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Resilience, reliability and risk analyses of maize, sorghum and sunflower in rain-fed systems using a soil moisture modeling approach

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ABSTRACT
This paper is aimed at examining the applicability of methods for resilience, reliability and risk analyses of rain-fed agricultural systems from modeled continuous soil moisture availability in rain-fed crop lands. The methodology involves integration of soil and climatic data in a simple soil moisture accounting model to assess soil moisture availability, and a risk used as indicator of sustainability of rain-fed agricultural systems. It is also attempted to demonstrate the role of soil moisture modeling in risk analysis and agricultural water management in a semi-arid region in Limpopo Basin where rain-fed agriculture is practiced. For this purpose, a daily-time step soil moisture accounting model is employed to simulate daily soil moisture, evaporation, surface runoff, and deep percolation using 40 years (1961-2000) of agroclimatic data, and cropping cycle data of maize, sorghum and sunflower. Using a sustainability criterion on crop water requirement and soil moisture availability, we determined resilience, risk and reliability as a quantitative measure of sustainability of rain-fed agriculture of these three crops. These soil moisture simulations and the sustainability criteria revealed further confirmation of the relative sensitivity to drought of these crops. Generally it is found that the risk of failure is relatively low for sorghum and relatively high for maize and sunflower in the two sites with some differences of severity of failure owing to the slightly different agroclimatic settings.

KEYWORDS
Resilience; Reliability; Risk Analysis: Agricultural Drought Index; Rain-Fed Agriculture; Soil Moisture Modeling; Limpopo Basin

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