identifying critical solutions in the course of the overlying optimization process (Schütze et al. 2011b).

At present, interfaces to APSIM, DSSAT and DAISY SVAT models as well as the FAO-33 yield response model are implemented (Schütze et al. 2011a).

References

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