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Evaluating potentials and corresponding risks of deficit irrigation systems: comparison of two stochastic optimization strategies

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In this contribution, 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) a mechanistic model 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 Monte Carlo 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 specific crops and specific agricultural areas. In addition, we applied a stack-ordering technique instead of the comprehensive Monte Carlo simulation for generating SCWPFs, which are based on a statistically appropriate sample size and a reliable optimal management. In comparison to an always exhaustive evaluation of the realizations in the case of the Monte Carlo set the stack-ordering procedure yields considerable computational savings by identifying critical solutions which define the user chosen reliability quantile in the course of the overlying optimization process.