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Forest restoration in the South *A case study from Ethiopia*

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Ethiopia

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Forests in Ethiopia

Nature Precedings : doi:10.1038/npre.2011.2437.2 : Posted 8 Jun 2011

Forests in Ethiopia

Northern Ethiopia

Nature Precedings : doi:10.1038/npre.2011.2437.2 : Posted 8 Jun 2011

Forest fragmentation taken to the extreme...

Nature Precedings : doi:10.1038/npre.2011.2437.2 : Posted 8 Jun 2011

Northern highlands of Ethiopia: Landsat TM - blue is forest

Nature Precedings : doi:10.1038/npre.2011.2437.2 : Posted 8 Jun 2011

Forest fragments: church forests...

Nature Precedings : doi:10.1038/npre.2011.2437.2 : Posted 8 Jun 2011

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

...in a landscape almost without trees

Nature Precedings : doi:10.1038/npre.2011.2437.2 : Posted 8 Jun 2011

Typical for the northern highlands

Nature Precedings : doi:10.1038/npre.2011.2437.2 : Posted 8 Jun 2011

Environmental degradation

Nature Precedings : doi:10.1038/npre.2011.2437.2 : Posted 8 Jun 2011

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)?

Analysis of forest fragments: potential natural vegetation

Fig. 4 Hypothetical transect near the lower limit of the highlands of northern Ethiopia (1800 – 2000 m) with associated potential forest vegetation: MF, moist Afromontane forest; DF, dry Afromontane forest; SW, Afromontane savanna woodland; SS, shrub savanna. Key tree species: *Aab*, *Acacia abyssinica* Benth.; *Aet*, *Acacia etbaica* Schweinf.; *Ase*, *Acacia seyal* Del.; *Asc*, *Acokanthera schimperi* (DC.) Benth.; *Asi*, *Acacia sieberiana* DC. ssp. *woodii* (Burr. Davy) Keay and Brenan; *Asp*, *Aloe* sp.; *Caf*, *Celtis africana* Burm. f.; *Cau*, *Calpurnia aurea* (Ait.) Benth.; *Cco*, *Combretum collinum*

Fresen.; *Cof*, *Cordia africana* Lam.; *Csi*, *Cassia singueana* Del.; *Eab*, *Euphorbia abyssinica* Gmel.; *Era*, *Euclea racemosa* ssp. *schimperi* (A. DC.); *Fal*, *Faidherbia albida* (Del.) A. Chev.; *Fsp*, *Ficus* spp.; *Oeu*, *Olea europaea* ssp. *cuspidata* (Wall. ex G. Don) Cif.; *Jsc*, *Justicia schimperiana* T. Anders; *Psc*, *Psydrax schimperiana* (A. Rich.) Bridson; *Rna*, *Rhus natalensis* Bernh. ex Krauss. Soil groups according to FAO et al. (1998): CM, Cambisol; LP, Leptosol; VR, Vertisol; ca, calcareous; vr, vertic; sk, skeletal

Aerts et al. (2006) *Plant Ecol* 187:127-142

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 (runoff, waste water,...)

Even when decreasing nutrient load:
ecosystem blocked in turbid water state

Clear water state:
Submerged vegetation
Predatory fish

Nutrients (via runoff from fields, waste water,...)

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 $> F_d$.

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

Identifying the multiple stresses in exclosures

One restoration intervention (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

Biomass of the vegetation
Ecosystem thermal buffer capacity

TIME
(above-average rainfall)

STRUCTURE
(nurse shrub shape)

SPACE
(fertile patch)

PROCESSES
(dispersal, seed removal, germination, recruitment, survival)

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.

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2011

VN Internationaal Jaar van de Bossen

Lezingen 2011: Wetenschap van de Bossen

Volgende lezingen op dinsdagavond van 20:00 tot 21:30

Auditorium Zeger Van Hee (DV1 91.56)

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Prof. Olivier Honnay Genetische variatie, genetische erosie en inteelt in onze bossen: stand van de kennis en rol van het bosbeheer

18 oktober 2011

Prof. Vincent Kint Staat er nog (kwaliteits)hout in onze bossen anno 2050? Perspectieven op groei- en oogstvoorspelling

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Dr. Bruno Verbist REDD, REDD+, REALU, CDM: wegwijs in de prominente rol van bossen in het klimaatbeleid

13 december 2011

Prof. Martin Hermy Biodiversiteit van oude bossen: referenties voor de toekomst of beladen met extinctieschuld en wat met het bosbeheer?

www.kuleuven.be/bossen2011