

Nature Precedings : doi:10.1038/npre.2008.2437.1 : Posted 24 Oct 2008



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Sustainable Forest Management in Africa
African Solutions to African Problems in Natural Forest Management
3-7 November 2008, Stellenbosch, South Africa

**Assisting natural forest regeneration in
northern Ethiopia:**
one measure is not enough

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Northern Ethiopia





Northern Ethiopia





Northern Ethiopia





Northern Ethiopia



Northern Ethiopia



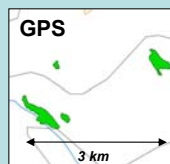
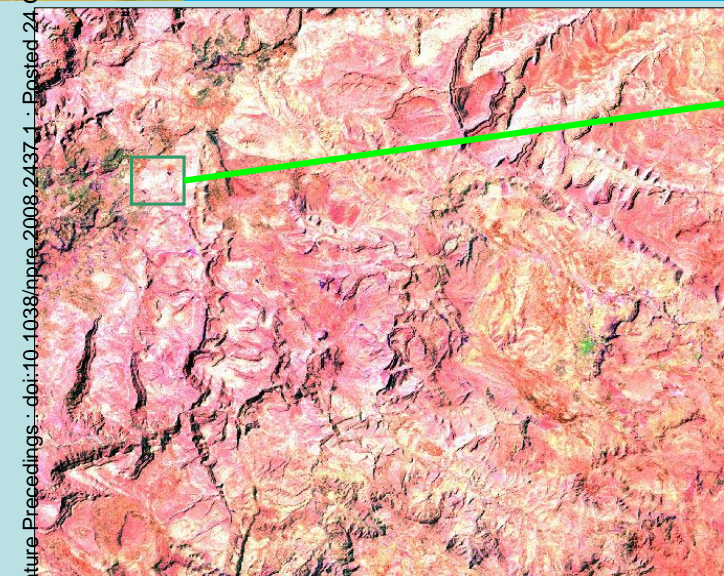
Sustainable Forest Management in Africa
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Forest fragmentation taken to the extreme...

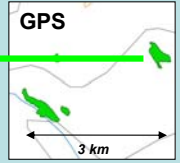
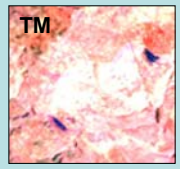
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Northern highlands of Ethiopia: Landsat TM - blue is forest



Forest fragments: church forests...

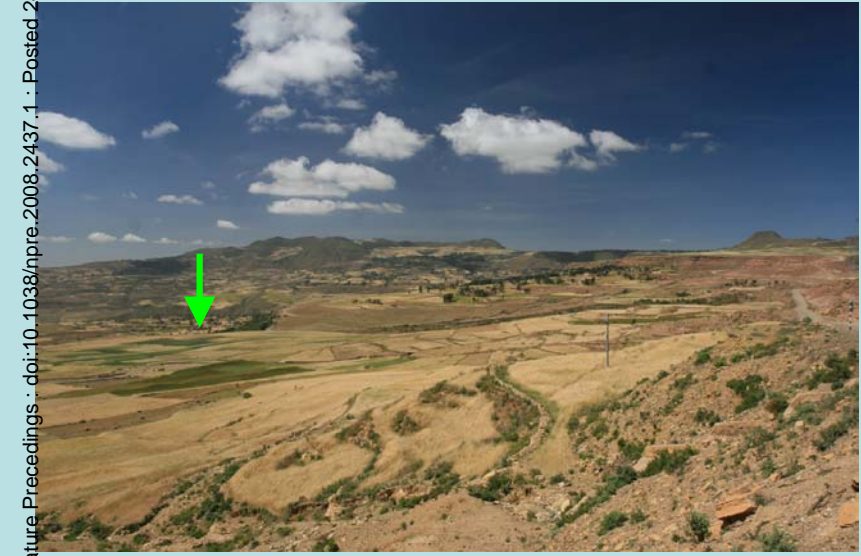


Aerts (2007) *Front Ecol Environ* 5:66

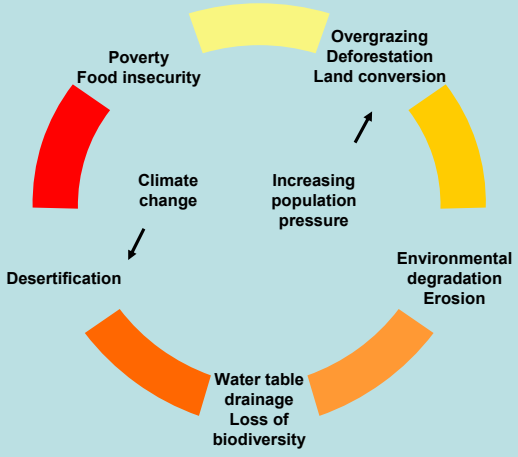
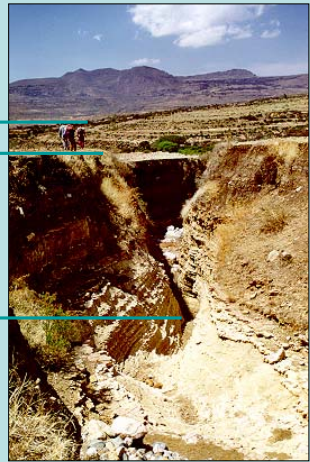
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...in a landscape almost without trees



Environmental degradation



See also Nyssen et al. (2004) *Earth-Sci Rev* 64:273-320

Land rehabilitation: exclosures



- No more grazing
- No more cutting of wood
- **Aim: restoration of natural forest vegetation**
 - to reduce erosion
 - to increase rainwater infiltration
 - to provide fodder and woody biomass

See e.g. Mekuria et al. (2007) *J Arid Environ* 69:270-284

Original “natural forest vegetation”: Afromontane forest?

- Undifferentiated (dry monodominant) Afromontane forest of the Ethiopian highland (Friis 1992)?





Situation in the field: no forest, but woody shrub land

- >10 years after establishing exclosures:
 - no (emerging) trees
 - dominance of thorn shrubs (*Acacia*, 50%)
 - mixed with other pioneers (e.g. *Euclea*, 10%)
 - soil seed bank dominated by grasses and herbaceous species
- What happened?
 - From a rangeland/savanna perspective:
shrub encroachment
 - From a forest restoration perspective:
arrested succession



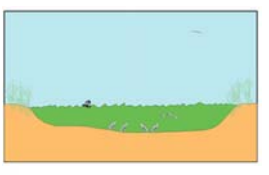
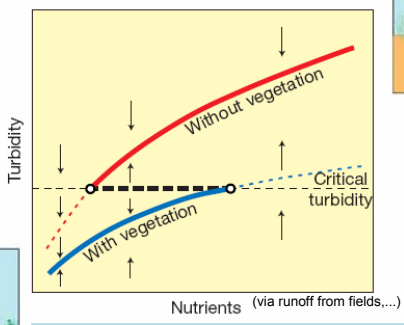
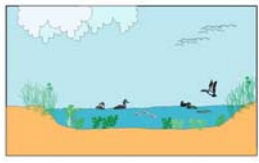
See e.g. Mengistu et al. (2005) *J Arid Environ* 60:259-281
Aerts et al. (2006) *Appl Veg Sci* 9:117-126



What happened? a little detour to pond ecosystems

- Sudden loss of transparency and vegetation in shallow lakes after human eutrophication

Clear water state:
Submerged vegetation
Predatory fish



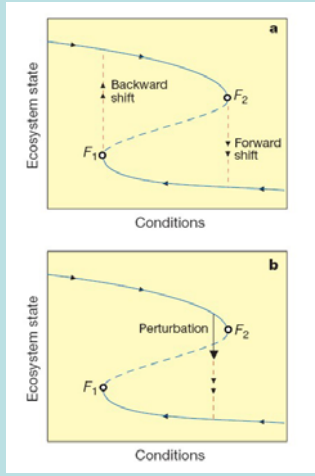
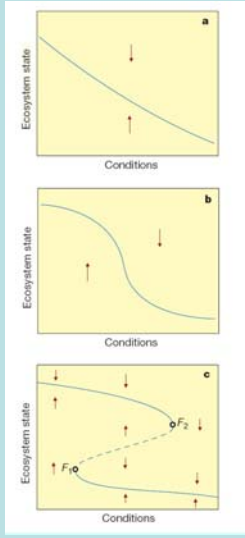
Turbid water state:
No submerged vegetation
Phytoplankton (algae)
Bottom-feeding fish

Scheffer et al. (2001) *Nature* 413:591-596

Drawings from Scheffer (1999) *Conserv Ecol* 3:11 (www.consecol.org/vol3/iss2/art11/)

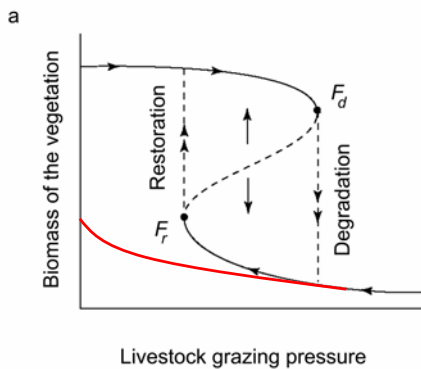


Catastrophic shifts in ecosystems

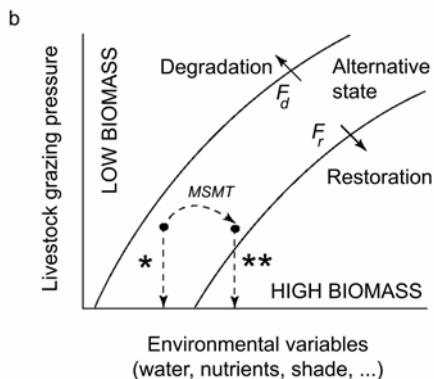


Scheffer et al. (2001) *Nature* 413:591-596

Alternative stable states: grazed ecosystems in semiarid environments



Biomass of vegetation in relation to grazing
Only low biomass levels are possible if the grazing pressure $> F_d$.

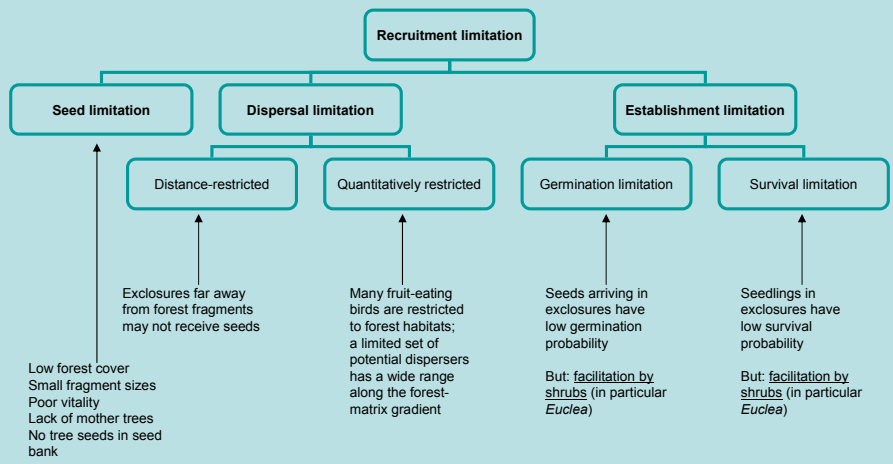


Critical grazing pressure in function of environmental variables. Reducing the grazing pressure (*) does not necessarily induce ecosystem (biomass) restoration: the system is stuck in the low biomass state.

After Holmgren et al. (2001) *Trends Ecol Evol* 16:89-94
Holmgren and Scheffer (2001) *Ecosystems* 4:151-159



Identifying the limitation problems in exclosures

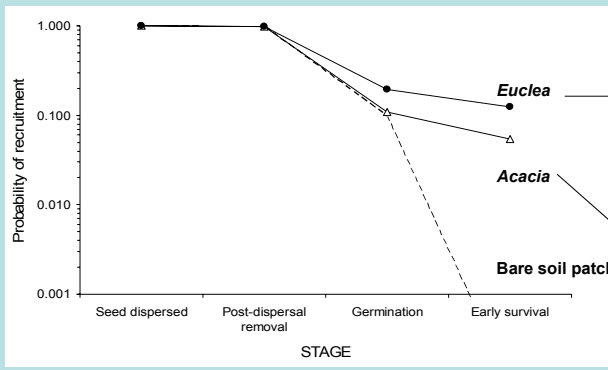


One restoration measure (exclusion of grazing animals) is clearly not enough!
Biotic and abiotic factors limit recruitment.

Aerts et al. (2008) *Biodiv Conserv* 17:53-69
 Aerts et al. (2007) *Rest Ecol* 15:129-138
 Aerts et al. (2006) *For Ecol Manage* 230:23-31



Solution: use facilitating effect of shrubs

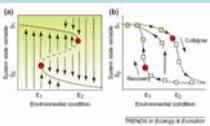
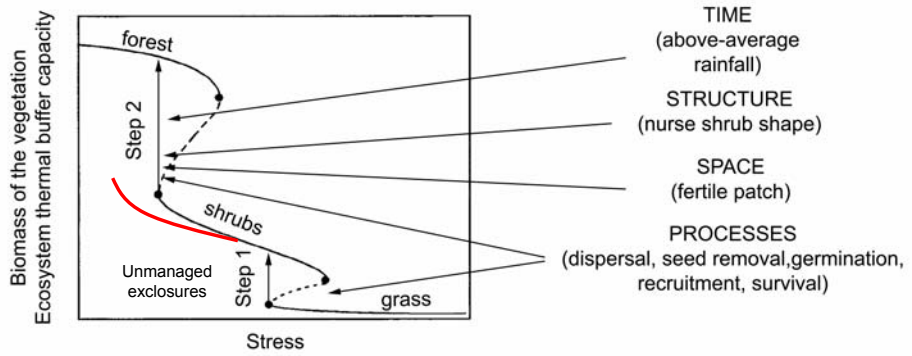


- Naturally established seedlings DO occur!
- Seedlings grow under pioneer shrubs that buffer against environmental extremes (facilitation)
- Sowing or planting under shrubs increases seedling survival


Aerts et al. (2006) *Appl Veg Sci* 9:117-126
 Aerts et al. (2007) *Rest Ecol* 15:129-138
 Aerts et al. (2006) *For Ecol Manage* 230:23-31



Alternative stable states and forest restoration in semiarid environments



After Holmgren and Scheffer (2001) *Ecosystems* 4:151-159
 See also Suding et al. (2004) *Trends Ecol Evol* 19:46-53

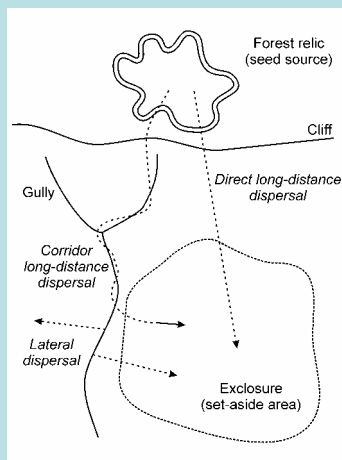


Implications for practice: overcoming seed limitation

- Forest fragments should be conserved, but also managed actively
 - Stop encroachment (cutting along the edges of the forest)
 - No more grazing (grazing eliminates regeneration)
 - Ensure follow-up of mature trees: if necessary, plant seedlings
 - If possible, increase patch size
 - If possible, also plant seedlings of regionally extinct species

Implications for practice: overcoming dispersal limitation

- If seeds don't reach the exclosures, sow seeds collected from forest fragments or plant seedlings under shrubs
- Create corridors for seed dispersing birds between forest fragments and exclosures
- Protecting vegetation in and along gullies reduces gully erosion and initiates the formation of such corridors





Implications for practice: overcoming establishment limitation

- Protect and create suitable microhabitats under pioneer shrubs in exclosures – avoid illegal cutting
- When sowing seeds under shrubs, sow several large seeds from healthy mother trees in the mulch under shrubs to overcome germination limitation (use seeds that have been eaten by birds and that were imbibed for 24 hours prior to sowing)
- When planting seedlings, plant under shrubs and not in bare soil patches. Take advantage of above-average summer rains



Overall conclusion

- Exclusion of grazing livestock is a prerequisite to induce forest recovery
- but to assist forest restoration, active management on different levels is needed
 - seed sources, existing shrubs in exclosures, seeds and seedlings all need attention.
 - If one phase is neglected, restoration will be hampered.
 - Zero-management (currently applied) is not a viable option.
- These management guidelines may lead to accelerated forest restoration, and along with other soil and water conservation efforts and socio-economical interventions, they may help to attain sustainable livelihood in northern Ethiopia.

