Effects of forest fragmentation and disturbance on biodiversity and ecosystem functions in an African rainforest

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"Biodiversity of Africa - Observation and Sustainable Management for our Future!"
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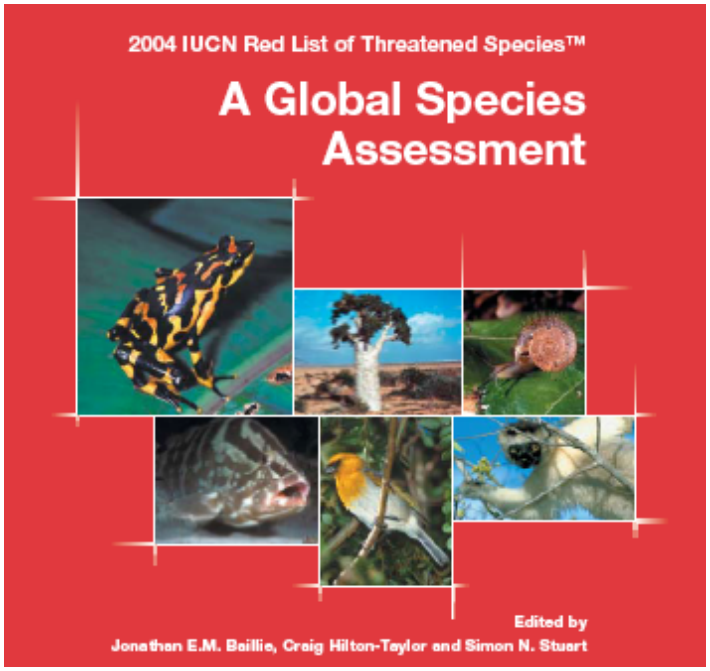
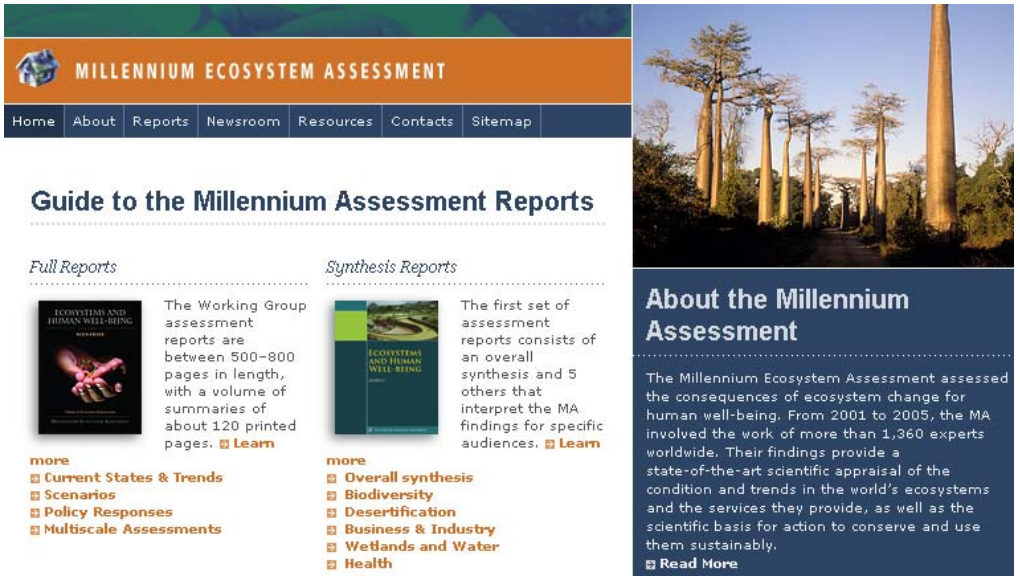
Projektträger im DLR

Federal Ministry of Education and Research

Biodiversity crisis

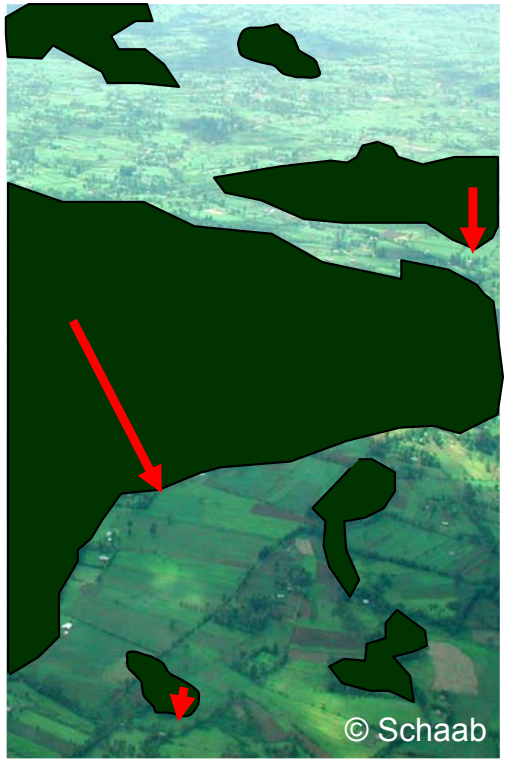
- Global extinction of >5,000 species per year
- Little known about consequences for ecosystem processes





Human disturbance

Fragment size

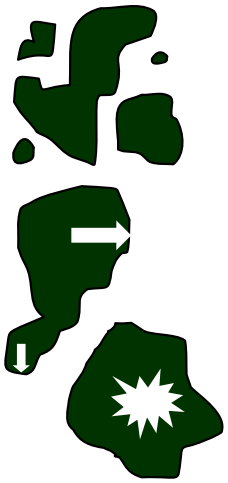


Distance to edge

Local disturbance

Effects on biodiversity

Disturbance → Biodiversity → Ecosystem process

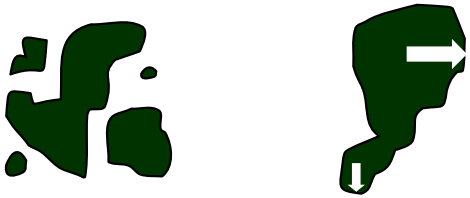


- Do species richness and composition of different taxa respond idiosyncratically?
- Does disturbance affect ecosystem processes directly or indirectly?

Kakamega Forest

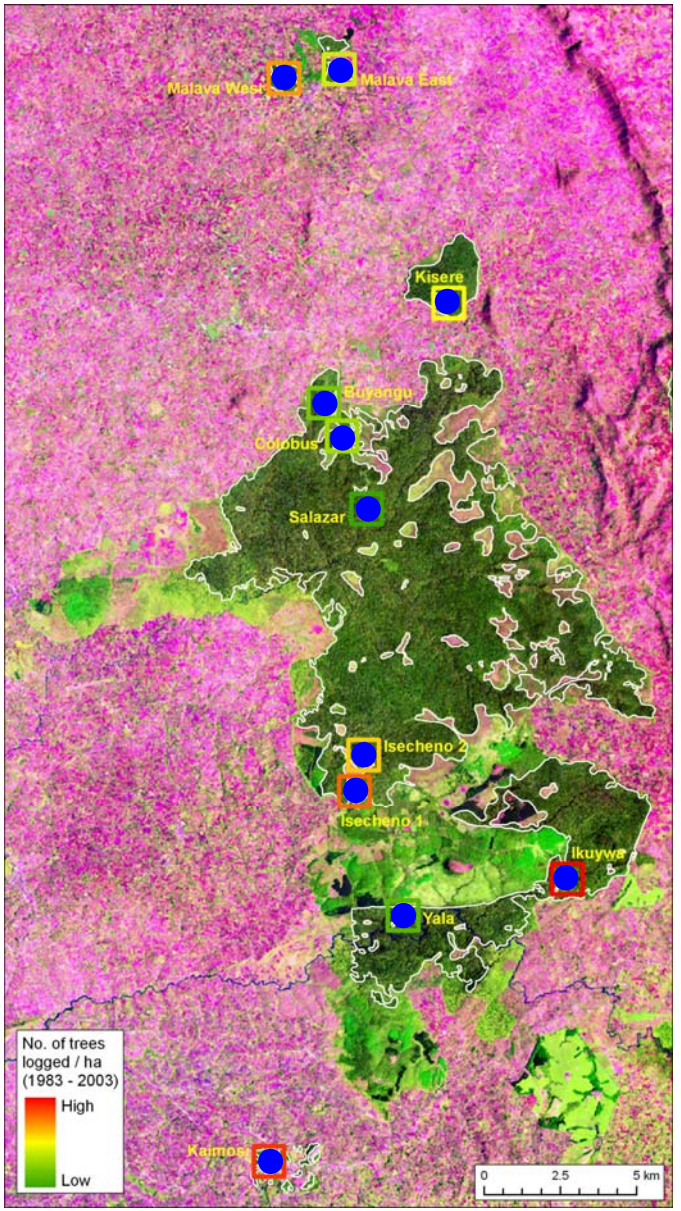
- Relict of Guineo-Congolian rainforest
- 11 biodiversity observatories (BDOs)
- Forest size and distance to edge from satellite images with GIS

  (Lung 2004, Karlsruher Geowissenschaftliche Schriften)



- Gradient of local disturbance: Logged trees during last 20 years

  (Bleher et al. 2006, Biodiv. & Cons.)



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Biodiversity

- Woody plants (Althof 2005, Dissertation Univ. Koblenz)
  - Plots of 10 × 10 m in 10 BDOs

- Birds (Peters et al. 2008, Ecol. Appl.)
  - Point counts in 11 BDOs

- Rodents (Farwig et al. 2008a, Biotropica)
  - Sherman traps in 9 BDOs

- Ants (Peters, Fischer, Garcia, unpublished data)
  - Pitfall traps in 11 BDOs

Disturbance → Biodiversity

Ant richness

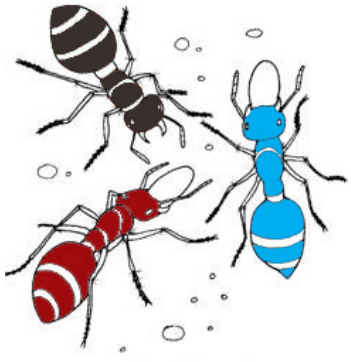


Figure 1, unpublished data

Decline of ant diversity with local disturbance

Table 1, unpublished data

Disturbance effects stronger on composition than on species richness

Disturbance → Biodiversity

Antbird composition

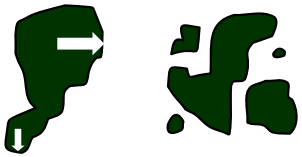
Figure 2, unpublished data

Different antbird composition in small and large fragments

Summary

Disturbance effects stronger on composition than on species richness

- Due to large-scale effects of fragmentation



- Idiosyncratic response of different taxa

Ecosystem processes

(1) Seed dispersal (Farwig et al. 2006, Oecologia)

→ Frugivorous bird biomass per *Prunus africana* tree [log]

(2) Forest regeneration (Farwig et al. 2008b, BAAE)

→ No. of seedling species / log (no. of seedlings)

(3) Lichen establishment (Yeshitela, Theisen, Fischer, unpublished data)

→ No. of epiphyllic lichen species [sqrt]

Ecosystem processes

(4) Rodent seed predation (Farwig et al. 2008a, Biotropica)

→ Proportion of removed *P. africana* seeds [angular]

(5) Antbird insect predation (Peters et al. 2008, Ecol. Appl.)

→ Antbird biomass per bird flock [log]

(6) Army ant insect predation (Peters et al., unpublished data)

→ Proportion of traps with army ants [angular]

Disturbance → Ecosystem process

Table 2, unpublished data

- Disturbance strongly affected ecosystem processes
- Direction of effects differed among ecosystem processes

Disturbance → Ecosystem process

Seed dispersal

Lichen establishment

Figure 3, unpublished data

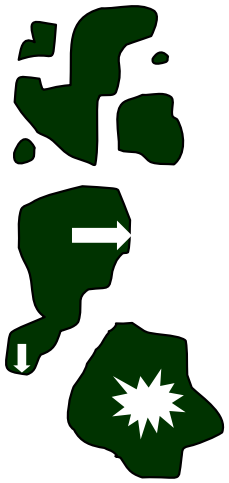
Figure 4, unpublished data

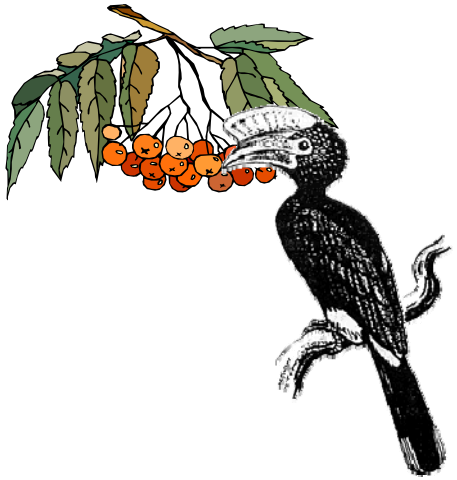
Seed dispersal increased with disturbance

Lichen establishment decreased with disturbance

Path analyses

Disturbance → Biodiversity → Ecosystem process





Disturbance → Biodiversity → Ecosystem process

Seed dispersal

Figure 4, unpublished data

Forest regeneration

Figure 5, unpublished data

Army ant insect predation

Figure 6, unpublished data

- Direct stronger than indirect effects
- Direct effects positive

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Disturbance → Biodiversity → Ecosystem process

Antbird insect predation

Figure 7, unpublished data

Lichen establishment

Figure 8, unpublished data

- Indirect effects reduced ecosystem processes

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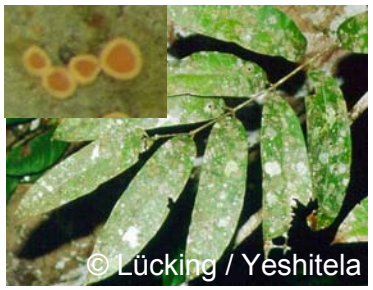
Summary

Disturbance affects ecosystem processes

- Direction of effects differs among ecosystem processes



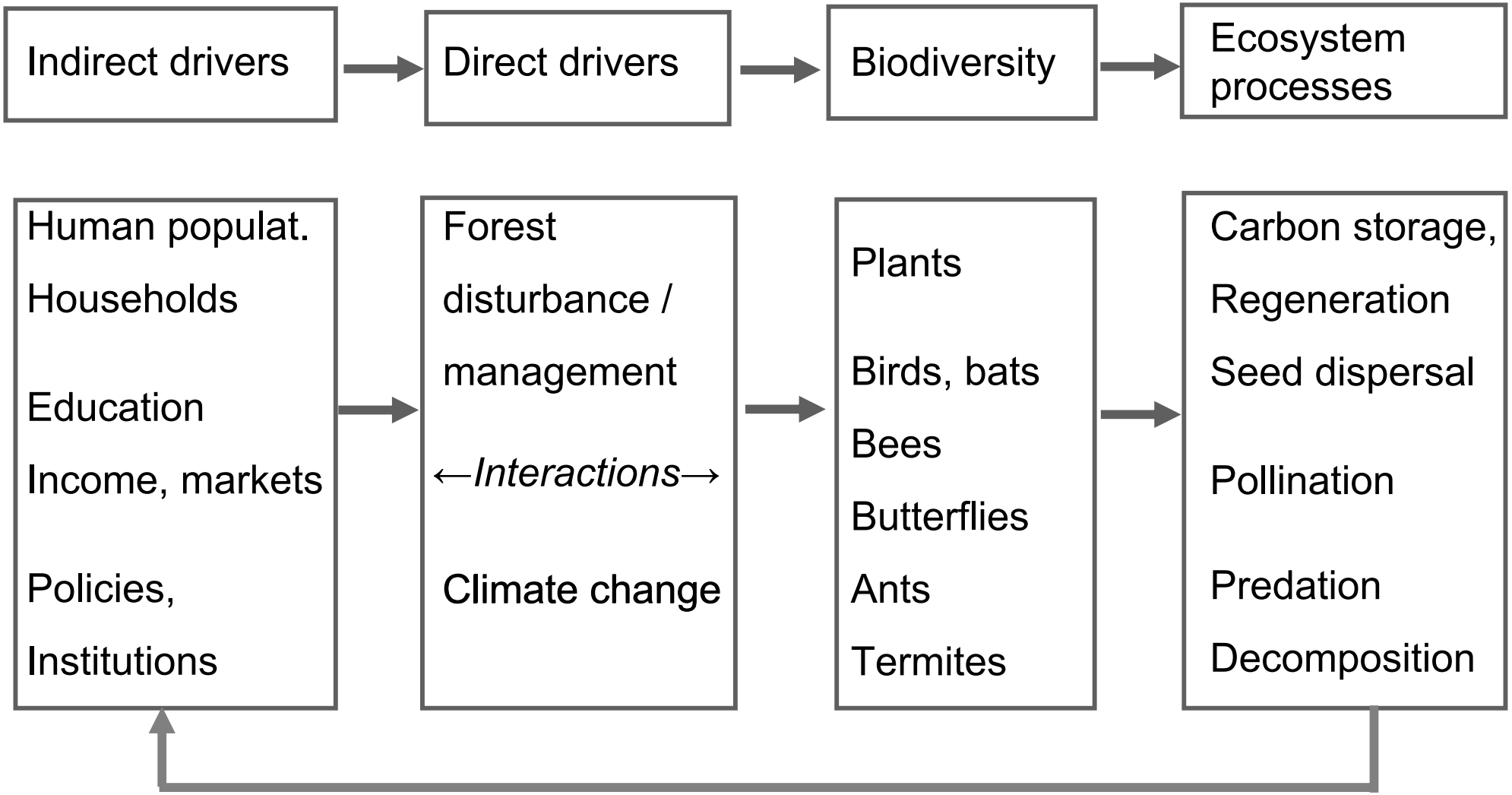
- Direct effects positive

Indirect effects negative

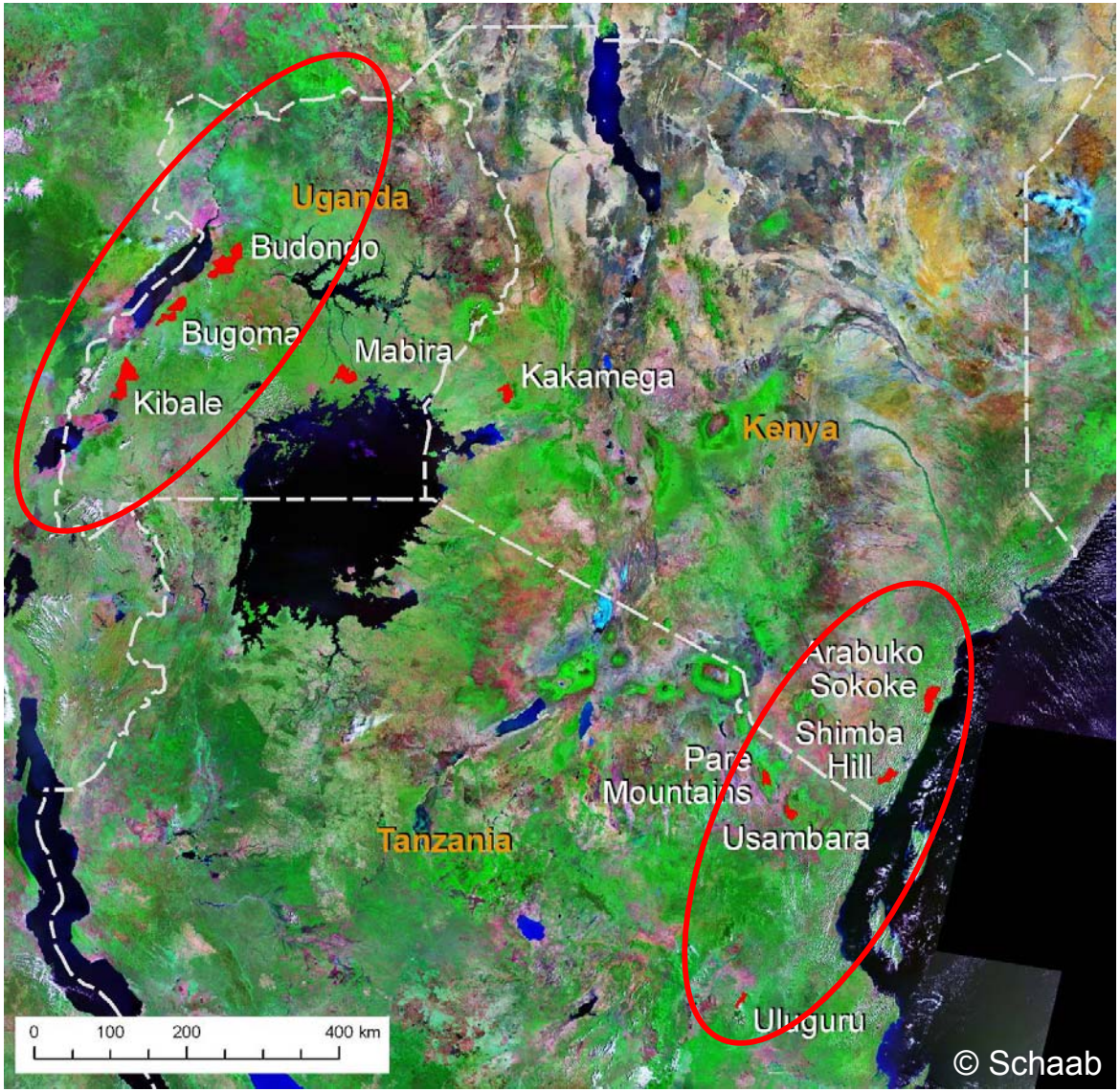
Outlook

Socio-economic drivers

More ecosystem processes



Outlook



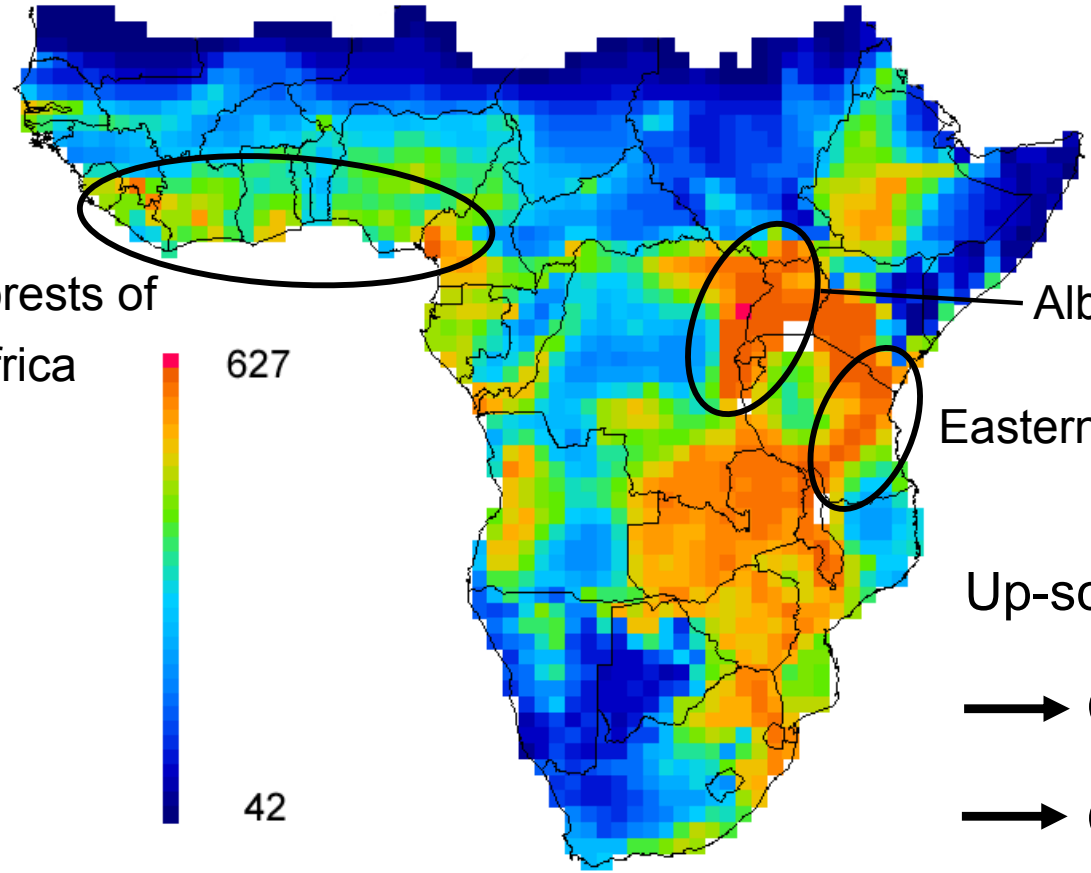
Up-scaling to more forests

→ Albertine Rift

→ Eastern Arc forests

Outlook

Bird species richness



Up-scaling to more forests

→ Centers of species richness

→ Centers of endemism

Kissling, Rahbek, Böhning-Gaese 2007, Proc. Royal Soc. London B

Acknowledgements

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- Kenya Forest Service

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