Geography Department

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Global Patterns of Agricultural Land-use Intensity & Biodiversity

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Background

- Land-use change is the single biggest cause of biodiversity loss.
- Land-based production faces increased demands due to growing human population, surging consumption & changing diets.
- The same production goal can be reached through (1) expansion of agricultural land or (2) intensification of existing agricultural land.
- Understanding the trade-offs between these alternatives is key to improve food security while at the same time conserve biodiversity.

Intensive cotton production, Mato Grosso, Brazil
Photo: F. Gollnow

- Yet, studies have so far mainly focussed on agricultural expansion.
- It is unclear how global patterns of biodiversity & land use intensity (LUI) relate.
- Investigating how LUI affects biodiversity is challenging, because LUI is a complex, multidimensional issue which can address inputs (e.g., fertilizer), outputs (e.g., yields), or the land system as a whole (e.g., biomass removed).

Datasets

- We compiled a geodatabase of thirteen complementary global LUI metrics circa the year 2000 (see refs below).
- As biodiversity indicators, we used endemism richness (ER) for birds, mammals & amphibians.

Top Left: Farmland Abandonment in Russia. Photo: A.Sieber. *Left:* Intensive livestock in Argentina, Photo: M.Piquer-Rodriguez. *Right*: Low intensity land use in the Ukraine Photo: T. Kuemmerle

Research questions:

1. How do patterns of LUI relate to the spatial distribution of biodiversity?
2. Where are hotspots of potential conflict between high LUI & high biodiversity?

Patterns of LUI & Biodiversity

- To delineate hotspots of high LUI & high biodiversity, we abridged datasets to the top 2.5 percentile of their distribution (Fig. 1).
- The majority of high biodiversity areas exhibited high ER for all three taxa, especially in hotspots of high LUI.
- On the other hand, LUI metrics varied considerably, emphasizing large spatial differences between LUI metrics.
- Results highlight the variability of relationships of LUI & biodiversity depending on the choice of LUI metric.

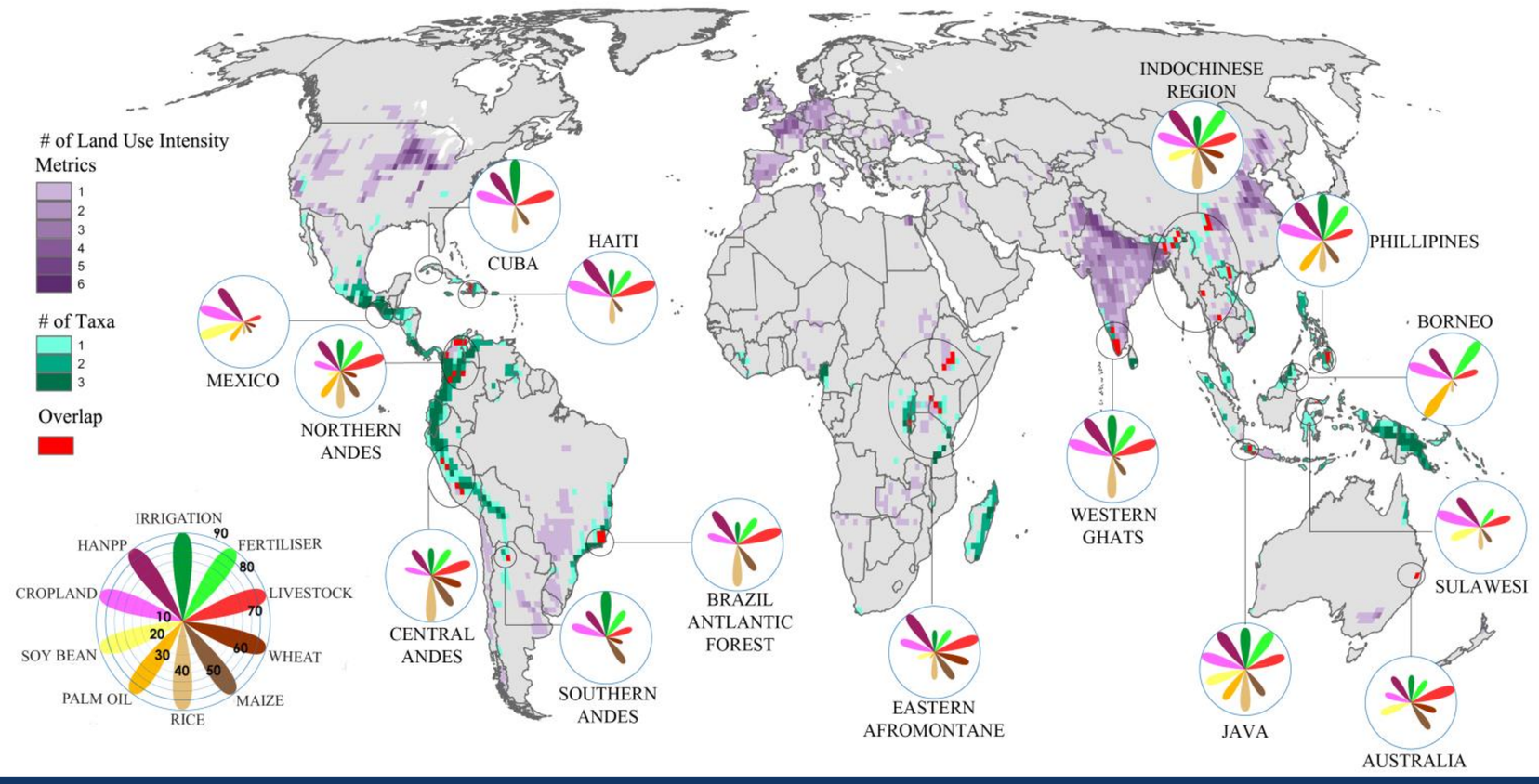

Figure 1: Top 2.5% of LUI & biodiversity, where any one top 2.5% intensity metric overlaps with any one top 2.5% of endemism richness. Multiple overlapping LUI metrics of top 2.5% are shown in purple & multiple taxa shown in green, overlap between LUI & endemism richness in red. Numbers on the petal diagram represent percentile ranks for each LUI metric in regions of overlap with high biodiversity. Larger petals indicate higher percentile ranks, & thus higher intensity of land use.

Comparison with Conservation International Hotspots

- In order to identify regions where any one LUI metric was associated with any one taxa, we combined individual results from local indicators of spatial association (LISA) by LUI metric & ER (Fig. 2).
- To date, no established conservation prioritization scheme has considered LUI.
- We found substantial areas of high biodiversity, for all three taxa & high LUI which are not contained within Conservation International (CI) hotspots (shown in dark blue, Fig. 2).
- Such areas include parts of Venezuela, Eastern Africa, China, Papua New Guinea, & Eastern Australia.
- These areas may merit increased conservation attention.

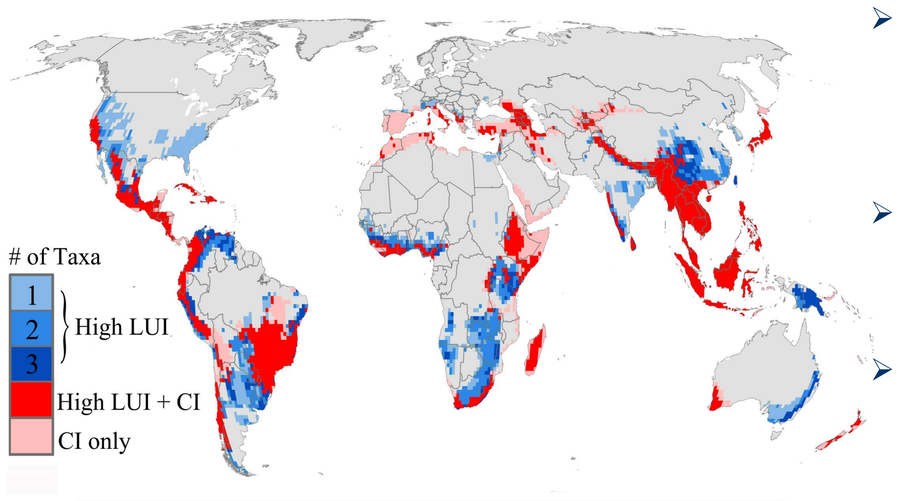

Figure 2: Regions of high LUI & high endemism richness (shown in blue), from statistically significant ($p < 0.05$) local indicators of spatial association.
Darker blue regions show higher numbers of taxa associated with at least one LUI metric. Biodiversity hotspots from Conservation International (CI) which do not overlap with our high LUI & high biodiversity areas are shown in pink.
Red areas signify regions of high LUI & high biodiversity (for at least one taxa) overlapping with CI hotspots.

Conclusions

- We provide a global view of the patterns of LUI & its concordance with biodiversity, thereby shedding light on regions where highly intensive agriculture & unique wildlife coincide.
- Most assessments of land-use impacts on biodiversity either disregard LUI or include a single metric to measure it. This can underestimate biodiversity threat.
- A wider spectrum of relevant LUI metrics should be considered when balancing the needs of agricultural production & biodiversity.

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