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Watershed Management Decisions in Semi-Arid Regions by Considering the Uncertainty in Simulations

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Watershed based hydrological models are increasingly being used for the planning of watershed management practices. One such application of watershed based hydrological model is the sizing of the check dams for water conservation in the watershed. The water conservation would aid in improving the soil moisture availability for the crops during the growing period. The sizing of check dams is achieved through a simulation-optimization framework, such that enough water is stored to mitigate the water stress during the crop growth while maintaining sufficient flows to downstream reaches. The simulator in the simulation-optimization framework is a hydrological model and optimizer is AMALGAM algorithm. Generally, in developing countries watershed management is practiced in an ungauged catchment, thus, calibrating the hydrological model is a challenging task in the absence of data. In practice, uncalibrated hydrological models are used in a deterministic way, by ignoring the uncertainty associated with the model simulation output. Various studies have indicated the importance of considering the uncertainty in model simulation output, as in some cases certainty of the desired outcome may be the deciding factor. However, most of the studies have focused only on the uncertainty in the model simulation output and construction of the prediction band, which may not aid the decision maker. This study considered the parametric uncertainty in the hydrological model and its consequent impact on the check dam sizing. Monte Carlo simulations were performed for the hydrological model by forcing the parameter sets, which were randomly sampled using LHS method. From the ensemble of simulations, 5 parameter sets were selected to analyze the impact of parameters on the check dam sizing. The check dams are sized using optimization algorithm AMALGAM for the conflicting objective functions of increasing in-situ soil moisture and minimizing the affect on downstream reaches and structures. The pareto-optimal fronts obtained from the optimization showed significant variability. The wet and dry spell lengths, which are essential for the crop growth, showed very little variability across the parameter sets. The results of the analysis suggest the simulation uncertainty has a significant impact on the final decisions. Further studies needs to be conducted for the impacts on the check dam sizing due to other sources of uncertainty.