FIRE DISTRIBUTION IN NORTHWESTERN BOTSWANA: CROSS-COMPARISON OF MODIS FIRE PRODUCTS, LANDSAT ETM, AND POPULATION DENSITY

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1. PURPOSE OF STUDY

Ngamiland District in northwestern Botswana is home to internationally recognized environmental and cultural systems that both impact and are impacted by disturbance regimes including fire, flooding, and grazing. Though recognized as critical for ecosystem function and indigenous livelihoods, fire is nonetheless cited by both researchers and local resource managers as one of the least understood components of this savanna-wetland system. Typically, fires are thought to be natural: either surface (lightning strike) or peat (combustion) in origin; however, interview data suggest a wider application of anthropogenic (purposive and accidental) fire in the area to support local livelihood production as well as tourism, the largest employment industry in the country. This paper compares MODIS-detected active fire products with both land use management zones and recent census-based population densities to understand the spatial and potentially causal connections in this human-impacted ecosystem.

2. SITE AND SITUATION

Ngamiland District is located in northwest Botswana, bordering Namibia in the north (Caprivi Strip) and in the west. Ngamiland notably includes the Ramsar-listed Okavango Delta and World Heritage Site Tsodilo Hills. The area rests within the Kgalagadi (Kalahari) Desert (actually a semi-desert) with spatially and temporally variable precipitation ranging in the study area from 450mm in the south to 560mm in the north. The Okavango Delta is not a true delta, but an [inland] alluvial fan; it covers roughly one-third of Ngamiland. As such, a disparate set of land covers are found in the area, including permanent swamps, riparian woodlands, seasonal floodplains, grasslands, and savanna/woodlands with varying densities of both shrubby and woody species (primarily *Acacia spp.* and *Colophospermum mopane*). The juxtaposition of wetland and savanna environments contain high levels of biodiversity, supporting 1304 plant, 71 fish, 33 amphibian, 64 reptile, 444 avian, and 122 mammal species including threatened and endangered species such as wild dog, elephant, leopard, cheetah, rhinoceros, wattled crane, and Nile crocodiles among others [6].

3. DATA AND METHODOLOGY

3.1 Population, Land Management, and Precipitation Data

The Central Statistic Office of Botswana conducted a complete (100%) Population Census in 1981, 1991, and 2001 that covered all towns, villages, settlements, remote lodges, and cattle posts. Here, the 2001 census was interpolated and gridded to establish human population density for the entire Ngamiland District for comparison with fire data from late 2001 through 2003. Land use management zones were established prior to this census and were also used in comparison since burning has anecdotally been linked to use away from actual residences. Land use management zones in the area include as follows: 1) national park (located on state land and managed by the Ministry of Environment and Tourism, or MET), 2) game reserve (located on tribal land and managed by MET), 3) Wildlife Management Areas (WMAs) (designated as either hunting or photographic tourism, are tribal lands and managed by the Tawana Land Board or TLB who awards concessions to companies or communities), and 4) "other" tribal lands (also managed by TLB, and includes usages such as crop and livestock agriculture settlements). Notably, a significant amount of the area is declared as a Ramsar site for the Okavango

Delta, which while still tribal land falls under management of tribal authorities as well but is technically subject to tighter environmental regulations. Lastly, monthly precipitation data were available throughout the time series in the southern portion of the district (Maun) and northern portion of the district (Shakawe).

3.2 Fire Products and Processing

Fire data were acquired from the MODIS Rapid Response System, (the MODIS Active Fire Product) from FIRMS (Fire Information for Resource Management System) [3, 4]. Reliable active fire data became available commencing in November 2000 up to the present, and utilize the MOD14 fire and thermal anomalies algorithm [1]. Minimum fire size detection has been reported to range from a conservative 100m2 to 50m2 from 50% to nearly 100% of the time, pending fire temperature (related to fuel load and winds), atmospheric conditions, sun glint, and spurious landscape components [4]. The micro-scale spatial heterogeneity of the landscape and field-investigated burn scars and active fires suggests that the relatively cool fires in the area may be too fragmented to necessarily be reliably detectable. As such, this work takes a two pronged approach to fire assessment. First, MODIS fire data for the southeastern portion of Ngamiland District are compared to a Landsat TM/ETM+ time series of approximately 15 images acquired through the MODIS fire data record period. Previous remote sensing and field-based work extracted burn scars throughout multiple seasons in each year of the study period with the Landsat spatial scale of 30m [2, 5]. These data were compared with the spatially coarser MODIS-based products to determine the rate of misclassification of MODIS for smaller burns. Second, this information was used to calibrate the interpretation of the spatial and statistical comparison of MODIS fire products throughout the entire district to human population density and land use management zones.

4. EXPECTED RESULTS AND IMPLICATIONS

This work will contribute both methodologically and to natural resource management in the area. Testing higher-resolution Landsat products and field-based knowledge against the coarse-resolution MODIS-derived products will provide additional testing for the sensitivity of these products to smaller, cooler, and patchier fires in a fire-prone landscape. Ecologically, this work will assist in establishing spatial and potentially causal connections to fire origin. As such, it will provide assistance as a monitoring and surveillance tool for effective natural resource management. Given the ecological importance of fire in maintaining savanna systems and the role it plays in shaping and being shaped by local livelihood production, the increasing population density in Ngamiland District and that district's relationship to management and fire remains a vital component of understanding this complex social-ecological system.

5. REFERENCES

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