



Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology



Mechanisms of vegetation change: ecological transition zones in southern and West Africa

Shiponeni, N.¹; Goetze, D.² Allsopp, N.³; Hennenberg, K.J.⁴;
Kersting, P.⁵; Carrick, P.J.¹; Porembski, S.²; Vogel, M.⁶; Keil, M.⁶;
Hoffman, M.T.¹

¹Department of Botany, University of Cape Town; ²Institute of Biosciences/Botany, University of Rostock; ³ ARC-Livestock Business Division, Bellville; ⁴Institute for Applied Ecology e.V., Energy and Climate Protection, Darmstadt; ⁵ Institute of Geography, University of Mainz, Germany; ⁶German Aerospace Center (DLR), German Remote Sensing Data Center (DFD), Germany

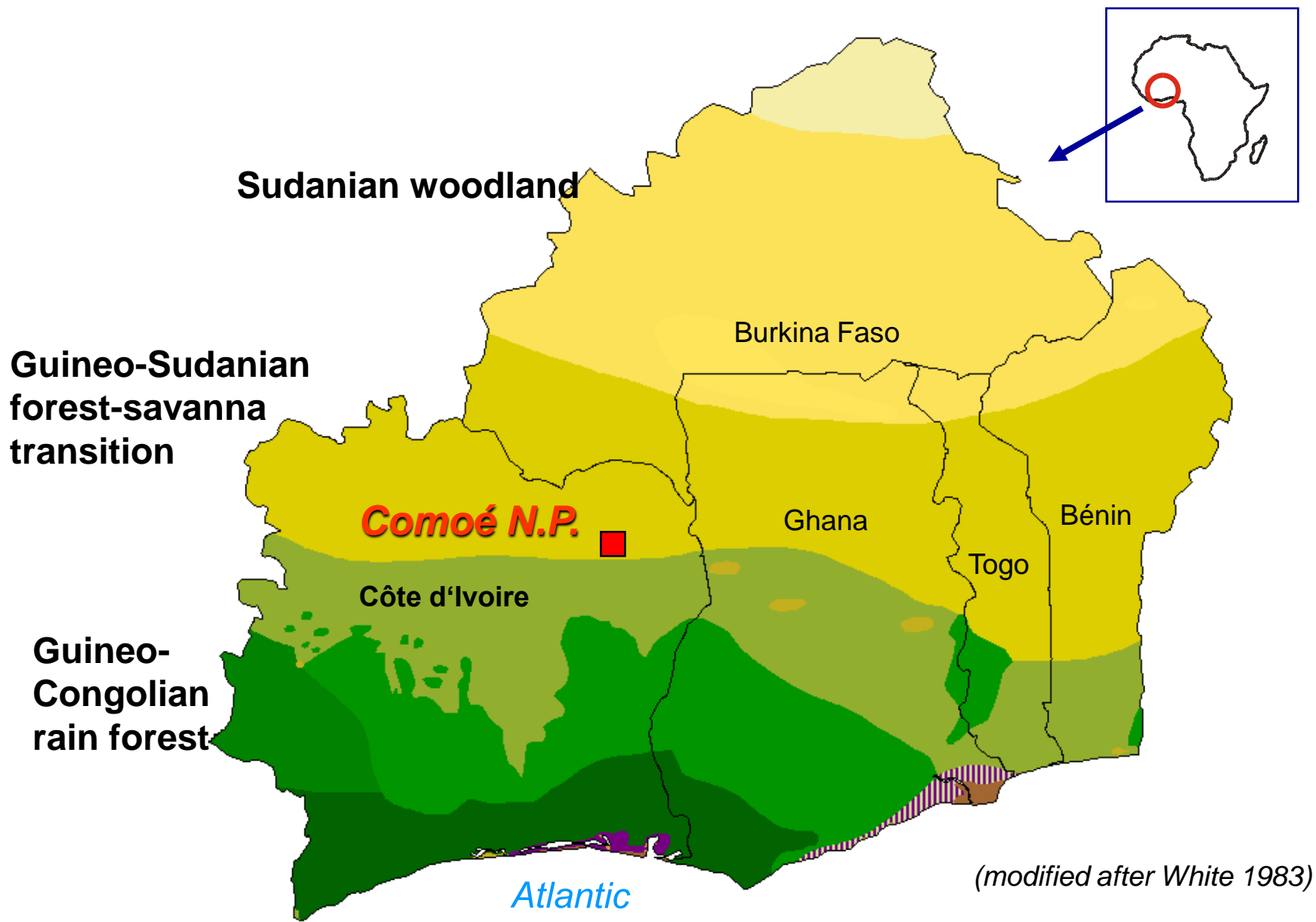


BIOLOG

"Biodiversity of Africa - Observation and Sustainable Management for our Future!"
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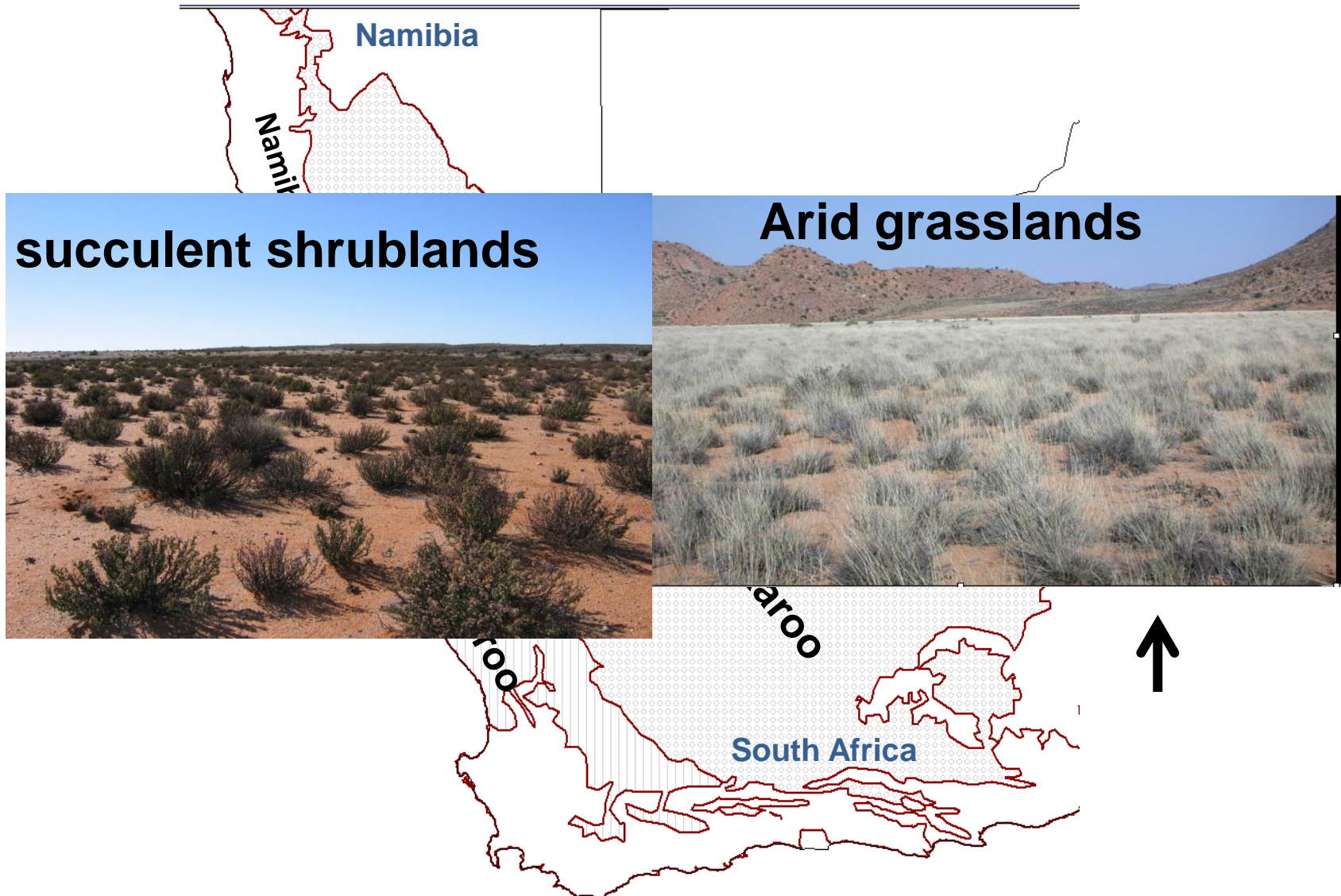
Federal Ministry
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and Research



Forest-savanna transition



Namaqualand-Bushmanland ecotone



Forming abrupt changes



Objectives

1. What causes the spatial change?
 - from forest to savanna Or
 - succulent shrubs and arid grassland
2. Changes over the past decades?
3. Implications related to global change?

Approach

- Soil properties across vegetation types,
- Relief, available fuel for fires
- Community studies on Plant competition
- Remote sensing – Aerial photos & Landsat data

Position of forest islands on relief?

Formation	meter a.s.l.	± SD
Forest savanna	311	33.6
Island forests	294	46.9
Tree savanna	286	45.0
Gallery forests	271	50.8
Shrub and grass savanna	264	38.9

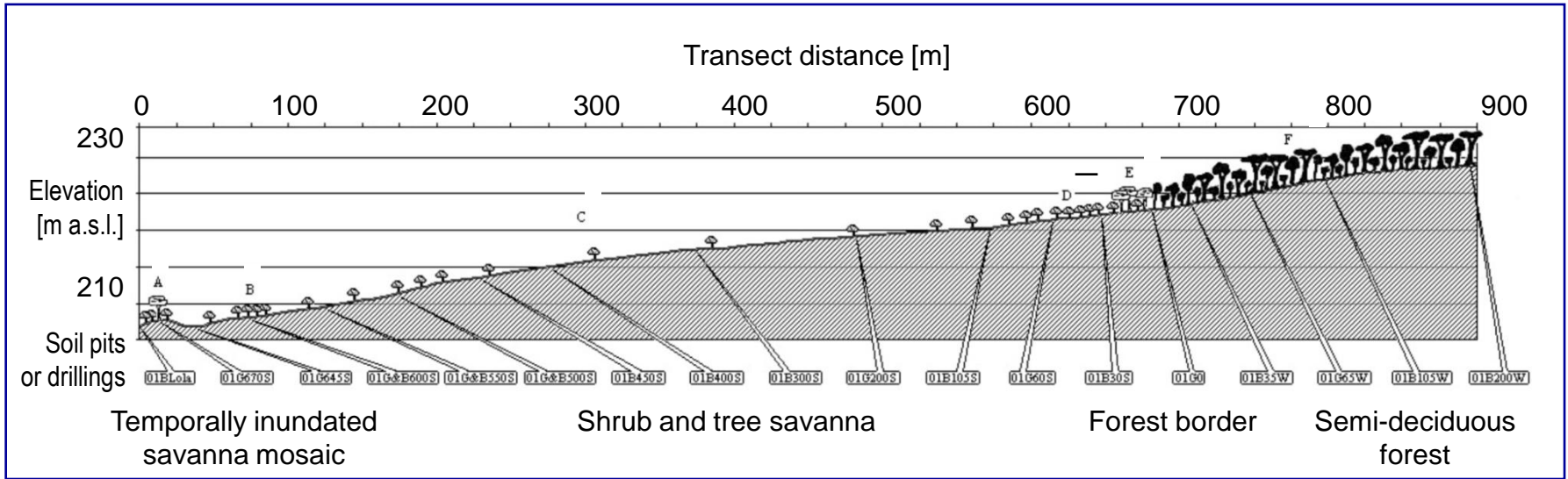
→ **Forests Island in slightly elevated positions**

Topographic Wetness Index

Formation	Mean TWI	\pm SD
Gallery forests	5.18	1.74
Shrub and grass savanna	5.05	1.61
Tree savanna	4.90	1.60
Island forests	4.74	1.42
Forest savanna	4.61	1.49

→ **Forests islands in topographically drier positions**

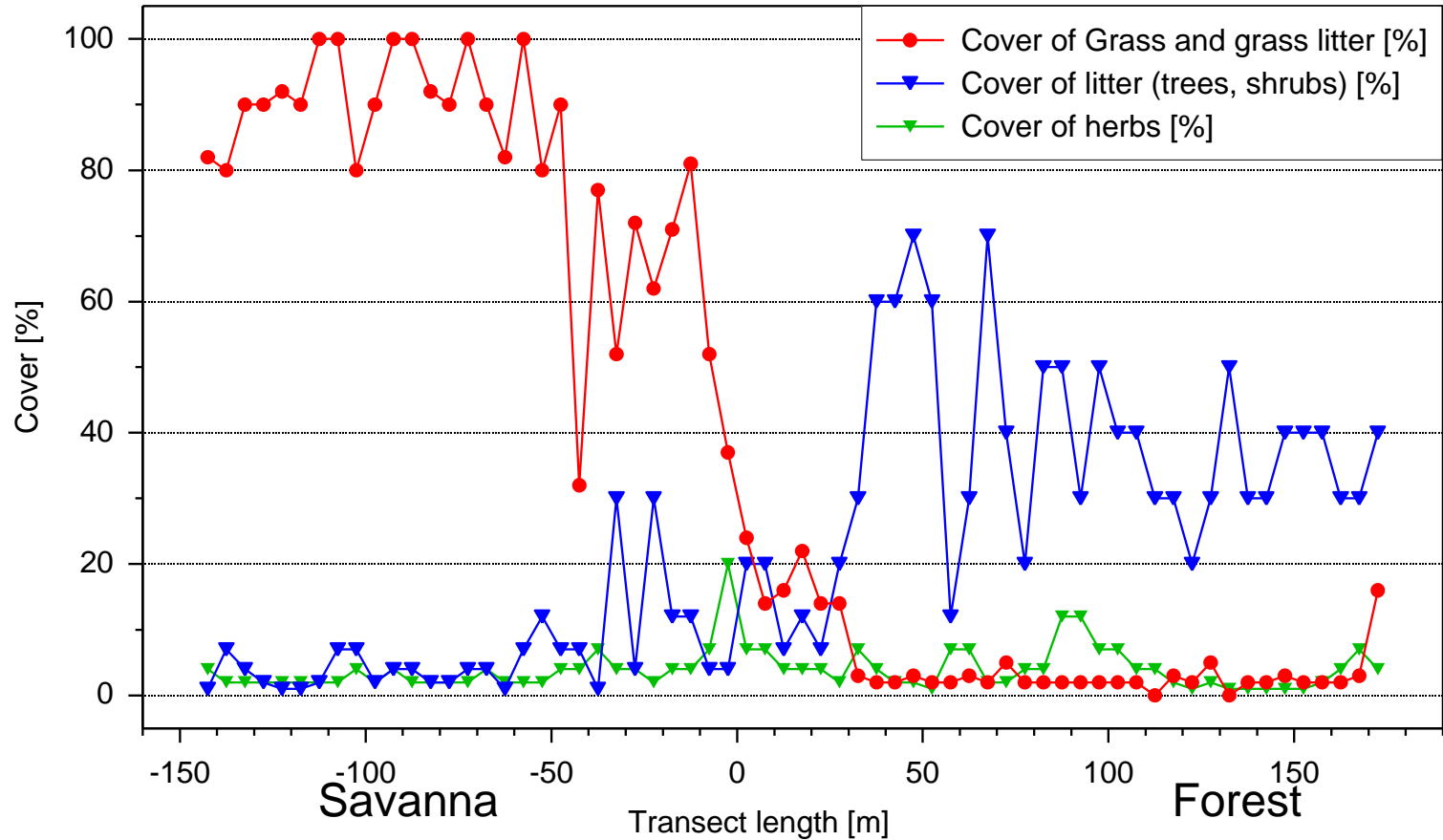
Soil properties along forest border transect



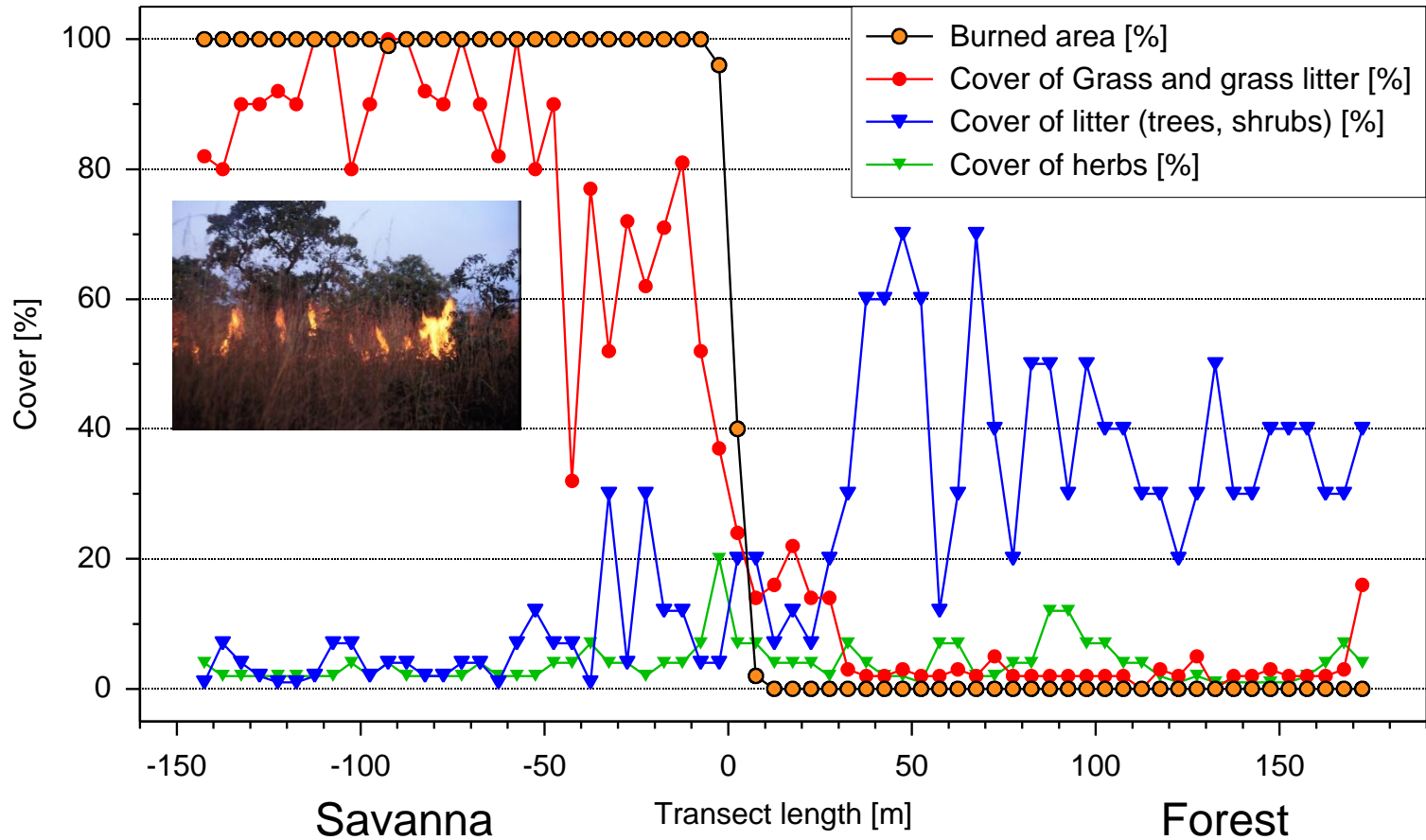
Soil properties	Savanna	Forest islands
Soil type	Loamy sand	Sandy loam
C _{org} content in top layer	0.7 %	2 %
L horizon	scarce	yes
Leaching	Al-Bt horizons	not visible
pH	5.3	6.6
Water capacity	lower	higher
Soil depth	0.2 to > 1.4 m	0.3 to > 1.4 m

soil properties do not solely account for the presence of either savanna or forest

available fuel for potential fires - Cover of grasses, litter, and herbs



Cover of grasses, litter, and herbs- and fire occurrence

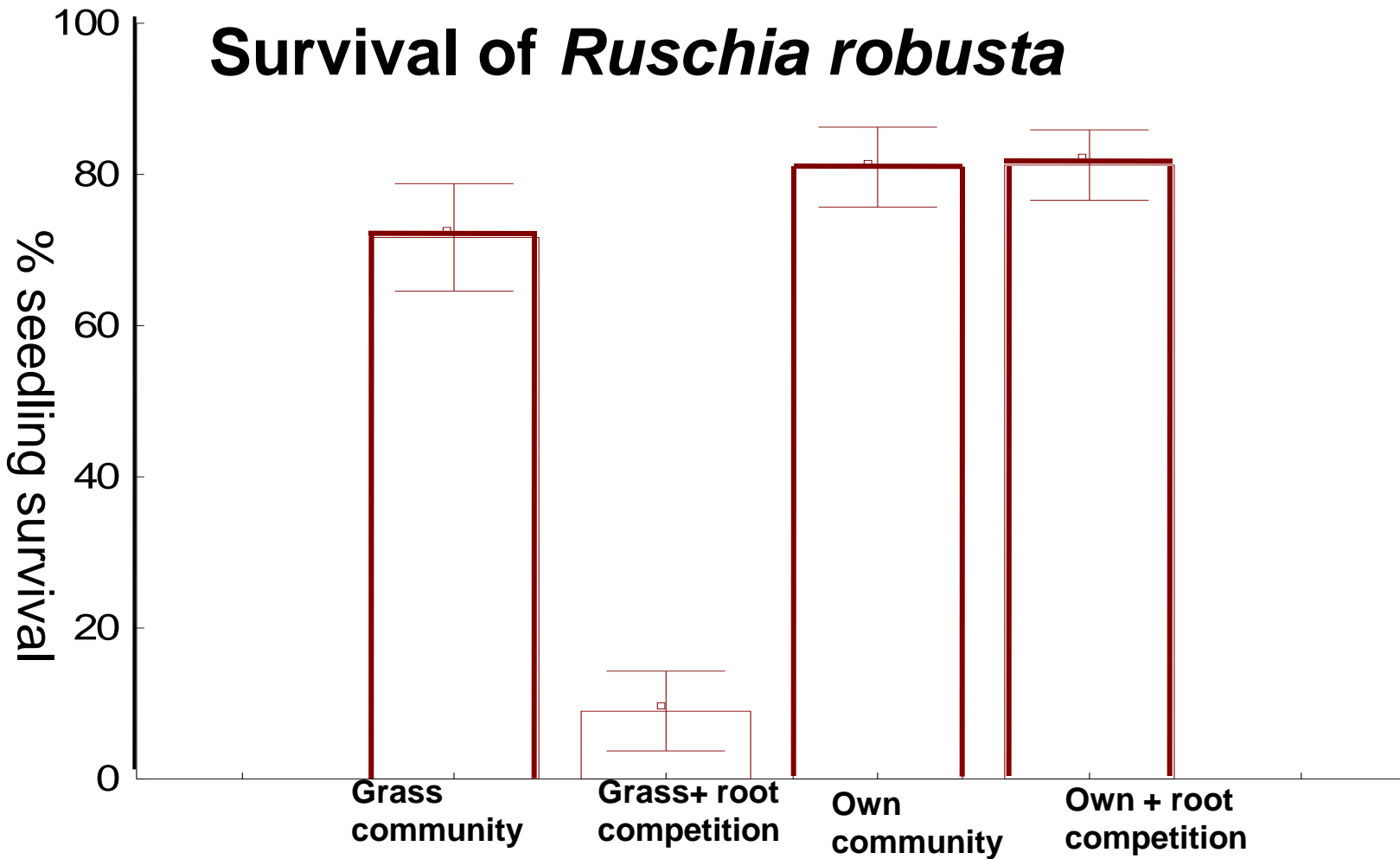


Hennenberg, Fischer, Kouadio, Goetze, Orthmann, Linsenmair, Jeltsch & Porembski (2006), Journal of Tropical Ecology

Studies on plant Competition and Soil influence

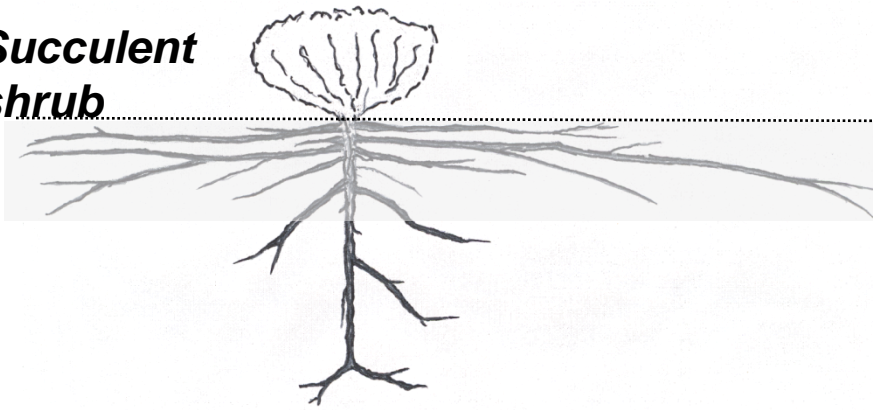


Survival of *Ruschia robusta*

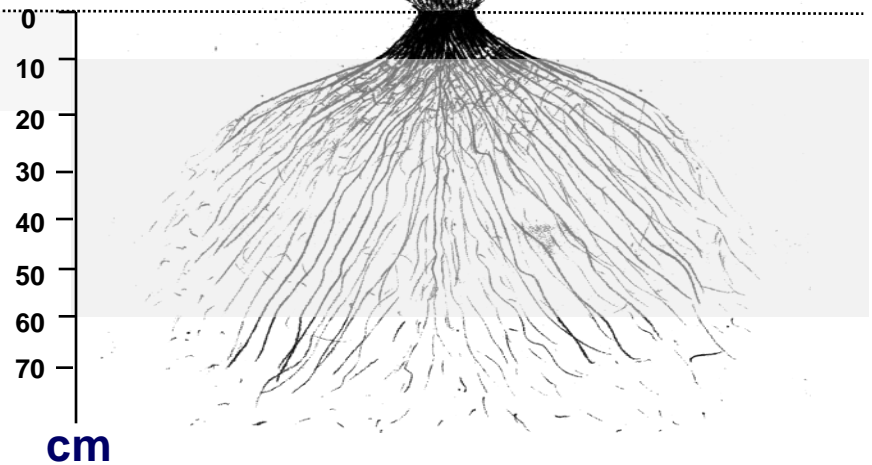


- Local vegetation patterns is not due to soil differences
- Competition from established grass prevents shrubs establishment

**Succulent
shrub**



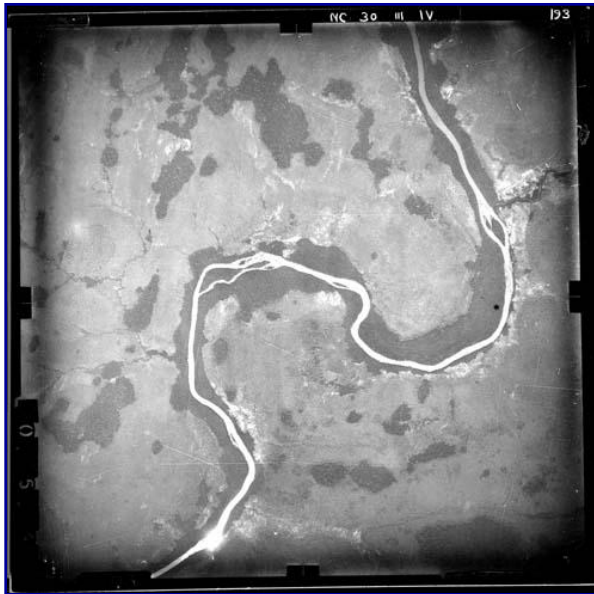
Grass



- Stronger competition from grass reflects a reduction in water availability in the upper soil layer,

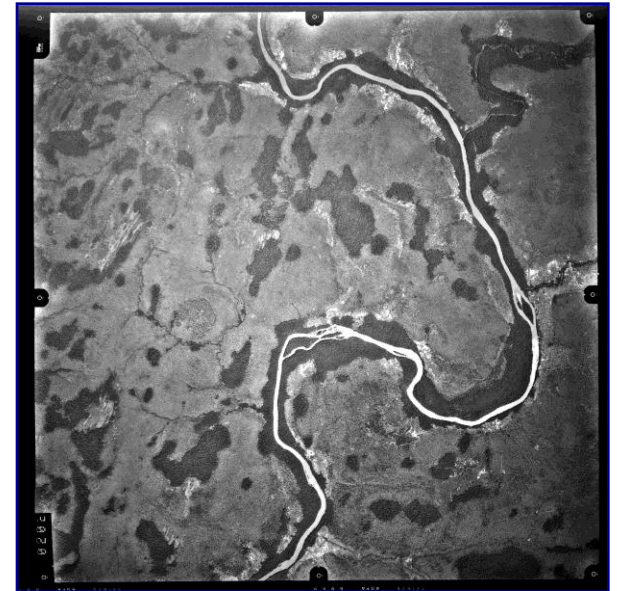
Temporal vegetation dynamics

1954



106 photos
covering
1200 km²
res. 2 x 2 m²

1996



Spatial development 1954-1996

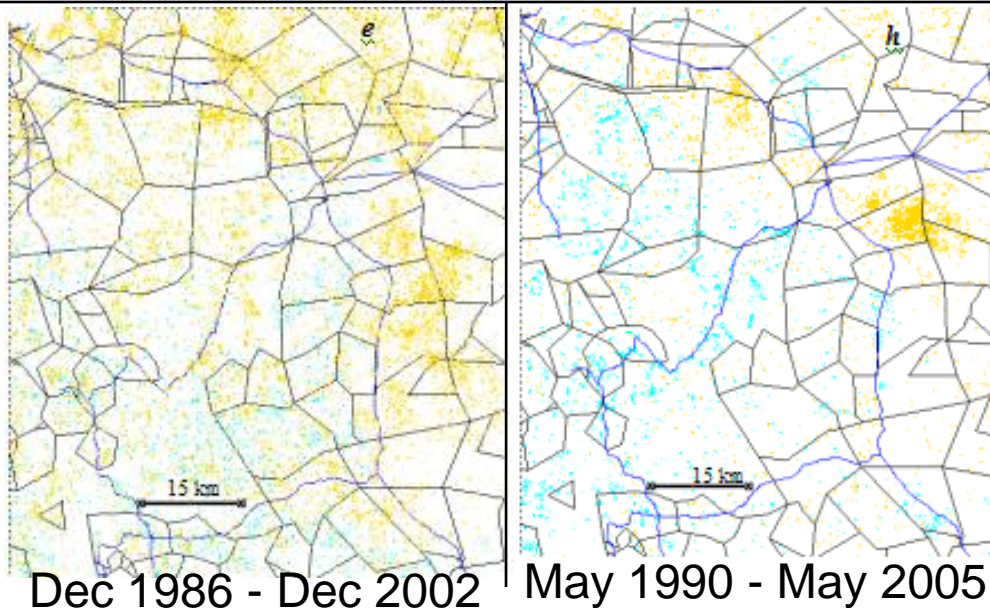
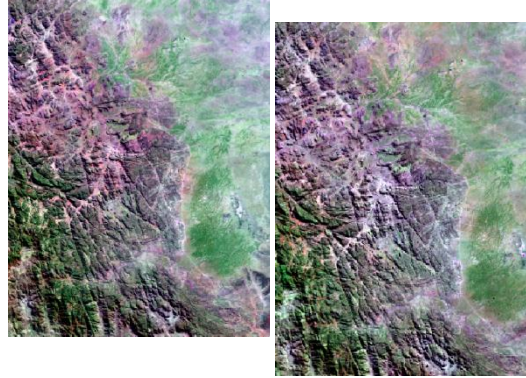
653 forest islands examined: 650 still existing



	number of islands studied	equal in size (contour unchanged) [%]	increase in size [%]	loss in size [%]	vanished [%]	newly estab- lished [%]
inside Comoé NP	379 = 100%	97,9	0,5	0,8	0,3	0,5
outside Comoé NP	274 = 100%	92,0	2,9	4,4	0,7	0,0

→ High stability of the forest-savanna pattern

Goetze, Hörsch & Porembski (2006), Journal of Biogeography.

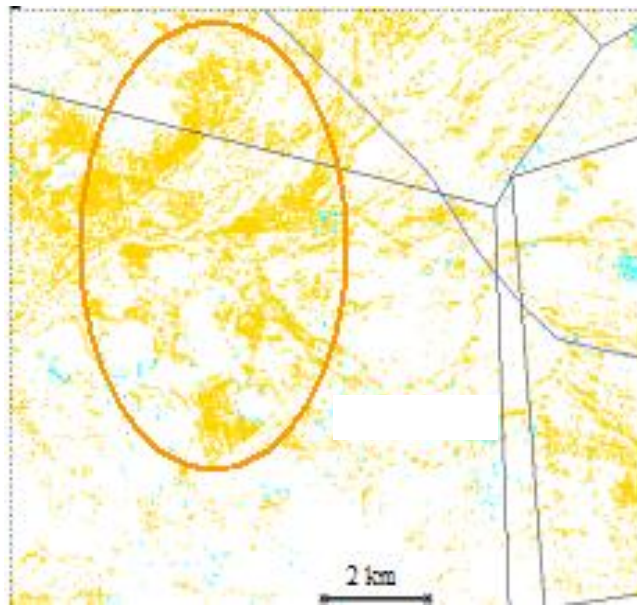
Multi-temporal analyses of Landsat data 1986 - 2005



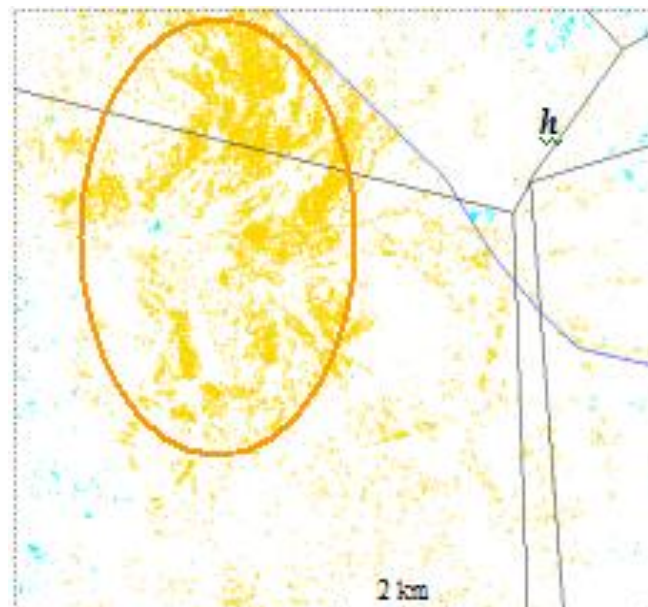
-  Change to grass
-  Change to shrubs

• **Changes dominantly non directional over time**



Persistent signs of increasing grass cover,



Dec 1986 / Dec 2002



Nov 1990 / May 2005

-  Change to grass
-  Change to shrubs

Conclusions

- Water availability patterns in space and time
- Forest islands occupy drier hilltops
 - less intense fires due to decreased grass biomass production
- Savanna fires and plant competitive processes
 - stability of forest –savanna pattern
- Direct competition for water, in favor of grass
- Evidence of increasing grassiness -sign of shift in seasonality of rainfall

Future perspectives

- suitable for modeling woody- grass dynamics
- baseline to the global challenge of understanding possible vegetation responses
- detecting vegetation change is advanced,
- interpretation, in terms of climatic & anthropogenic processes
- detailed land use patterns

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