Modelling the Impact of El Niño-Related Drought on Smallholder Farmers in Central Sulawesi, Indonesia: An Interdisciplinary Approach Combining Climatic and Hydrologic Modelling with Regression Analysis and Linear Programming

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Abstract

Crop production in the tropics is subject to considerable climate variability caused by the El Niño-Southern Oscillation (ENSO) phenomenon. In Southeast Asia, El Niño causes comparatively dry conditions leading to substantial declines of crop yields with severe consequences for the welfare of local farm households. Using a modelling approach that combines regression analysis with linear programming and integrates climatic and hydrologic modelling results, the objective of this paper is to assess the impact of El Niño on agricultural incomes of smallholder farmers in Central Sulawesi, Indonesia, and to identify suitable crop management strategies to mitigate the income depressions. The results contribute to the formulation of enhanced development policies and provide guidance for future research activities.

Based on resource endowment and location within the mountainous research area, we identified five classes of smallholder farms by cluster analysis. Our linear programming model maximised their cash balance at the end of the six-month period most severely affected by El Niño. Main activities were the cultivation of rice, maize, and cocoa, for which external Cobb-Douglas production functions were estimated that include water supply as an input factor; they generate output according to level of production intensity as well as predicted weather patterns.

The results illustrate that, even within a relatively small geographic area, advisable crop management strategies diverge between different types of farm households during El Niño events, depending on the micro-climatic and hydrologic characteristics of their location, the farming system, and resource endowment. Hence, related recommendations and policy measures need to be carefully tailored according to these factors if they are to be effective and economically efficient.

Keywords: El Niño, Indonesia, interdisciplinary modelling, linear programming, risk management