RICE AT RISK: HOW CLIMATE AND SOIL CONDITIONS IMPACT FOOD SECURITY IN WEST AFRICA

Introduction
Global climate change has had a myriad of negative impacts on traditional agriculture systems by exacerbating conditions in various agro-ecological zones, a phenomenon that often affects soil conditions, rainfall patterns and crop production. This project uses GIS to analyze risk of rice crop failure in West Africa through the analysis of several key environmental factors that stem from global climate change and contribute to declining yields in rain-fed rice production: precipitation variability, soil nutrient deficiency and aluminum contamination. These ecological constraints impact cultivation in nations with long cultural traditions of rice consumption. Paradoxically, nations with such rich histories in rice production have become net rice importers. This analysis demonstrates how the countries that are the most severely impacted by rice crop failure are the most reliant on the international rice market.

Area of Interest

Background
The cultivation and consumption of rice has been an essential component of West African cultures for the last 3000 years. The region has a history of heavy rainfall and low lying floodplains conducive to rice agriculture. Over thousands of years the crop has assumed a sacred quality; it is deeply entrenched in West African economic, social and religious life. In the 15th century, European colonial policies in the region mandated the shift in the role of rice from a food crop for local subsistence to a cash crop for European consumption (1). In the wake of Western economic imperialism, an area that was historically defined by rice production has seen a rise in urbanization and a decline in rural development. The shift to a cash economy has compromised the food sovereignty of West African nations; over the last 50 years, the region became increasingly dependent on the global market for rice imports (2). Though West Africa has high potential for rice cultivation, yields are consistently lower than those of the world’s leading rice production regions in Southeast Asia. High marketing and production costs, coupled with low productivity, prevent local rice farmers from competing with global market prices. In 2008, this situation was exacerbated by the global economic crisis, when world food prices tripled. As consumer purchasing power declined, so did retailer profits. As a result, food insecurity in urban areas increased (3). Governments have reacted to this crisis by lowering taxes on imports and supporting domestic production through investments in agriculture. However, growth in rice production remains lower than local demand. Even now, West Africa only produces enough rice to account for 60% of its consumption needs (3).

Methods

First, raster data for rain-fed rice production, annual variation in rainfall, aluminum toxicity and low nutrient capital reserves was downloaded, projected to Africa Albers Equal Area Conic and clipped to the West Africa study area. Each raster layer was re-classified to a 5-class scheme that ranks the prevalence of each factor: low, medium, high, very high and toxic. The weights and units of each raster factor are as follows:

Rain-fed rice production is given the highest weight as it is the cornerstone of the analysis. Rainfall is weighted twice as high as the soil components because it has the largest impact on rain-fed rice yields.

Limitations
Due to constraints on data availability, this project only examines 3 ecological factors impacting rain-fed rice yields. Other important spatial components to consider include: plant diseases, major pests, population pressure, and weed control. Also, the resolution of rainfall variability is not to the same scale as the other factors due to the source of the raster data. Lastly, in the interest of obtaining full data sets, economic and population statistics are only as recent as 2013.

Results

The final map shows areas of West Africa with varying degrees of risk of rain-fed crop failure. Much of the area classified as moderate or high risk lies within the boundaries of West African countries with relatively high rice imports per capita. This spatial relationship shows how such economic hardship is exacerbated by climate conditions (soil contamination, low nutrient-retention and unpredictable rainfall patterns). Progress towards regional self-sufficiency is contingent on prioritizing sustainable rural development and implementing policies that help farmers face the agricultural challenges posed by global climate change. By improving the resiliency of domestic, rain-fed rice agriculture, West African nations can reduce economic dependency on the volatile global food market and increase regional food security.

Analysis Factors

Risk of Rain-Fed Rice Crop Failure

Rain-Fed Rice Production

Low Nutrient Capital Reserves

Variation in Long-Term Annual Rainfall

Aluminum Toxicity

Risk Severity

Low

Medium

High

Very High

Area of Study

200 500 1,000 Miles

Reference:


Growling Potential: Rain-Fed Rice

Upland rain-fed rice cultivation is the most extensive rice farming system in Africa, and is a key component of West African rice production (2). However, rain-fed rice systems are especially vulnerable to climate threats. Three ecological factors that greatly impact rice yields are examined in this analysis:

Rainfed: precipitation is the only source of water for rain-fed rice, therefore high variation in rainfall can have a dramatic effect on yields.

Nutrient Capital: soils in rain-fed rice ecosystems are highly weathered with low nutrient-retention capacity—usually poor in nitrogen, phosphorus and sulfur.

Aluminum Toxicity: soil contaminated with aluminum can be toxic to crops, causing plant nutrient deficiency by fixing with phosphates in acidic soils.

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