Do community-conserved areas in Tanzania achieve conservation goals?

Addressing the challenges of impact evaluation using matching methods and hyper-temporal satellite imagery

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Tanzania's Wildlife Management Areas

Wildlife Management Areas (WMAs), community-managed zones outside of core PAs, were implemented to balance the competing needs of Tanzania's valuable large mammals and poor, rural communities[1] (fig. 1).

In return for curtailed settlement and activities (e.g. agriculture/livestock grazing/hunting) **villages within WMAS receive user-rights to wildlife**, in theory providing an **incentive for sustainable natural resource management** and reduced pressure on wildlife[2].

With 3% of Tanzania's total land area currently under WMA protection and a further 4% undergoing registration[3] **WMAs represent a major conservation initiative**, but their **ecological effects are poorly understood**, partly due to a paucity of baseline data.

Aim

Undertake the first, initiative-wide environmental impact evaluation of WMAs, drawing on open access satellite imagery to assess the effect of gazettement on habitat degradation.

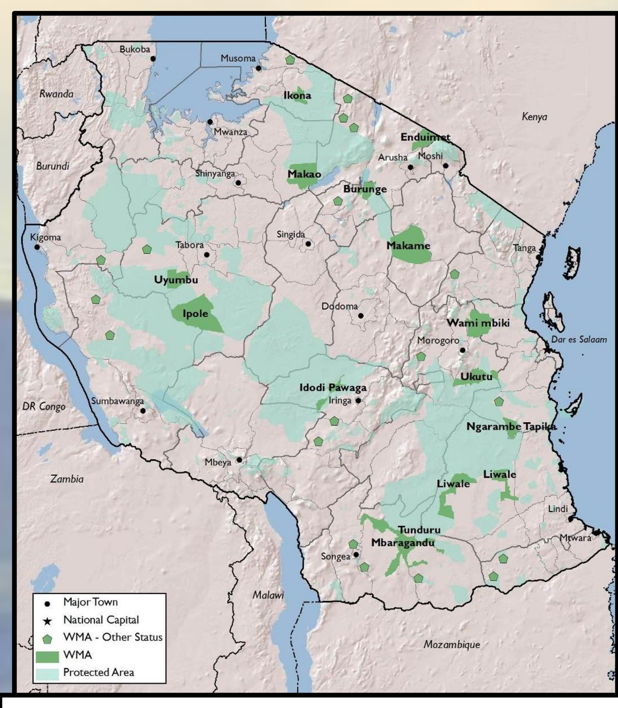

Figure 1: WMAs and PAs of Tanzania

Preliminary work

Preliminary analyses indicate that **WMAs are located in areas predisposed to lower land conversion pressure** (problem 1)[4].

In addition, results suggest that the **effect of WMAs on degradation may be small relative to high background variation**, such that **traditional evaluation methods which draw conclusions from short time-series would produce misleading results** (problem 2)[4].

Problem (1): Establishing a credible counterfactual for comparison

Rigorous measurements of counterfactual scenarios are essential to be able to establish causal links between participation and outcomes, but are often lacking[5].

PA assessments in particular fail to account for a strong source of bias: non-random location[6]: **PA networks tend to be geographically biased towards areas which are less attractive to humans for settlement or agriculture** and thus experience lower land conversion pressure[7].

Our solution (1): Matching methods

We will isolate the causal impact of WMAs on habitat degradation from other factors affecting participation and outcomes by statistically **matching WMA lands with a subset of unprotected areas in Tanzania**, according to environmental, physical and anthropogenic **characteristics which account for biases** in WMA placement and degree of land pressure[8] (fig. 2).

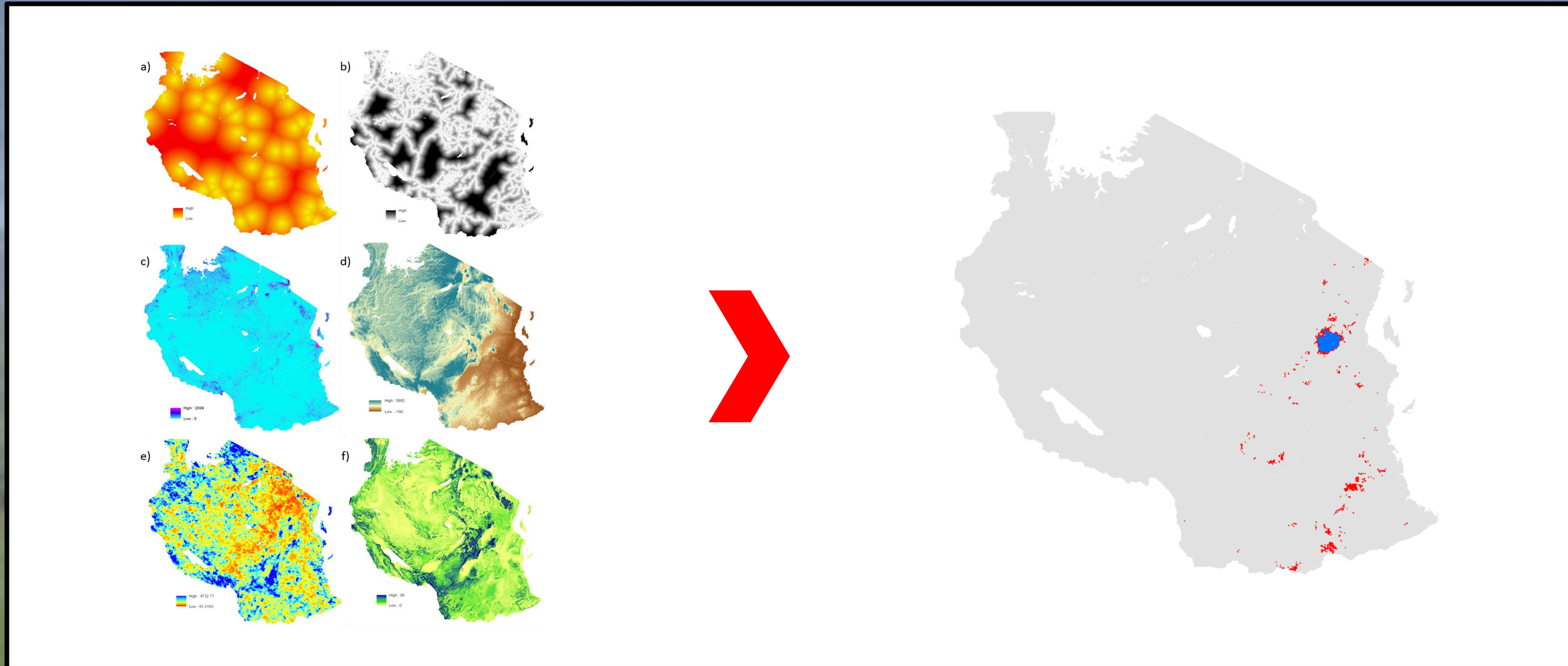

Figure 2: We match WMAs with unprotected lands according to characteristics which account for biases in their placement, such as elevation and population density (left), to produce a pool of control units (right; red) for outcomes comparison (here Wami-Mbiki WMA, blue).

Problem (2): Assessing fine-scale degradation in a stochastic, dryland environment

In East African drylands vegetation fluctuates widely according to irregular variation in natural factors, predominantly rainfall[9].

Methods for detection of **absolute conversion** of land based on **short time-series** are commonplace (e.g. to detect large-scale deforestation for agriculture), but **techniques for identification of finer habitat degradation, often masked by such natural stochasticity, remain elusive**[10].

In these environments traditional methods may overlook degradation or produce misleading results, as **observed change likely reflects background variation, not anthropogenic disturbance**[11,12].

Our solution (2): Hyper-temporal satellite imagery

The advent of **hyper-temporal satellite imagery**, observations of the same area at **regular, short intervals**, such as those captured by the MODIS sensor, present the opportunity for sophisticated **trend analysis of continuous, noisy data**[13].

We will make use of these full-resolution time-series to fit models to **a continuous, wildlife-relevant habitat attribute, productivity** (fig. 3). Combined with matching this rigorous approach allows us to **tease out the effect of WMAs on habitat trends from noisy, background factors**.

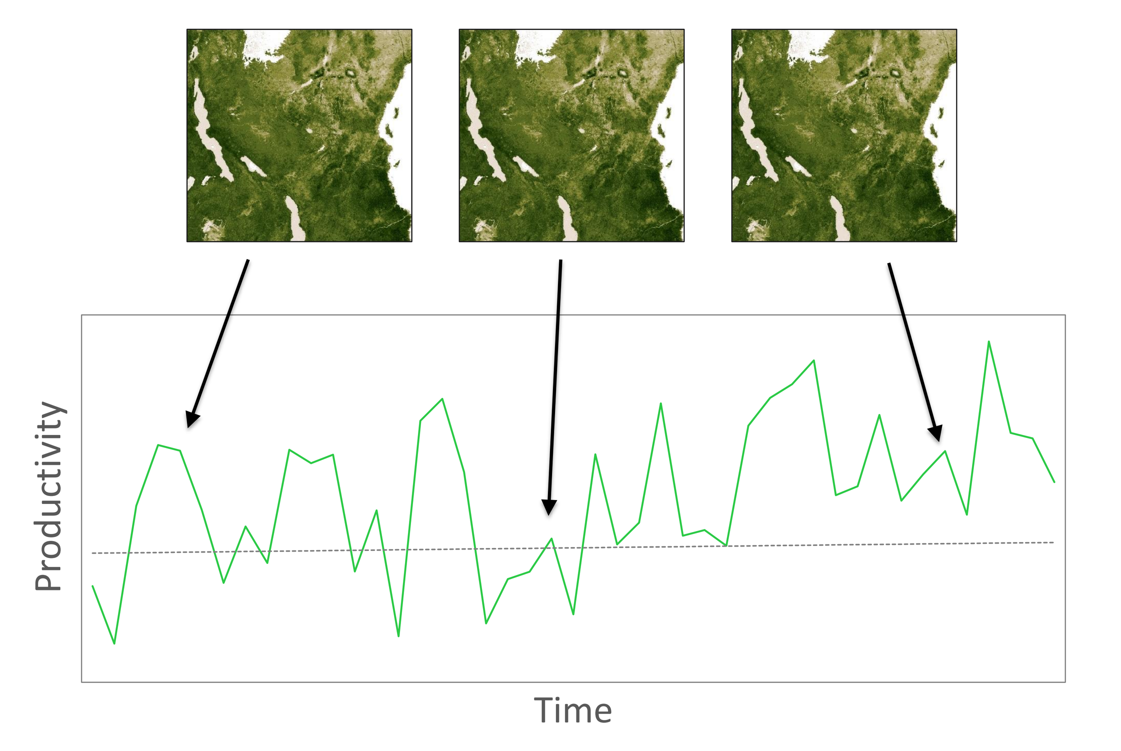

Figure 3: We detect trends in habitat degradation by fitting models to productivity data derived from hyper-temporal imagery.

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