WASCAL

West African Science Service Center on Climate Change and Adapted Land Use

Zentrum für Entwicklungsforschung
Center for Development Research
University of Bonn

Land degradation in Africa:

What we see is not what we get

NAS Presentation
A Sustainability Challenge: Food Security for All
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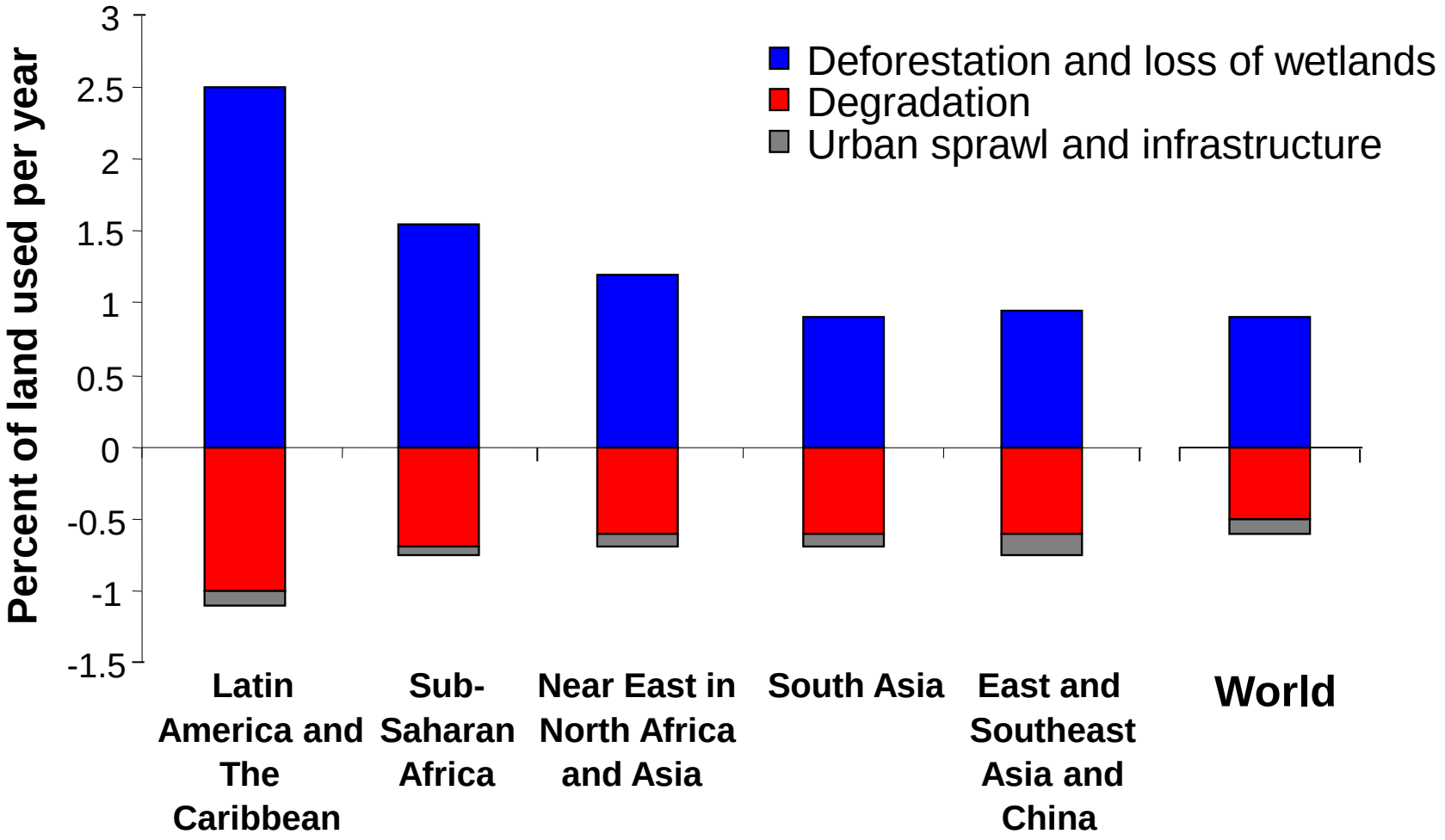
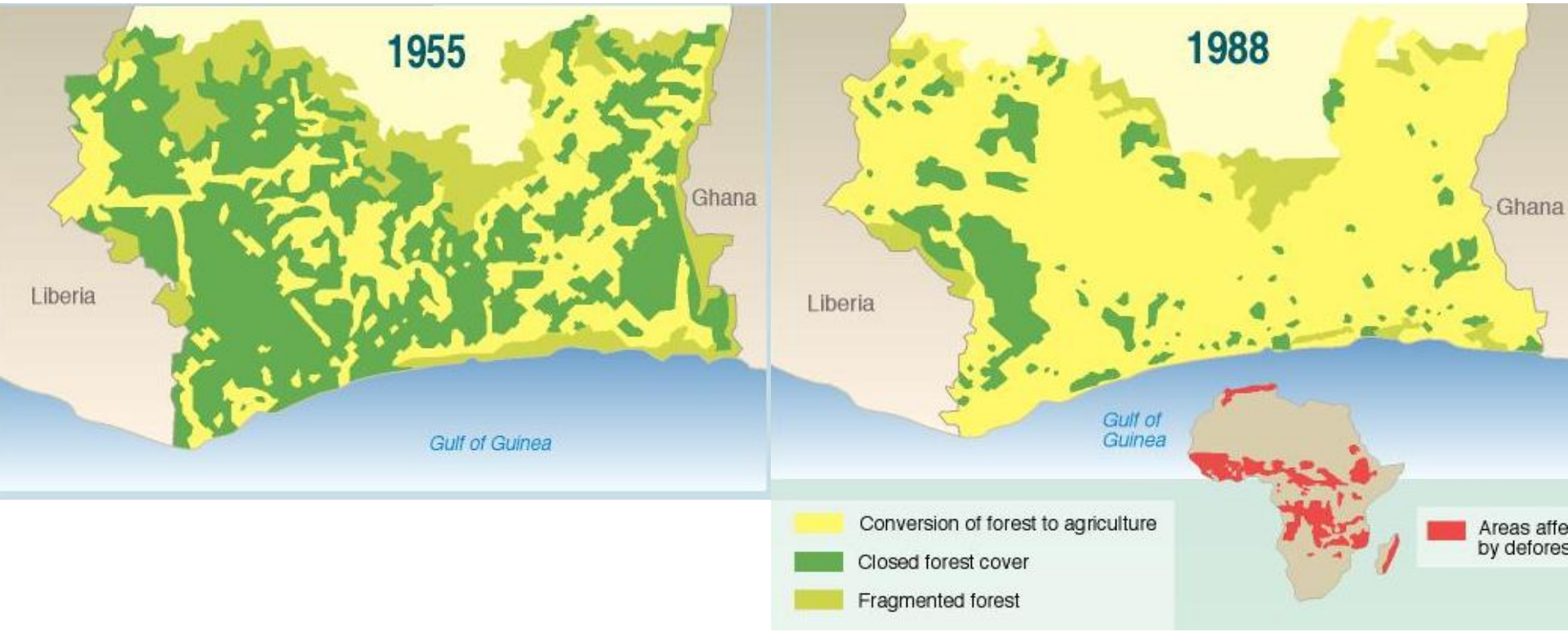
Change in three classes of land use 1960-2000



Deforestation in Cote d'Ivoire (source: UNEP-GRID



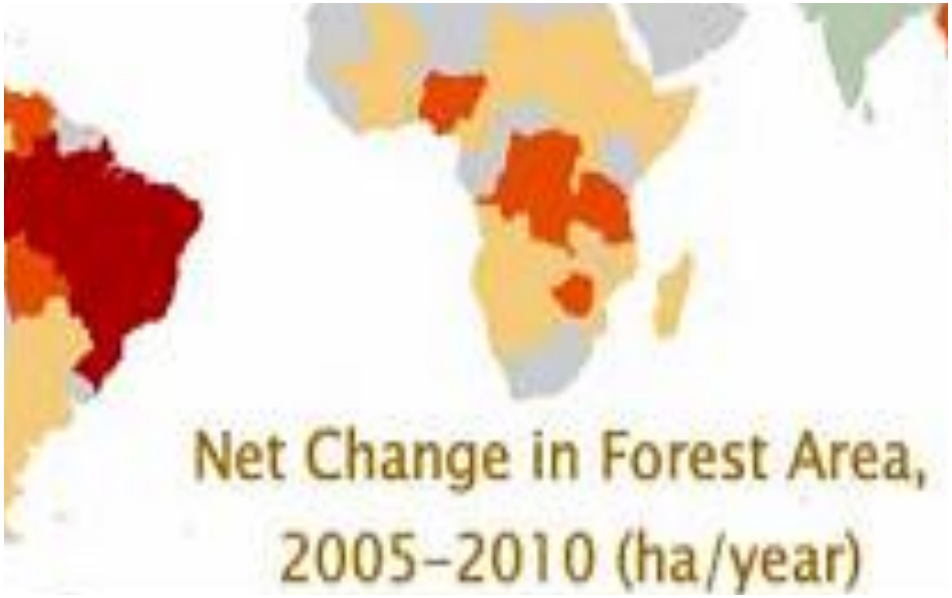
Land Use – Land Cover Change

- Deforestation
- Degradation & Fragmentation
- Fires

Loss/Gain in 1000

>500
250-500
50-250

50-250
250-500
>500



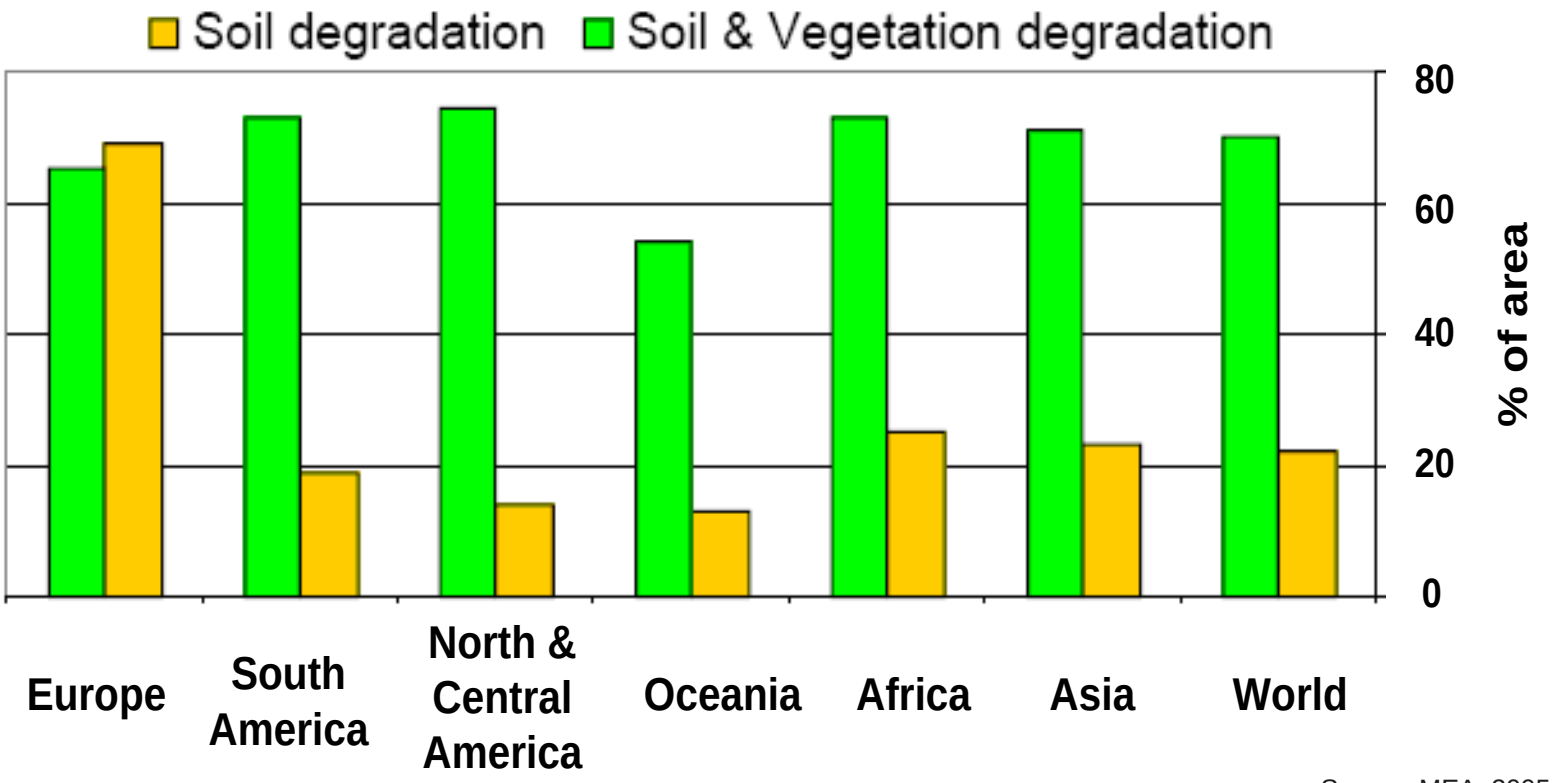
Net Change of Forest
Gains: plantations
Losses: Deforestation

Source: FAO, Global Forest Asessment 2010

Global forest cover

Source: Composite of FAO's 2005 Global Forest Resources Assessment and data from the World Agroforestry Centre. Zomer, R.J. et al. 2009. Trees on farm: analysis of global extent and geographical patterns of agroforestry. ICRAF Working Paper No 89. World Agroforestry Centre, Nairobi

Land degradation in various parts of the world

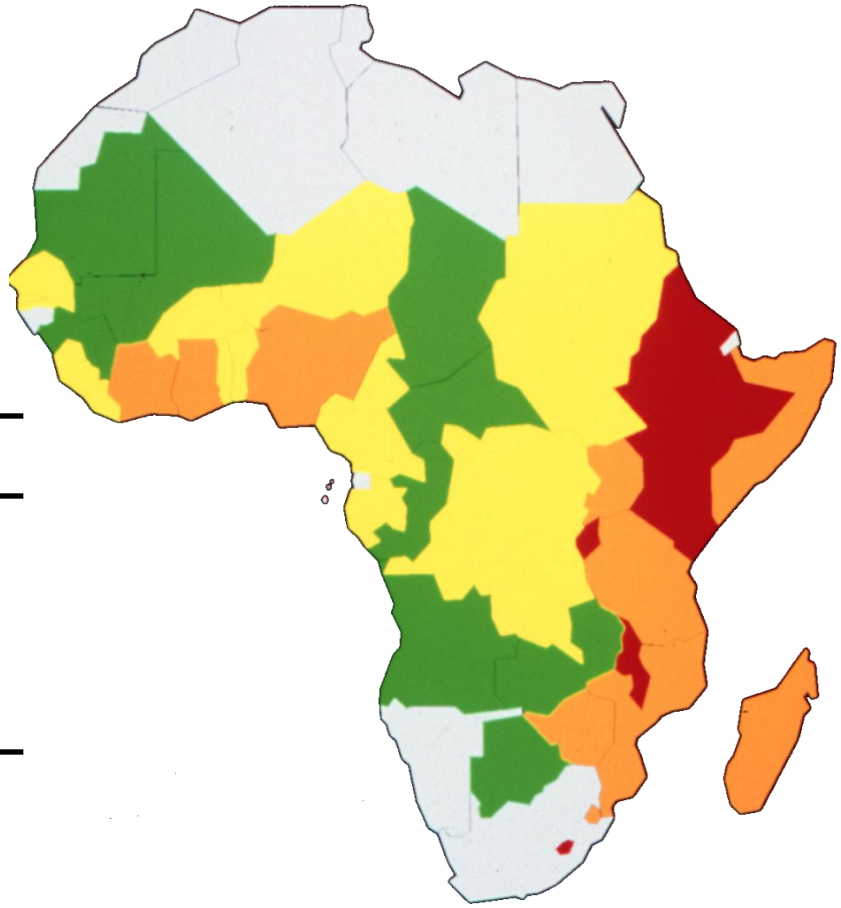


Source: MEA, 2005

Nutrient losses of Sub-Saharan Africa

Nutrient losses [kg ha^{-1} $year^{-1}$]

Class	N	P_2O_5	K_2O
Low	< 10	< 4	< 10
Moderate	10-20	4-7	10-20
High	21-40	8-15	21-40
Very high	> 40	> 15	> 40



Source: Stoorvogel & Smaling, 1990

Water erosion

Continent	Million ha
• Africa	227 (7%)
• Asia	441
• South America	123
• Central America	46
• North America	60
• Europe	114
• Oceania	83
• World total	1094

Land represents one of the most limited natural resources for rural livelihoods.

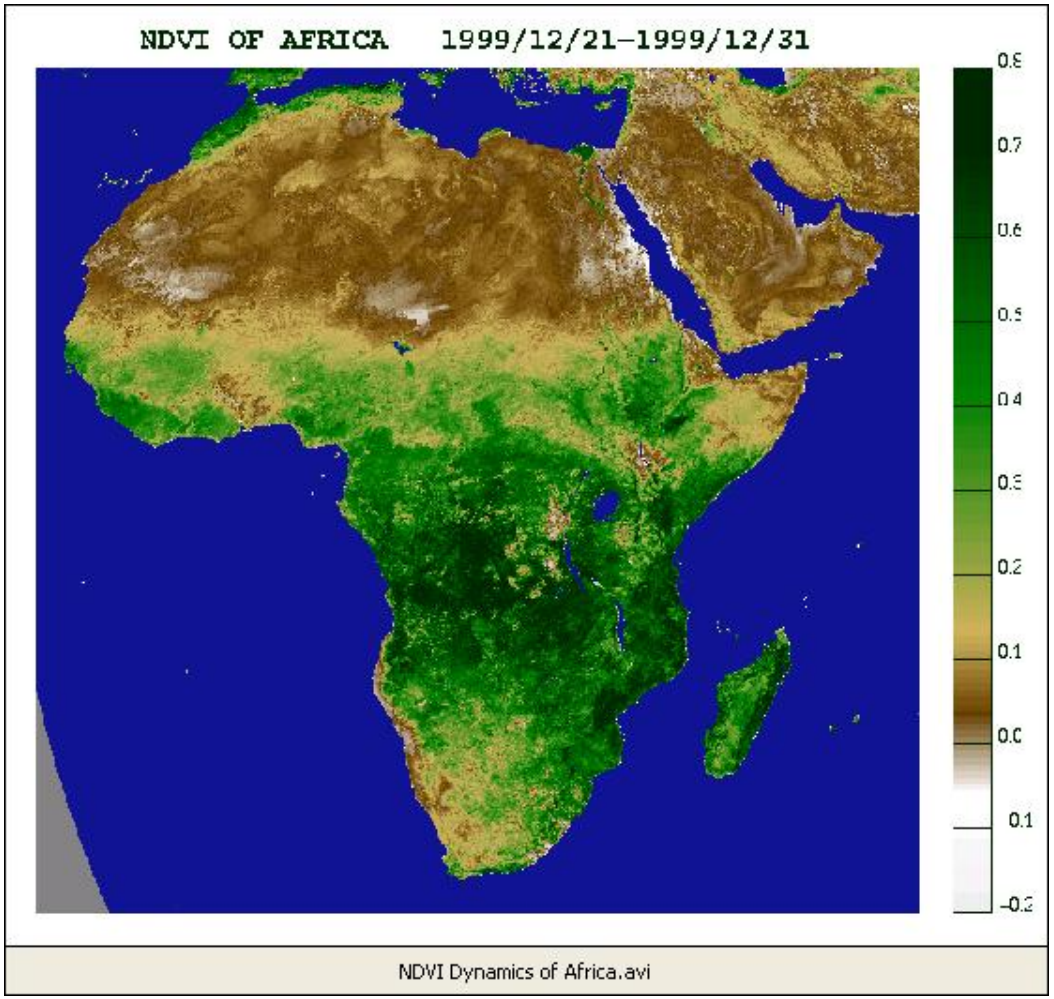
- The loss of revenue due to land degradation amounts to US $ 42.3 billion annually (UNEP 1992)

Questions:

How serious a threat is human-induced land degradation in SSA and where are the hotspot areas as seen from space?

I what we see also what we get?

AVHRR Normalized Difference Vegetation Index

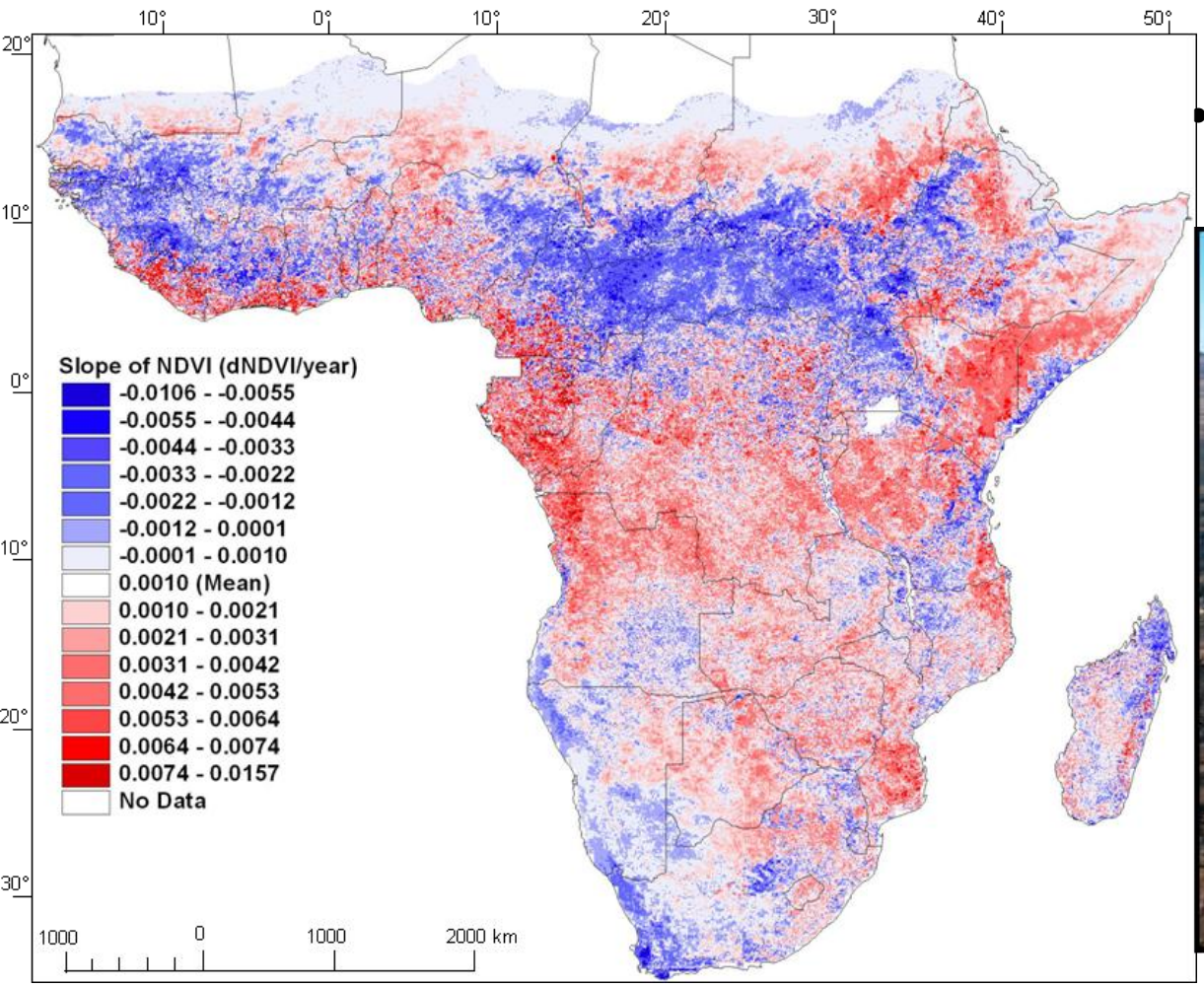


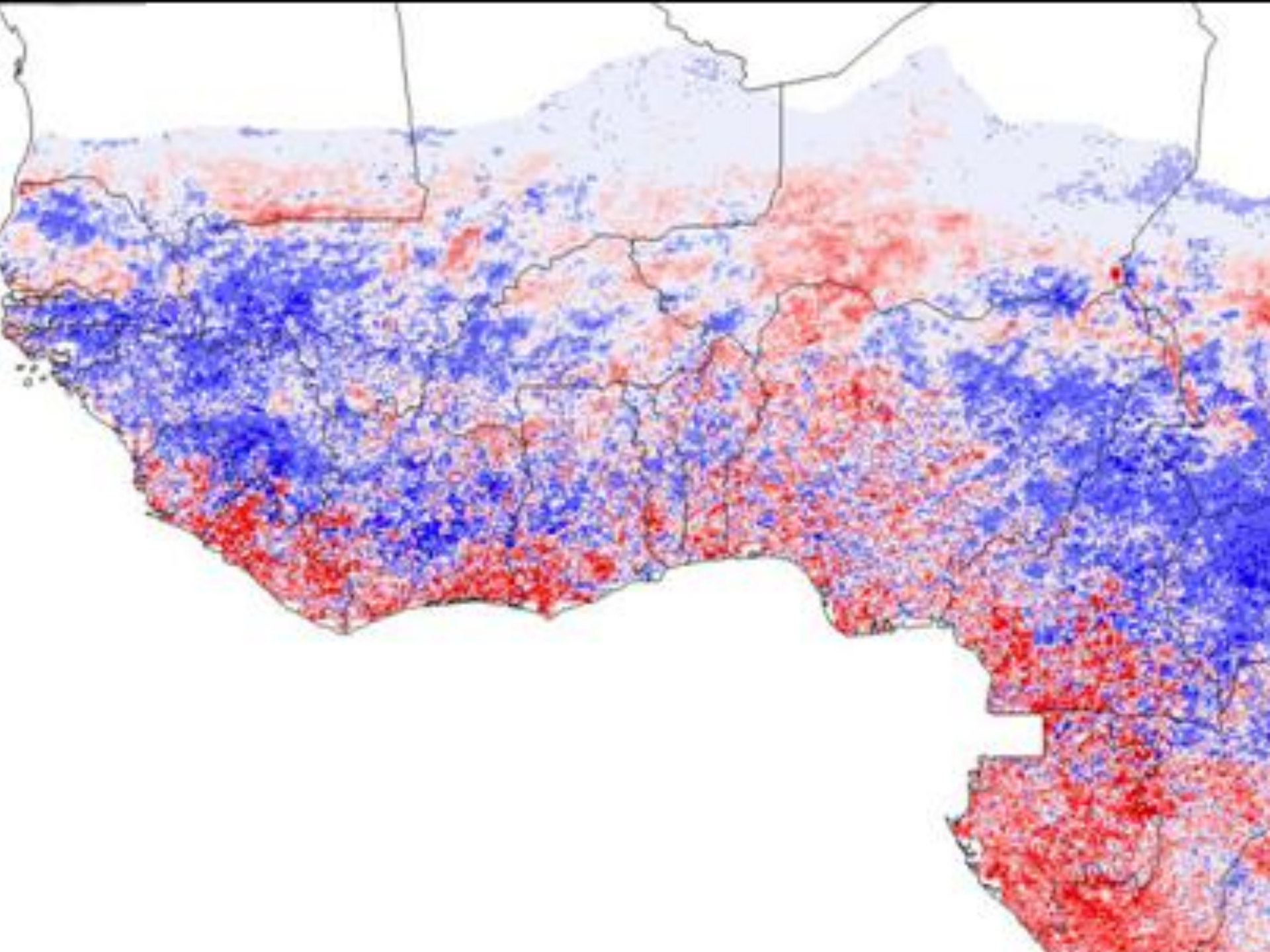
- AVHRR-NDVI data from GIMMS/GLCF
- NDVI as a proxy for Net Primary Productivity (NPP)
- Annual accumulative NDVI of year i*th* = bi-weekly NDVI x 24
- Mean of annual accumulative NDVI for the period 1982-2003

NDVI during the period 1982 – 2003

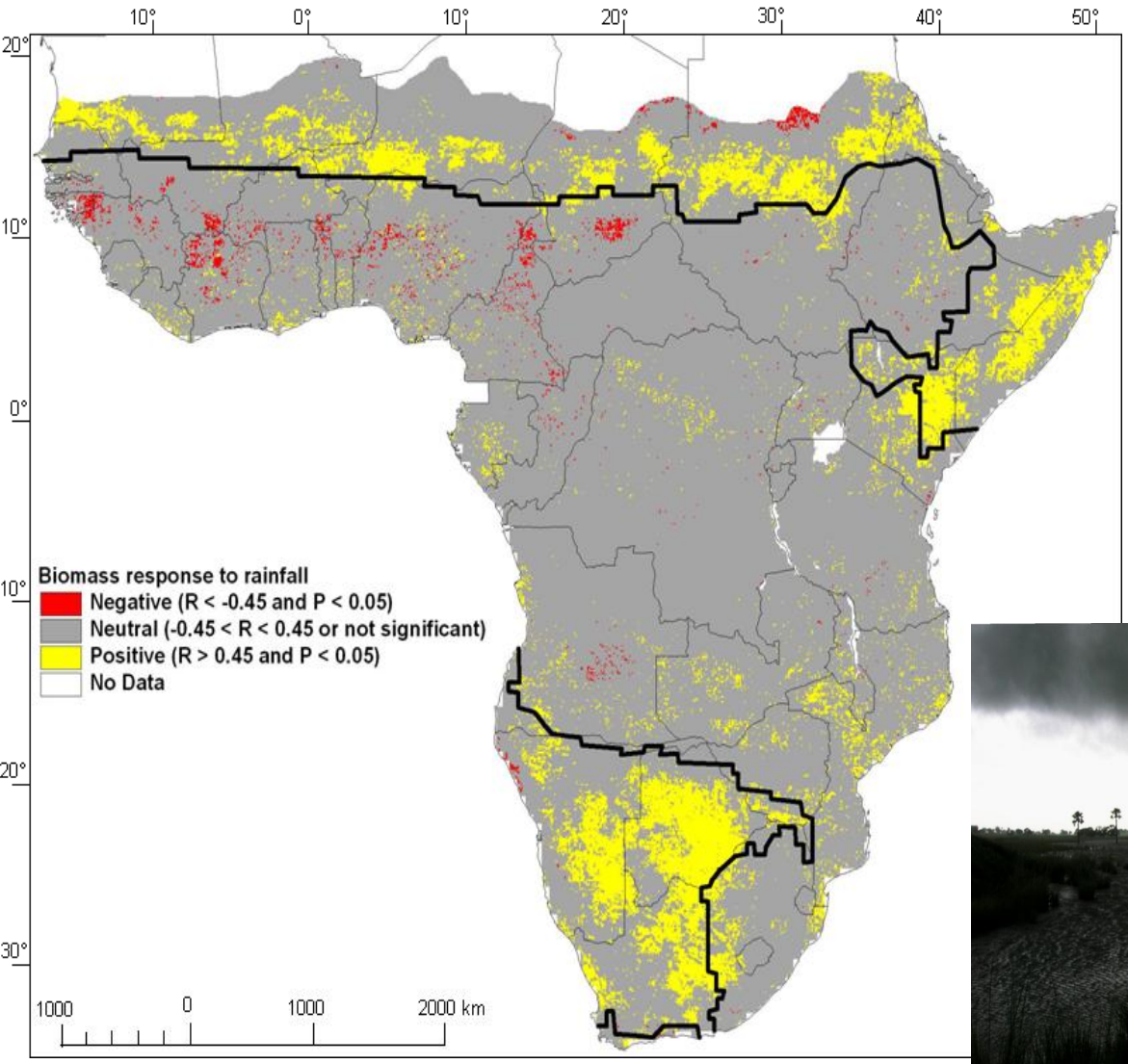
Significant shifts in green-leaf biomass between 1982 and 2003

- Long-term trend of annual NPP was measured using linear slope (A) of annual accumulative NDVI over time (*NDVI* = *A* x *year* + *B*)
- NDVI slope = ΔNDVI / year





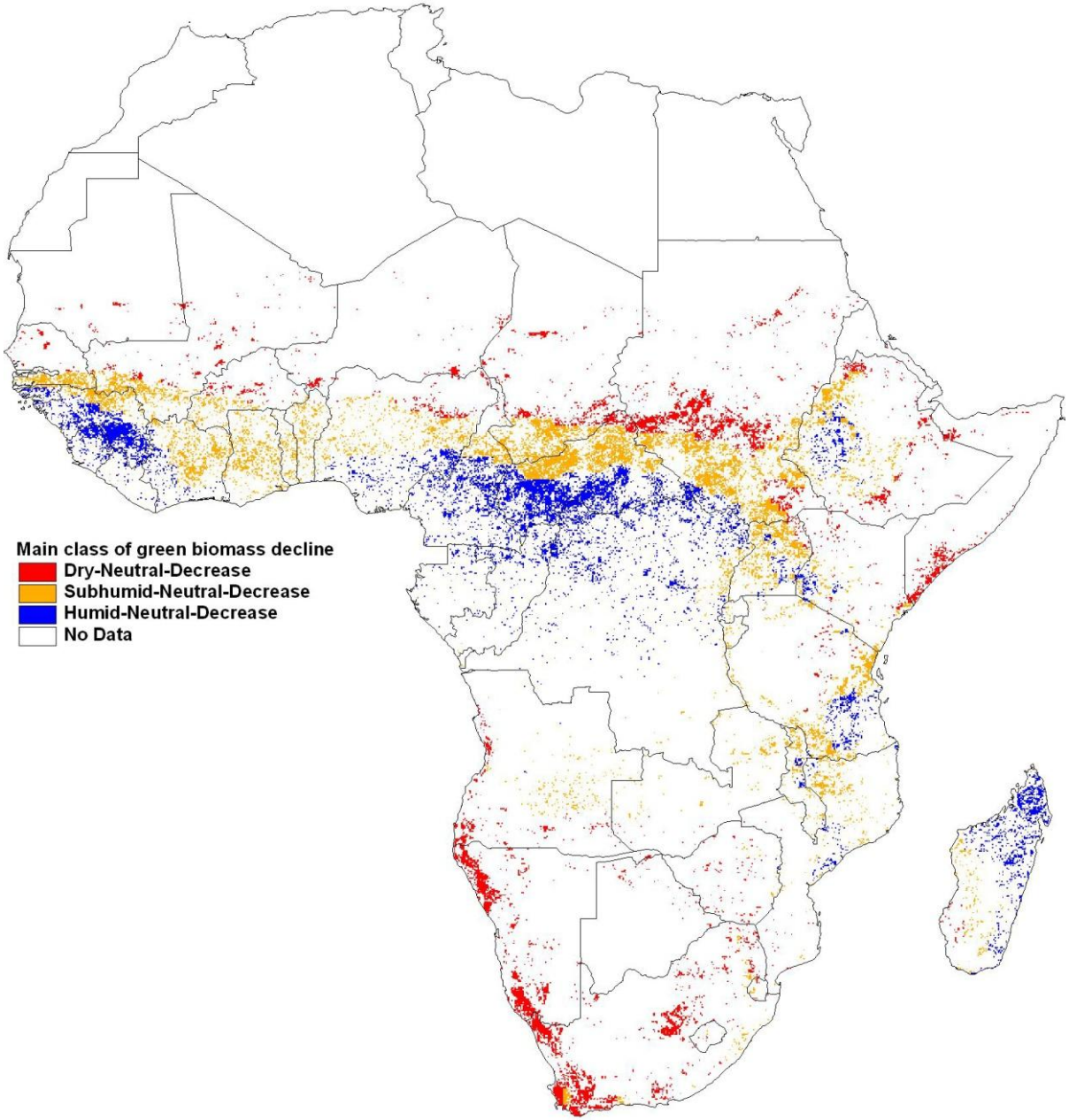
Areas where improvements in NDVI were significantly correlated with rainfall between 1982 and 2003



- Yellow areas of **improving** NDVI due to improved precipitation (largely in pastoral arid lands)
- Red areas where NDVI improved despite declining rainfall or where NDVI declined despite improving rainfall trends.

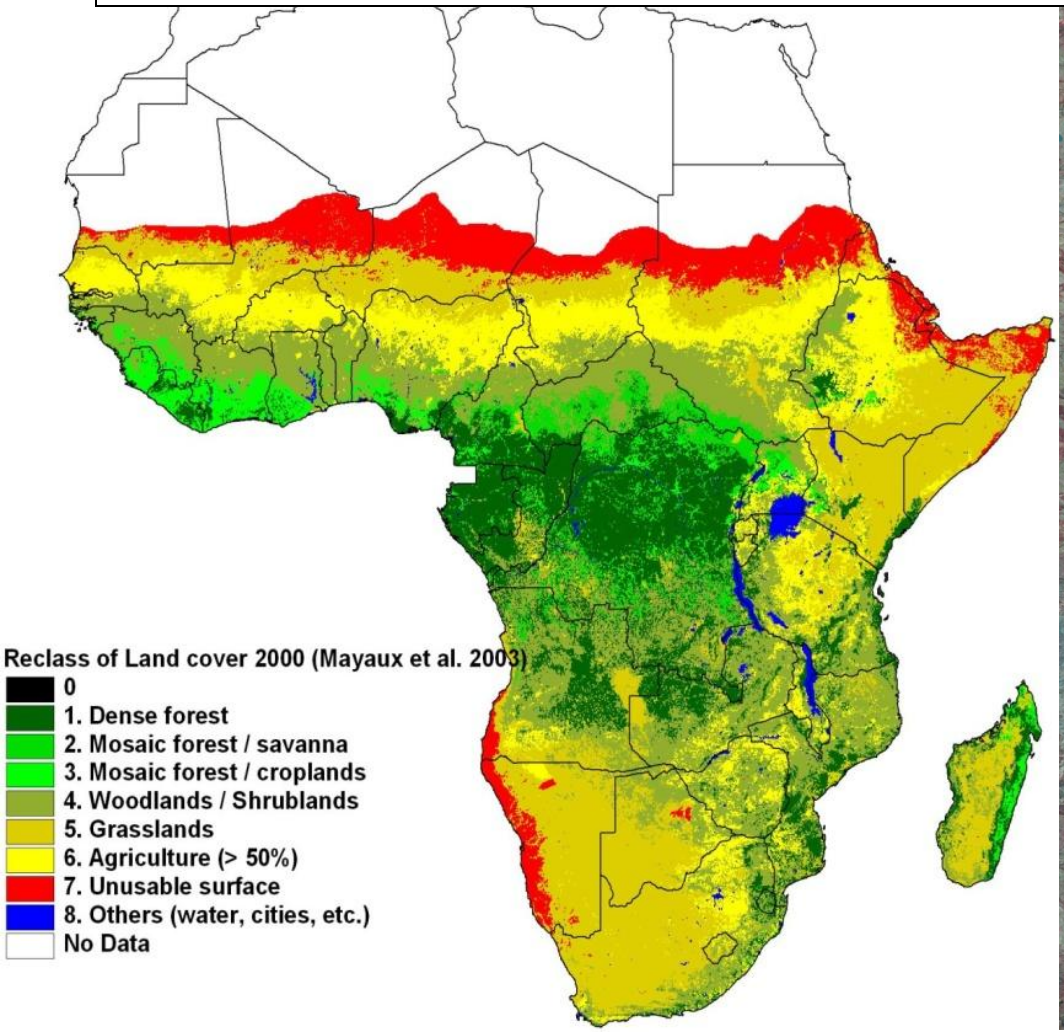
Zone	*Rainfall correlation*	*Area (km^2)*	*%*
Dry-	**Neutral**	**528443**	**26**
Subhumid -	**Neutral**	**854333**	**39**
Humid-	**Neutral**	**654332**	**30**

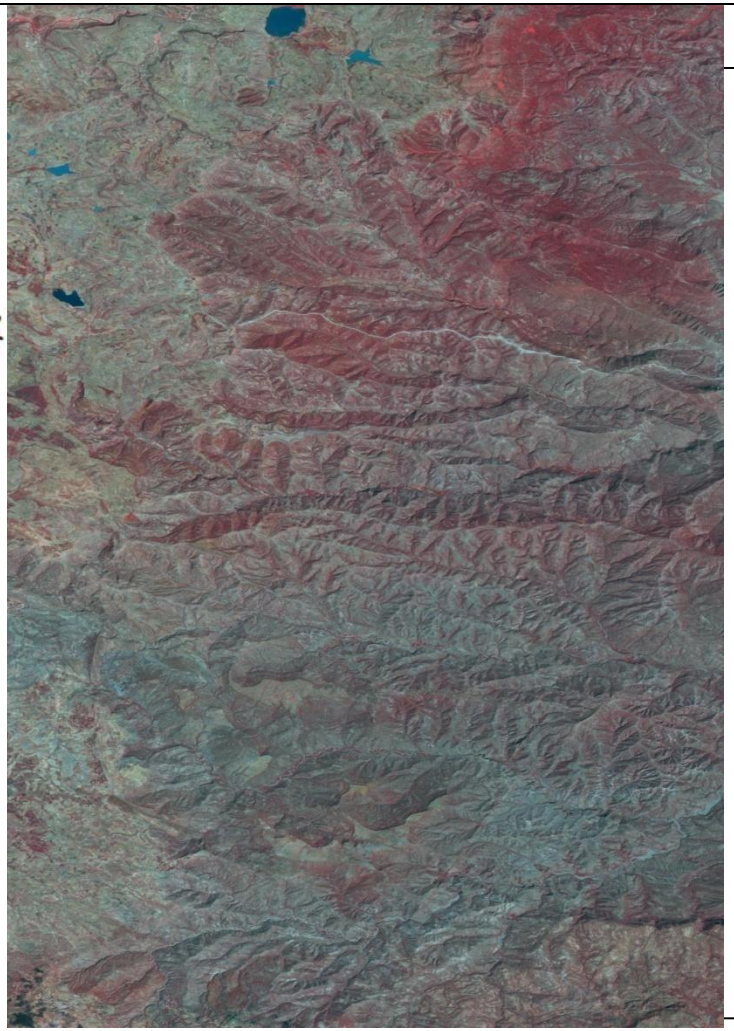
Area (km^2) of land with *declining* NDVI as a function rainfall zone and rainfall correlation



Human-induced vegetation decline in different rainfall zones (1982-2003)

Major land-cover classes in 2000 extracted from GLC2000 data (Mayaux et al., 2003)





Area of land-use/cover types calculated for each degradation class across soil/terrain constraints for zones not affected by rainfall trends.

Climate zone	*Area of land-use/cover type (1000km^2)*							*Total area (1000 km^2)*
	Dense forest	*Forest/ Savanna*	*Forest/ Cropland*	*Woodland/ Shrubland*	*Grassland*	*Agriculture*	*Others*	
Dry	10.5	0,6	0	103	201	126	97	*528*
Subhumid-	54	29	37	574	25	112	24	*855*
Humid-	166	137	83	203	35	25	8	*654*
*Total biomass declining zone**	230	166	119	879	252	260	130	2036
Total area in SSA	3370	677	808	5730	5560	3212	2324	21680

Preliminary Conclusions. By 2000:

Land degradation has affected 10% of the SSA (2 million km^2)

Agricultural land (380.000 km^2)

Grassland (250.000 km^2)

Degrading land has below average population density

60 million people live on land that is degrading

How does this fit with other oberservations?

Biomass accrual

0.63 ± 0.31 Mg ha^{-1} yr^{-1}

over the past 4 decades

for closed-canopy tropical forest in Africa

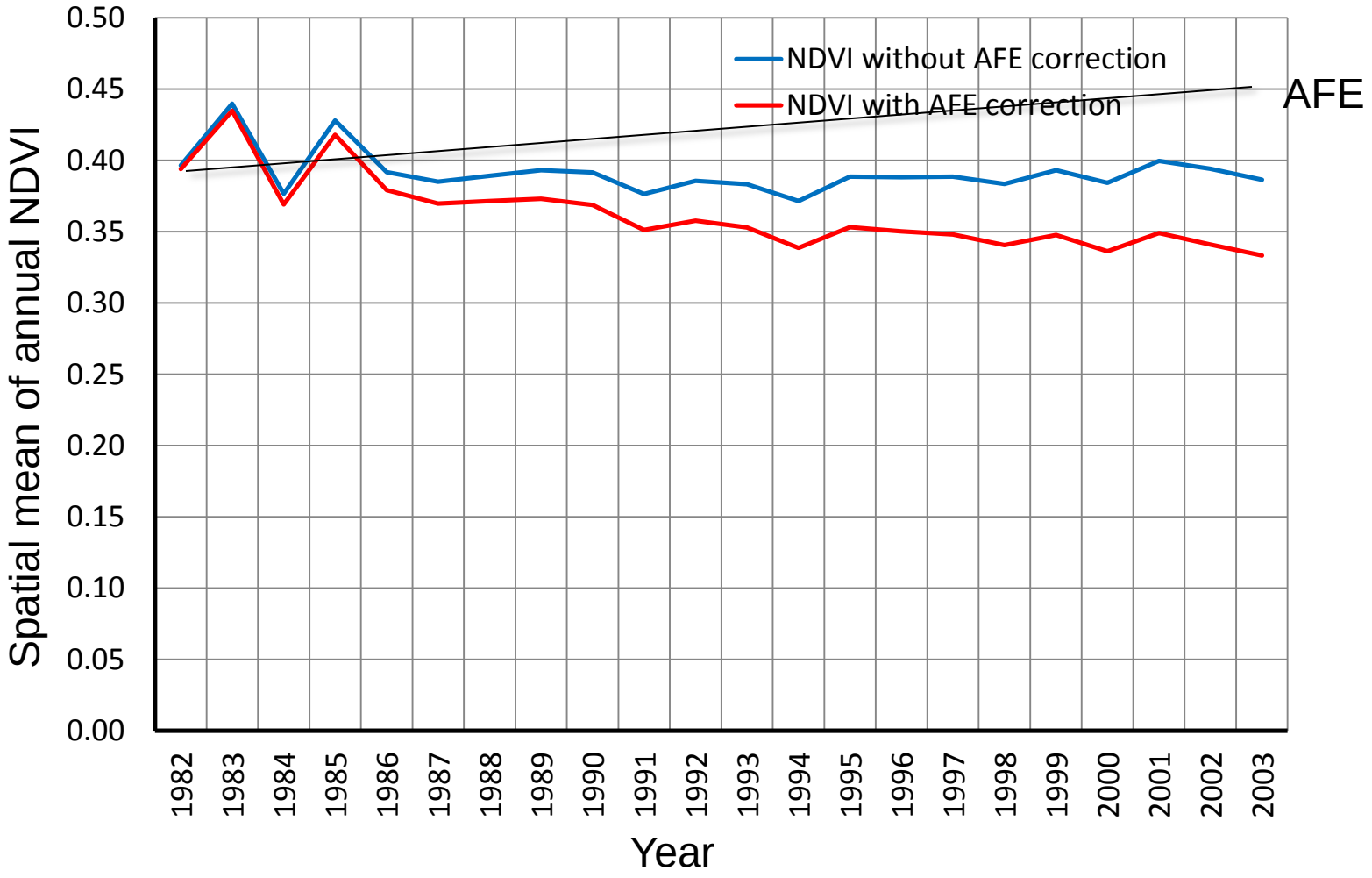
Nature 457:

1003 – 1006.

NDVI trends in the areas of no human disturbance (< 2 pers./km2) with increasing NDVI and no significant correlation between NDVI and rainfall.

Precipitation zone	Spatial average of NDVI slope (*A*)	Area (1000km^2)
Arid	**0.0012**	**686**
Semi-arid	**0.0025**	**144**
Sub-humid	**0.0028**	**178**
Humid	**0.0036**	**270**
Total		**1,279**

Shift in NDVI in SSA
without and with correction for Atmospheric Fertilization Effect (AFE)



Note: The time-series calculations were done for the area with a significant NDVI decline after AFE correction.

Shifts in green-leaf biomass between 1982 and 2003 without and with atmospheric correction

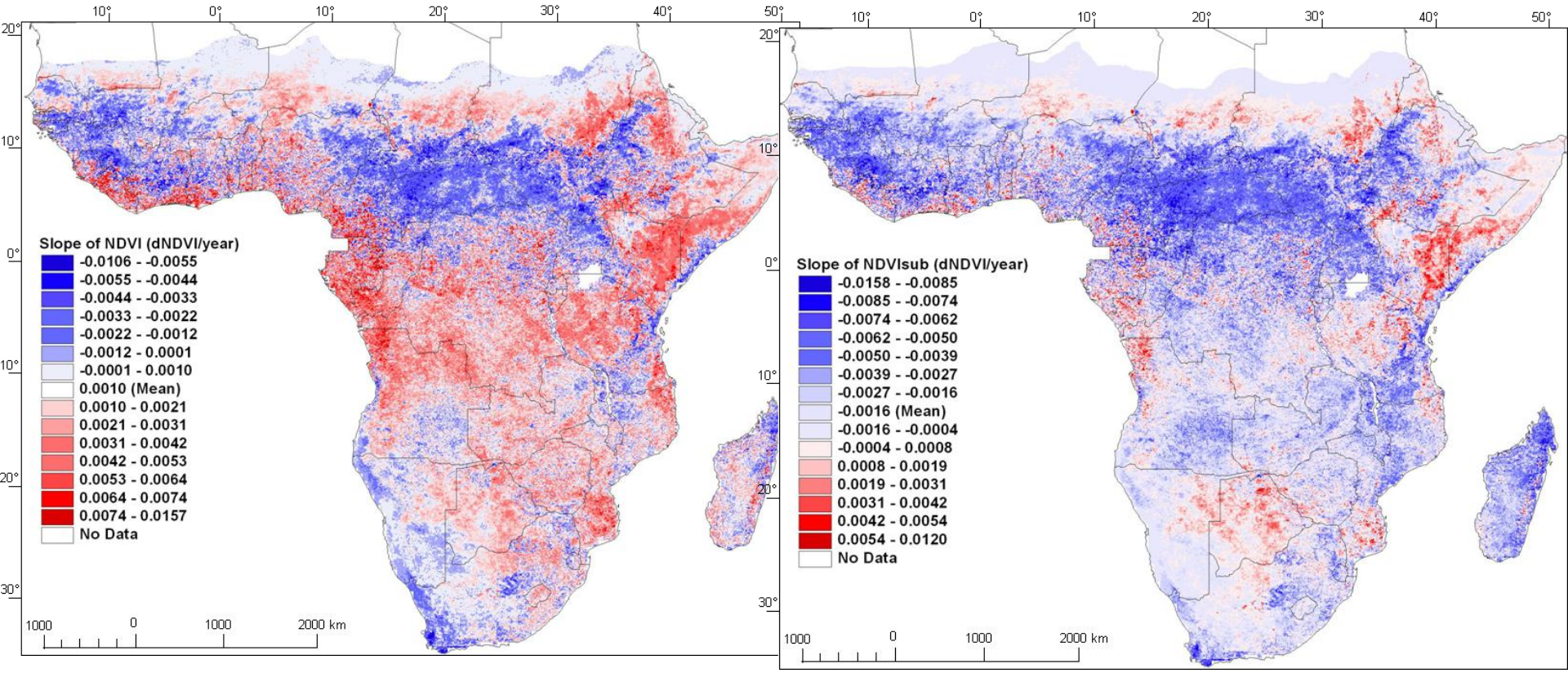
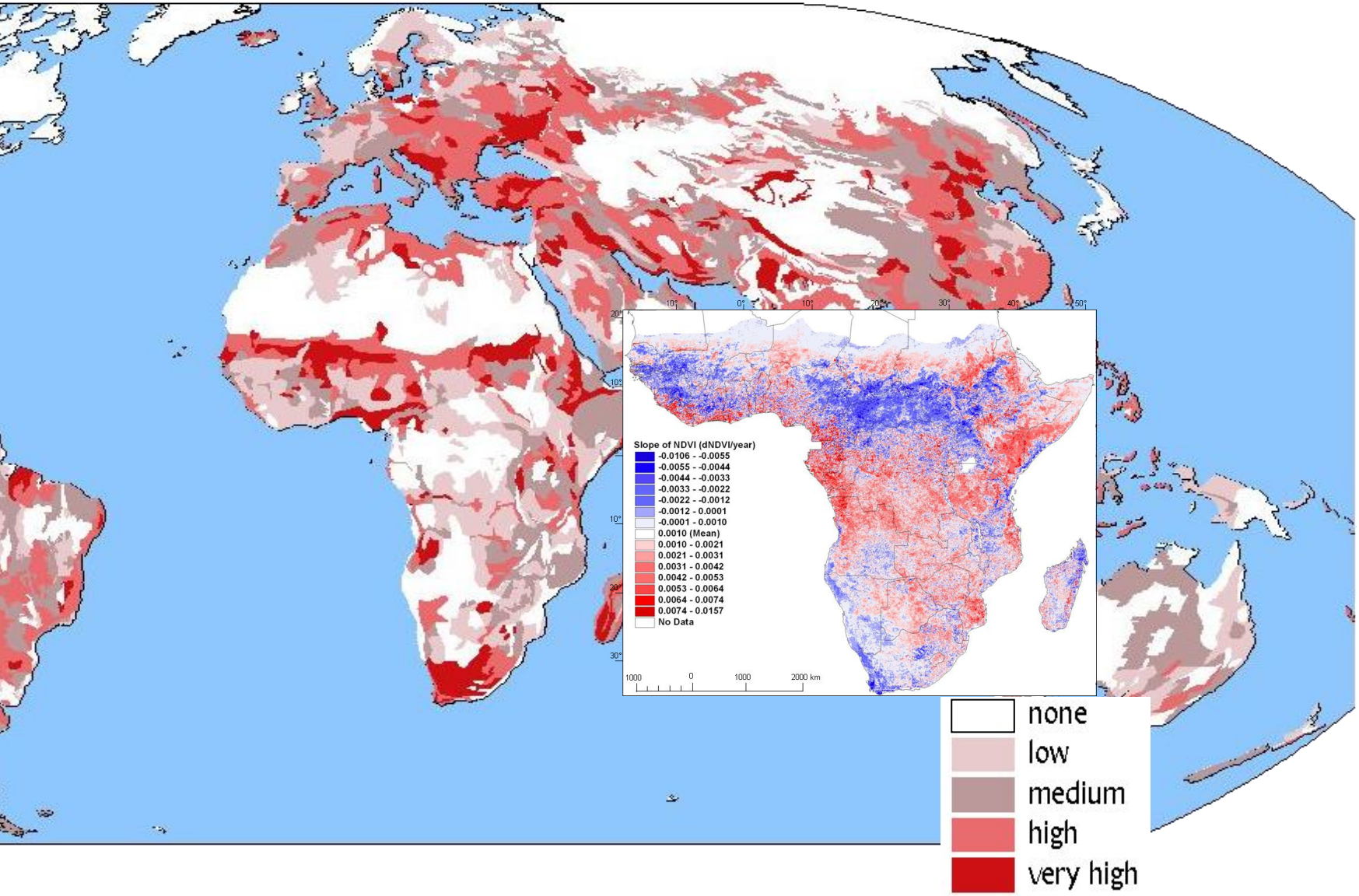


Fig. S2B. Linear slope of annual NDVI over the period 1982 – 2003 before (left) and after. Exclusion of the atmospheric fertilization effect

Severity of human-induced soil degradation



Source: GLASOD, Oldeman et al., 1990

Area of land degradation and soil degradation for each land use type
In regions not affected by rainfall trends (Out of 21.7 million km²)

Degradation class	***Area of land-use/cover type (1000km²)***							*Total area (1000 km²)*
	Dense forest	*Forest/ Savanna*	*Forest/ Cropland*	*Woodland / Shrubland*	*Grassland*	***Agricul-ture***	*Others*	
Total area with land degradation	*230*	*166*	*119*	*879*	*252*	***260***	*130*	***2036***
Potential area with soil degradation	466	276	254	1,633	951	1,003	1,327	5,910

Extended Conclusions

- **The land impacted by human activity is 3-4 times as large as visible, masked by GHG emissions**

- **Over 200 million people in SSA live on land that is experiencing soil degradation, threatening food security**

- **At the current rate of degradation, this century will see some serious conflicts over land resources**

- **…..Food for Thought**

Thank you for your attention