

Impacts of Climatic Change on the Arid Savanna Fire Regimes of West Africa

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Introduction: Changing global conditions may be driving increasingly severe fires that are further deteriorating already highly altered arid savanna ecosystems in West Africa. With the continued rise in anthropogenic fires, vulnerable ecosystems have undergone changes in species dominance, ecosystem structure, and even ecosystem collapse. I hypothesize that altered climatic variables are at least partially responsible for increases in fire severity that degrade the West African arid savanna.

Background: Arid savannas, dry grasslands with scattered shrubs and drought-resistant trees, are regarded as one of the ecosystems most likely to be affected by climate change (Louppe et al 1995). Though arid savannas require periodic surface fires to maintain their characteristic vegetation, increasingly severe fires have resulted in the annual degradation of more than 200,000 hectares of sub-Saharan arid savanna (Nsiah-Gyabaah 1994).

In the past, these losses were attributed either to unsustainable agricultural practices, or the belief that the Sahara was in a period of growth as part of the Earth's axial obliquity cycle. Today we accept the sophistication of West African land management techniques, and there is evidence that the Sahara is actually in a greening period (Nsiah-Gyabaah 1994). Many suspect that the increase in land degradation is the result of climate change driving fire intensity and frequency increases. The consequences of altered fire regimes are clear, but West African fire regimes are themselves poorly understood.

I became interested in studying fire-influenced land degradation when, during a Watson Fellowship studying fire, I returned to my childhood home in Ba'Nso, Cameroon. Throughout the region, I encountered Fulani herdsman who had relocated to find better pastureland. The Francophone farmers I met described barren fields, complaining that no amount of burning restored the land's fertility.

Objectives: The study I propose is designed to investigate the impact of altered climatic conditions on fire-induced land degradation, producing some of the first quantitative research on fire regimes in West Africa. Fire regimes have been defined using characteristics such as frequency, intensity, burning season, and fire size (Goldammer 1988). I will study these physical parameters in West African arid savannas in order to determine if there is a relationship between altered climatic variables and fire severity, and what the impact is on land degradation. After conducting field research in the Ghanaian Accra plains, I will analyze remote sensing data to determine the change at longer timescales.

Methodology: Working with Dr. Kwesi Orgle and Forest Resources Management, I will conduct field research on the arid savanna in the Accra Plains on fire plots maintained by the University of Ghana (Swaine 1992). We will analyze three study plots: a control in which fire has been excluded since 1957, another which has been burned annually since 1957, and a plot of extant vegetation which we will burn annually beginning in 2007 and for a subsequent two years. Our research team, including traditional landowners, will collect annual data on fires in study plots, measuring consumption of plant biomass, fire extent, and intensity with thermocouples. We will document plant species turnover, the

relative proportions of vegetation repopulation, and evaluate changes in rates of land degradation through a comparison with data collected since 1957.

To identify change over a longer timescale, I will conduct an analysis of NOAA-AVHRR satellite image data captured for West Africa between 1985 and 2005. These previously processed data will be compared to monthly temperature and precipitation datasets by the University of East Anglia's Climate Research Unit to determine what, if any, relationship exists between changes in numbers of fires, timing, and area burned, and altered precipitation and temperature. Dr. Johann Goldammer, head of the UN-FAO Team of Specialists on Forest Fire has agreed to collaborate with me on this analysis. We'll use these data to inform a broader scale analysis, using severity indexes and NDVI trends to discern any relationship between changing fire severity and land degradation.

Anticipated Results: Climate change may be the dominant influence on the surge in fire-influenced land degradation in West Africa, but the current paucity of quantitative data on fire in this region makes it difficult to understand the relationship between fire and climate. My research will provide the first quantitative measurements of fire regime characteristics, identifying fire frequency, size, and intensity thresholds above which ignitions may result in land degradation. Furthermore, it will explore the possibility of interactions between individual fire regime characteristics. I anticipate my research being able to conclude whether fire-influenced land degradation is caused by climate change.

Broader Impacts: This original project will provide critical information on fire regimes and offer insight into the extent to which climatic change is altering fire regimes in West Africa, constituting some of the first quantitative research on basic fire regime parameters in the West African arid savanna. Future researchers will utilize my data in their studies.

Traditional landowners, such as the subsistence farmers in Ba'Nso and the Fulani nomadic herders whose livelihoods are tied up in the complex relationships linking fire and land arability, have a vital interest in this research. We will engage key stakeholders as research collaborators and make all literature available in English, French, and Fulbe.

Regionally, this project will provide resource managers with ground-truthed data linking fire and climatic change. These data will assist them in formulating management plans and help them anticipate future changes in fire behavior from climate change.

Implications of this research stretch beyond Africa to other arid rangelands where fires might be increasing in incidence or severity. My study may help scientists and land managers identify vulnerable areas in other parts of the world. My partnership with The Nature Conservancy and other organizations will make my results widely available.

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