# Rainfall Patterns in Mozambique and Relationships to Income Change for Rural Subsistence Farmers

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As societies dependent on rain-fed agriculture are highly vulnerable to weather extremes, linkages between rainfall variability and economic well-being merit close attention. Since 2011, I have been working with Dr. Julie Silva (University of Maryland) to explore how rainfall variability and extreme rainfall events may be related to changes in income for rural subsistence farmers across Mozambique.

To date, we have characterized the rainfall patterns that occurred between two national surveys of socio-economic data. The National Agricultural Survey of Mozambique was conducted in 2002 and 2005 by the Mozambican Ministry of Agriculture and Rural Development and USAID. We extracted data for 3,859 households in 536 villages. We utilized rainfall estimates detected by satellites to develop monthly rainfall climatology and determined the percentage of normal rainfall received at each village in each study month of the growing season. We also calculated rainfall received at each village from two landfalling tropical cyclones. These rainfall totals plus the percentage of normal rainfall received in each month were analyzed to establish nine rainfall zones across the country. Rainfall was below normal overall in all three growing seasons.

To measure economic well-being, we calculated the change in income from 2002 to 2005 for each household. We found that more than 30% of villages experienced income declines over this 3-year period. We further explored linkages between rainfall patterns and change in income by developing a regression model to predict annual household per capita change in agricultural crop income as rain-fed agriculture is extremely vulnerable to high rainfall variability in the region. We discovered that variables measuring agricultural characteristics and regional rainfall patterns were significant, while none of the demographic variables were significant in the model.
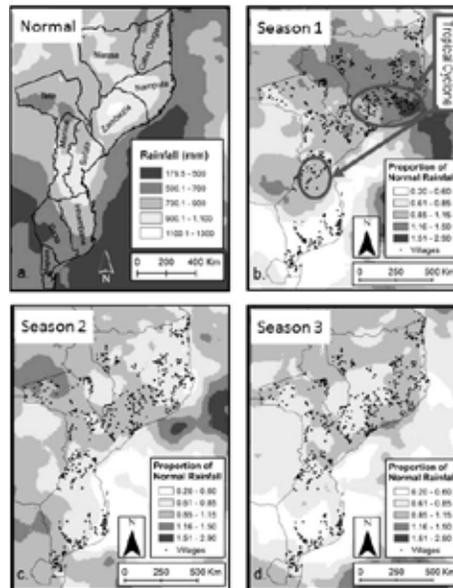
Regions experiencing the least variability in rainfall and fewest extreme rainfall events were characterized by better economic performance in agricultural crop income, after controlling for other predictors in the model.

Households affected by Cyclone Delfina in January 2003 exhibited the worst economic performance, indicating that heavy rainfall from some tropical cyclones can have long-lasting negative effects on income. Rainfall from Cyclone Japhet in March 2003 may have benefitted crops in an area that was previously experiencing drought as many households experienced increases in income. Households experiencing high rainfall totals from events other than tropical cyclones fared poorly relative to those that did not receive these heavy rains. The southern portion of the country experienced rainfall deficits in many months. In some locations, these deficits were interlaced with above-normal rainfall thereby increasing the month-to-month variability.

Various factors, including social, political, and historical elements, influence changes in household economic well-being. However, our research indicates that high rainfall variability and abnormally high or low rainfall amounts exhibit a stronger association with declining incomes than do demographic variables that are not associated with the weather, such as being a female-headed household.

We have published two papers with a third in the planning stages. Our first paper appeared in *Natural Hazards* and the second has been accepted by *Weather, Climate, and Society*. Although Drs. Silva and I hold separate CAREER awards from the National Science Foundation to examine rural development in southern Africa (Silva) and tropical cyclone rainfall in the U.S. (Matyas), our collaborative work examining rainfall and socio-economic outcomes in Mozambique is self-funded.

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