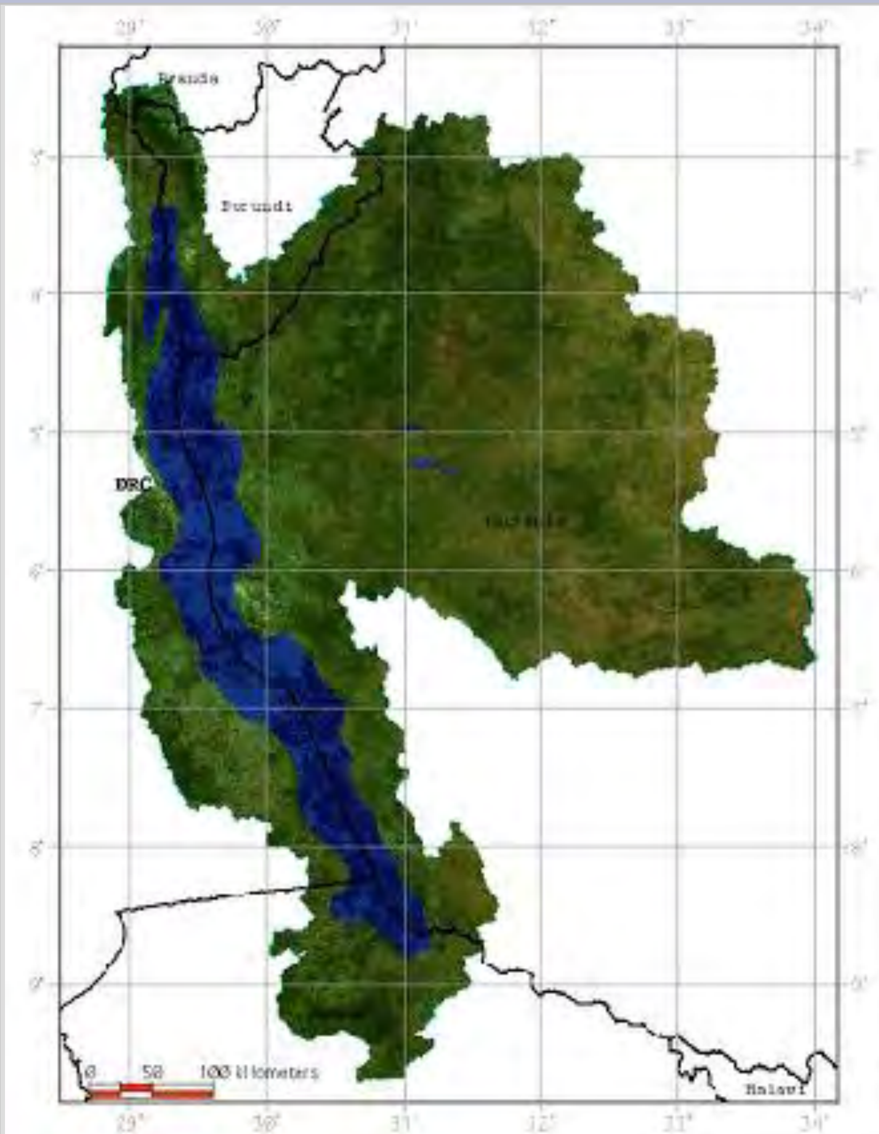
Lake Tanganyika Basin

Land cover change and degradation hotspots



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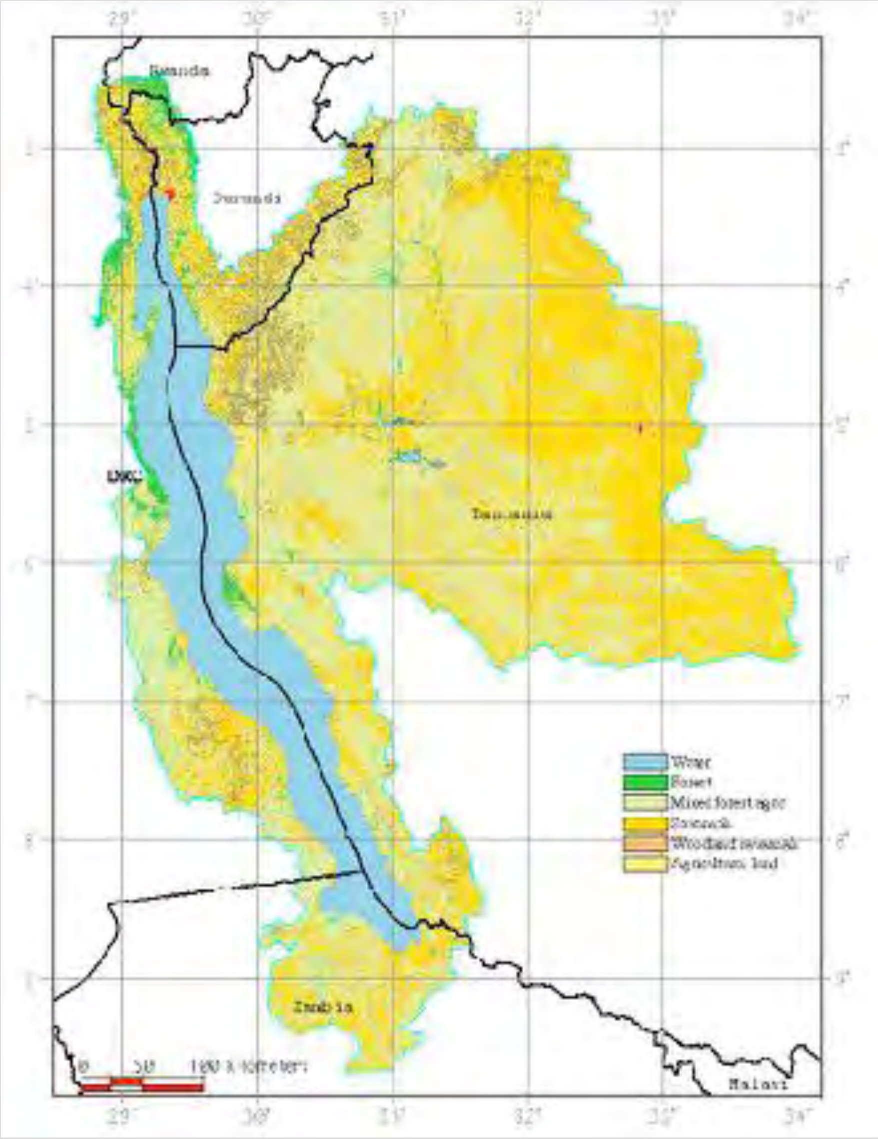
prepared for LTRIMP by Thomas Gumbricht

World Agroforestry Centre, ICRAF

Nairobi 29 June 2010

Lake Tanganyika Basin
Land degradation hotspots



This landcover map is one of several recent global landcover maps. This map is included in the framework dataset assembled for this project. Other datasets assembled include:

Topography(SRTM)
Land cover
Tree /bare/ herbaceous cover
Population density (1960-2015 prognosis)
Travel accessibility
Political boundaries, infrastructure, etc
Protected areas
Geology
Soil

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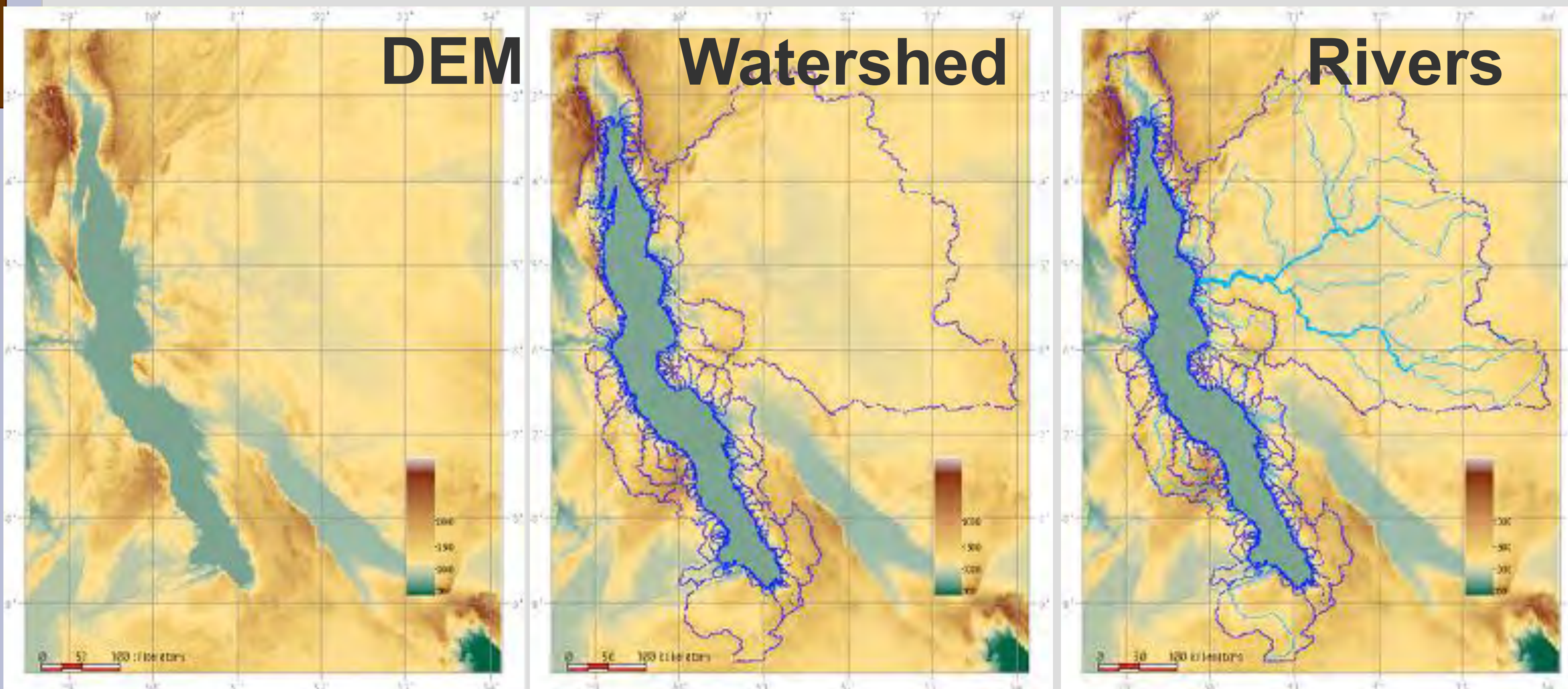
Lake Tanganyika Basin
Land degradation hotspots

DEM extraction of hydrography



The Digital Elevation Model was used to create maps of watersheds and streams.

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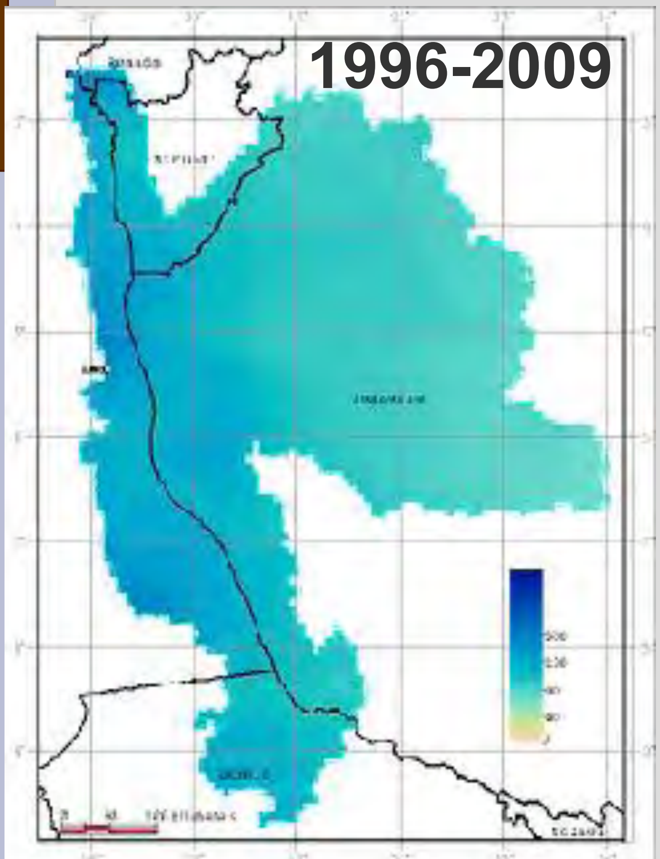
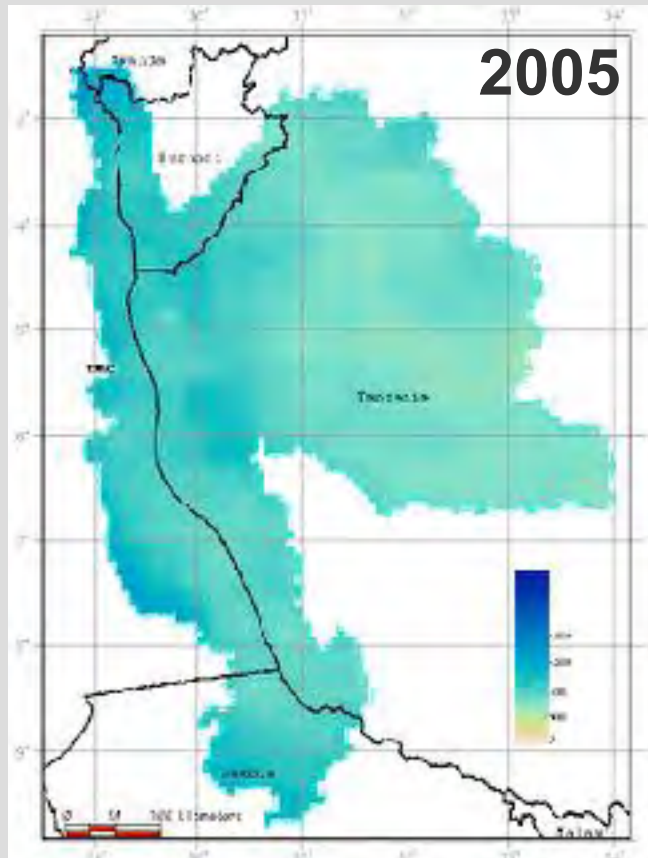
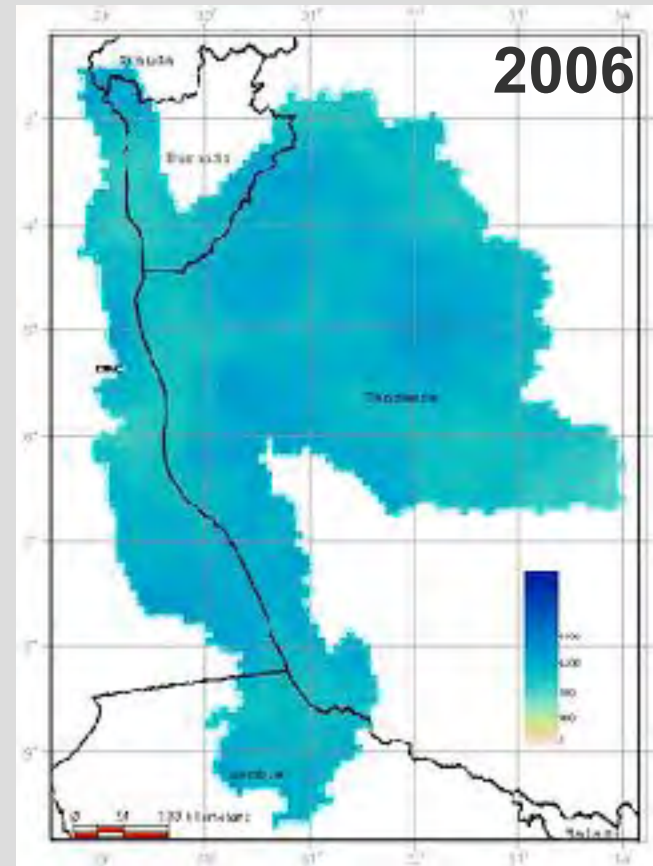
Lake Tanganyika Basin
Land degradation hotspots

Rainfall spatial and temporal variation







The rainfall maps are from satellite estimates combined with station data, and are available from June 2005. Only two rainfall stations in the vicinity of Lake Tanganyika are used to generate these maps. More rainfall and climate data are needed.

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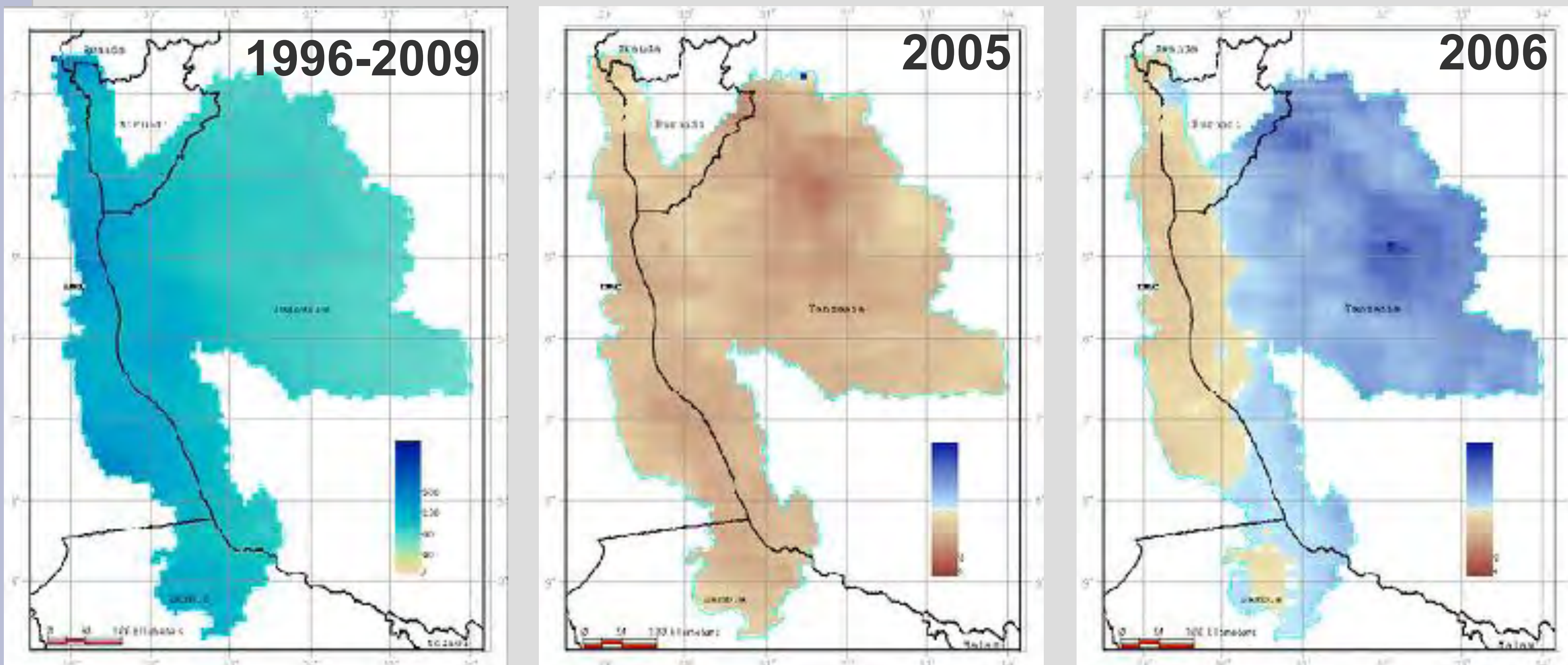
Land degradation hotspots

Normalized rainfall illustrating variation



Normalization is done by comparing the value from an individual year with the long term average value – it gives a more accurate result when anaysing trends.

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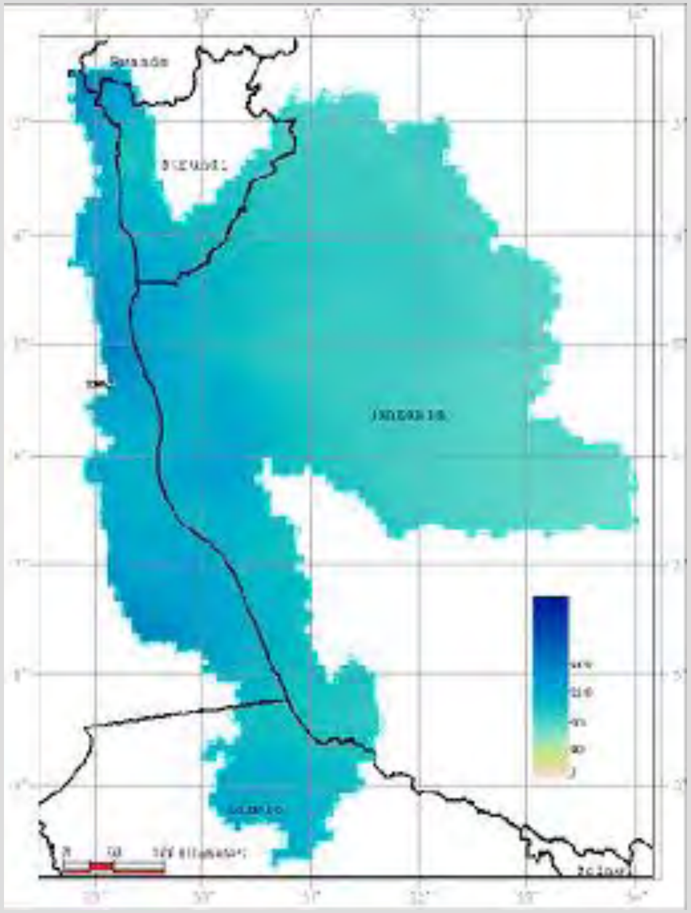
Land degradation hotspots

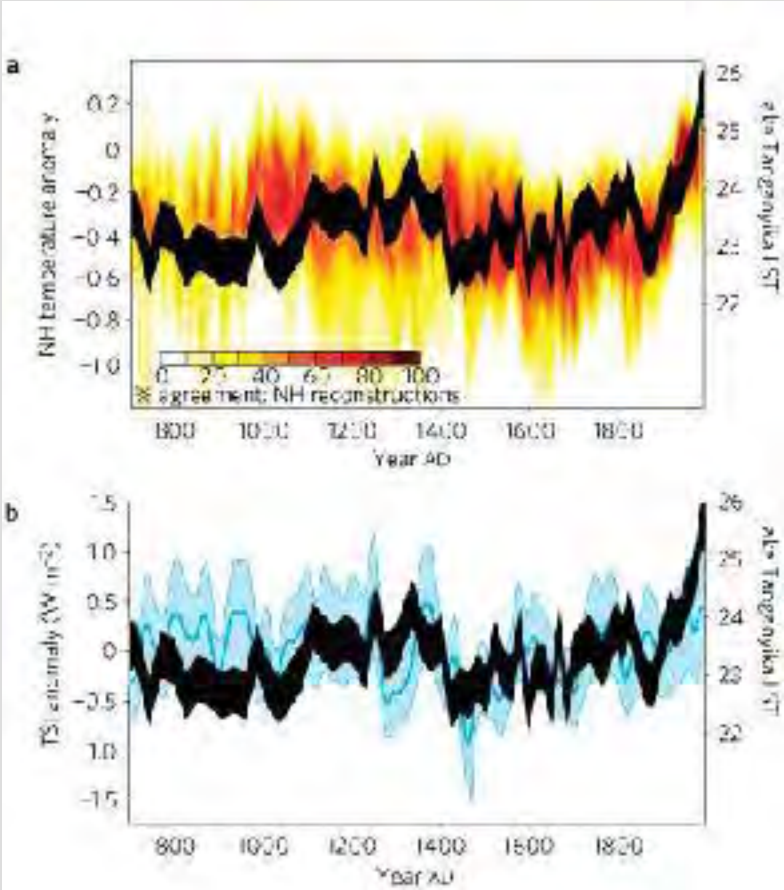
Country statistics

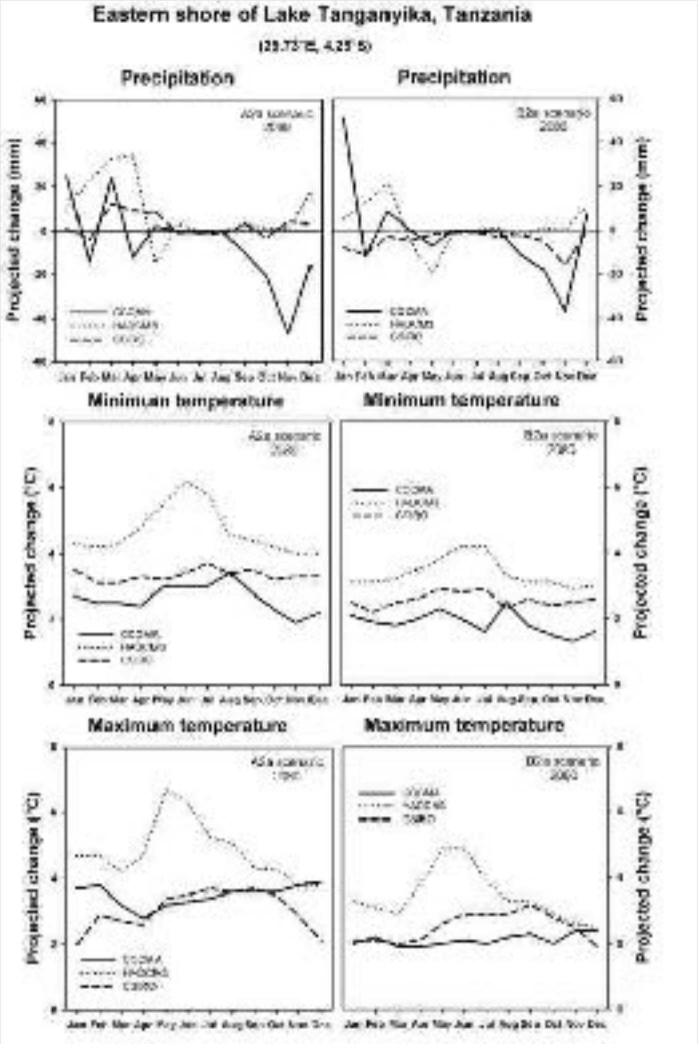


Country	Basin Area (km^2)	Basin %	Average annual rainfall (mm)
Burundi	14000	6	1070
Dem Rep. Congo	39000	16	1240
Tanzania	161000	67	925
Zambia	16000	7	1080
Rwanda	10000	4	1320
Total	240000	100	

Lake Tanganyika Basin
Land degradation hotspots

Climate past and future





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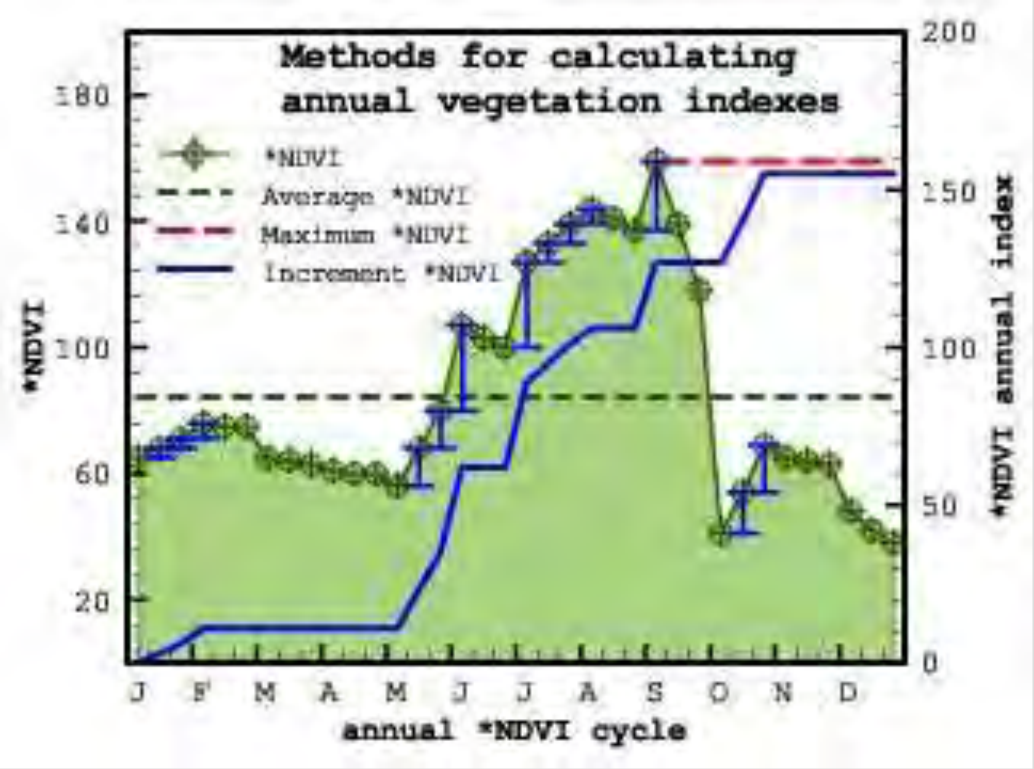
Lake Tanganyika Basin
Land degradation hotspots

Long-term vegetation changes in the Lake Tanganyika Basin were captured using satellite derived Normalized Different Vegetation Index (NDVI) data in 8 km resolution from several generations of Advanced Very High Resolution Radiometer (AVHRR) sensors. Vegetation changes for the shorter period 2001 to 2008 was screened using the Enhanced Vegetation Index (EVI) data in 250 m resolution from the Moderate Resolution Image Spectroradiometer (MODIS). Both sensors acquire daily images of the earth. Herein we use 10-day (AVHHR) and 8-day (MODIS) cloud free compositions to create annual time series of vegetation growth.



Calculating the annual vegetation production from time-series of satellite images can be done in several ways. The most common is to take the average (or sum) of the vegetation in each image over an annual cycle. For agricultural studies the maximum value is considered better – assumed to represent standing crop just before harvest. In grazing landscapes the intermittent gorwth of grass and herbs is not capured by the maximum or the average vegetation, but can be estiamted by the annual increments in growths.

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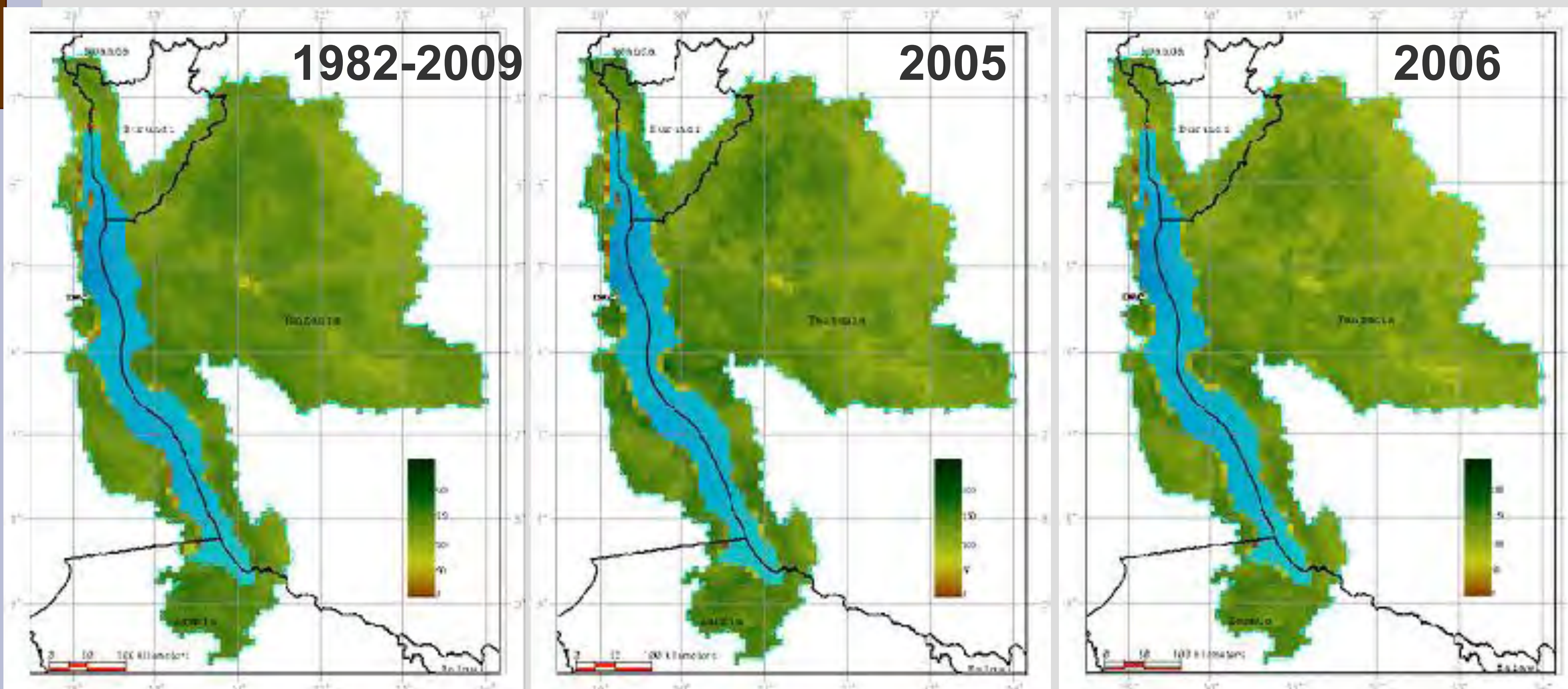
Land degradation hotspots

AVHRR NDVI (8km) average vegetation growth



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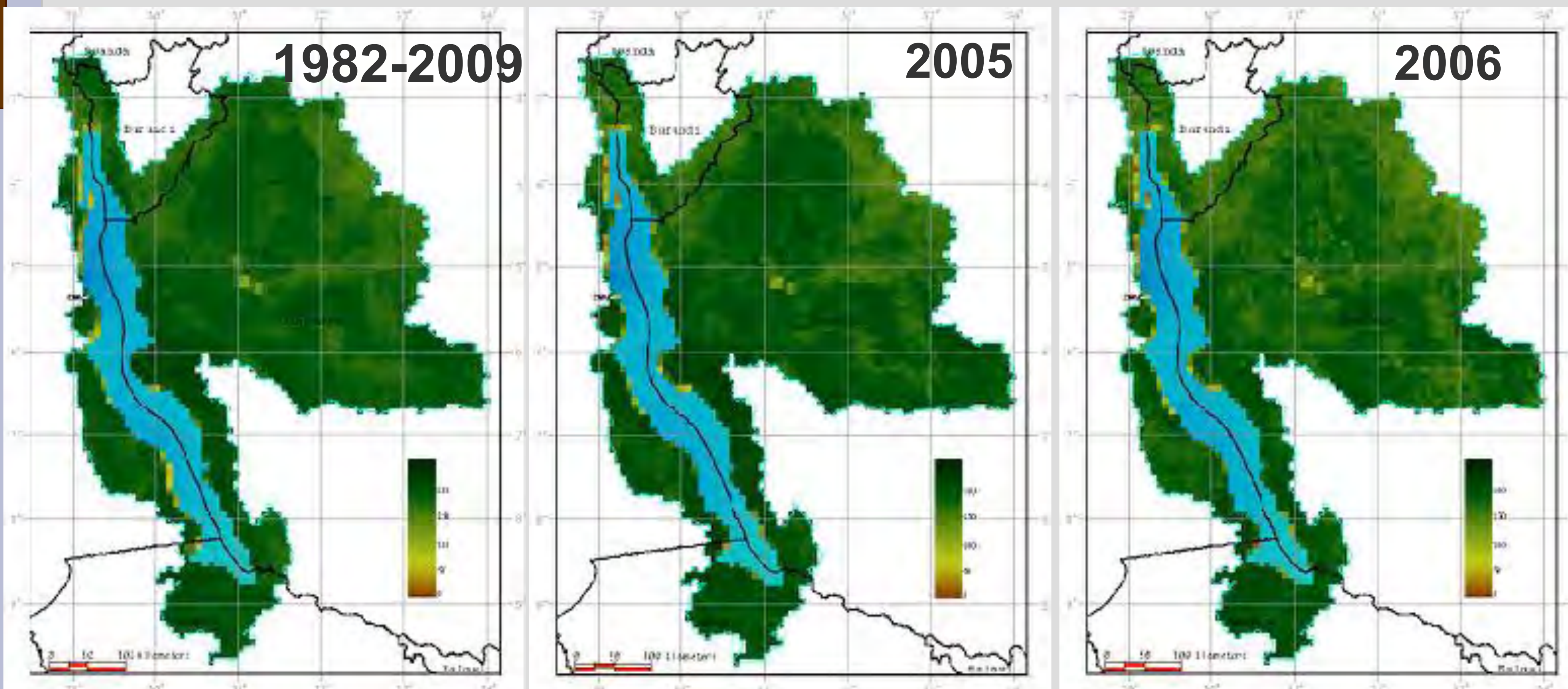
Land degradation hotspots

AVHRR NDVI (8km) maximum vegetation growth



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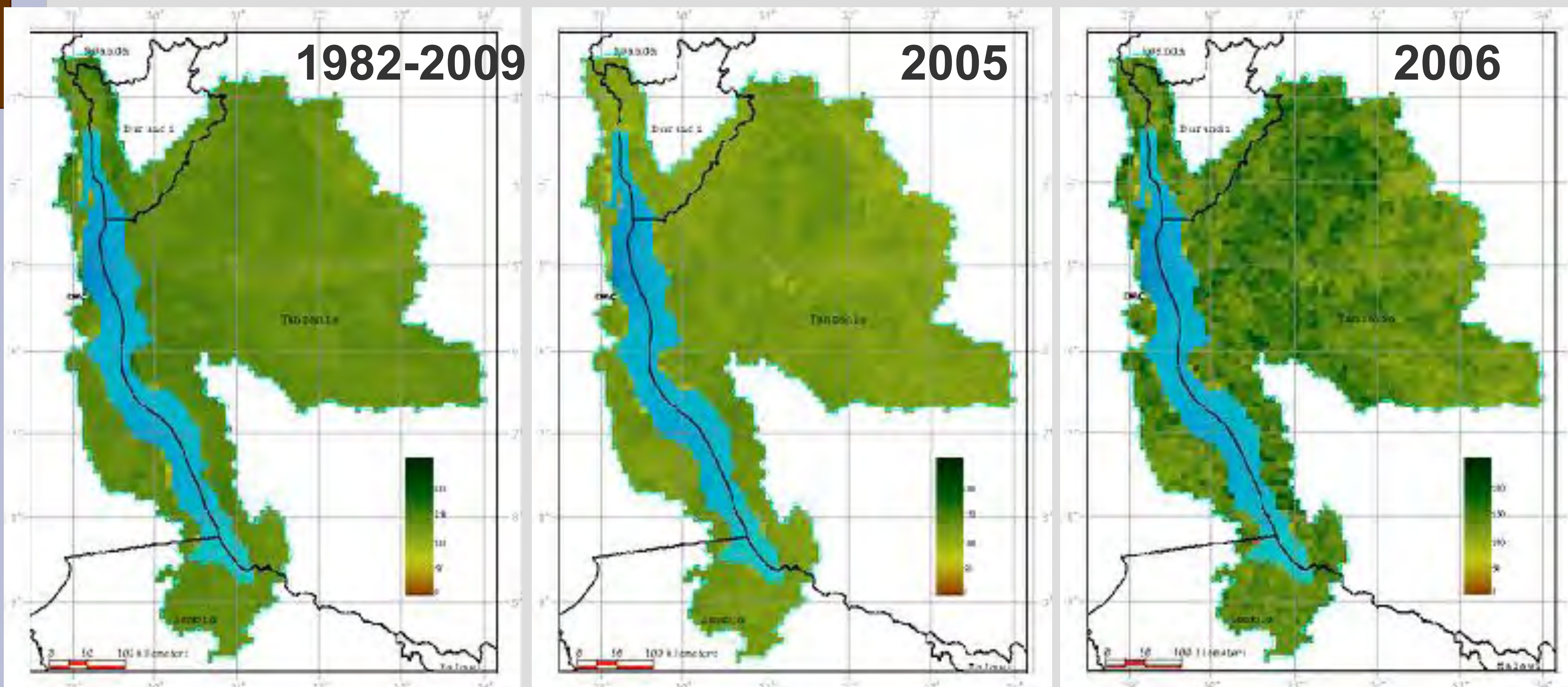
Land degradation hotspots

AVHRR NDVI (8km) increment vegetation growth



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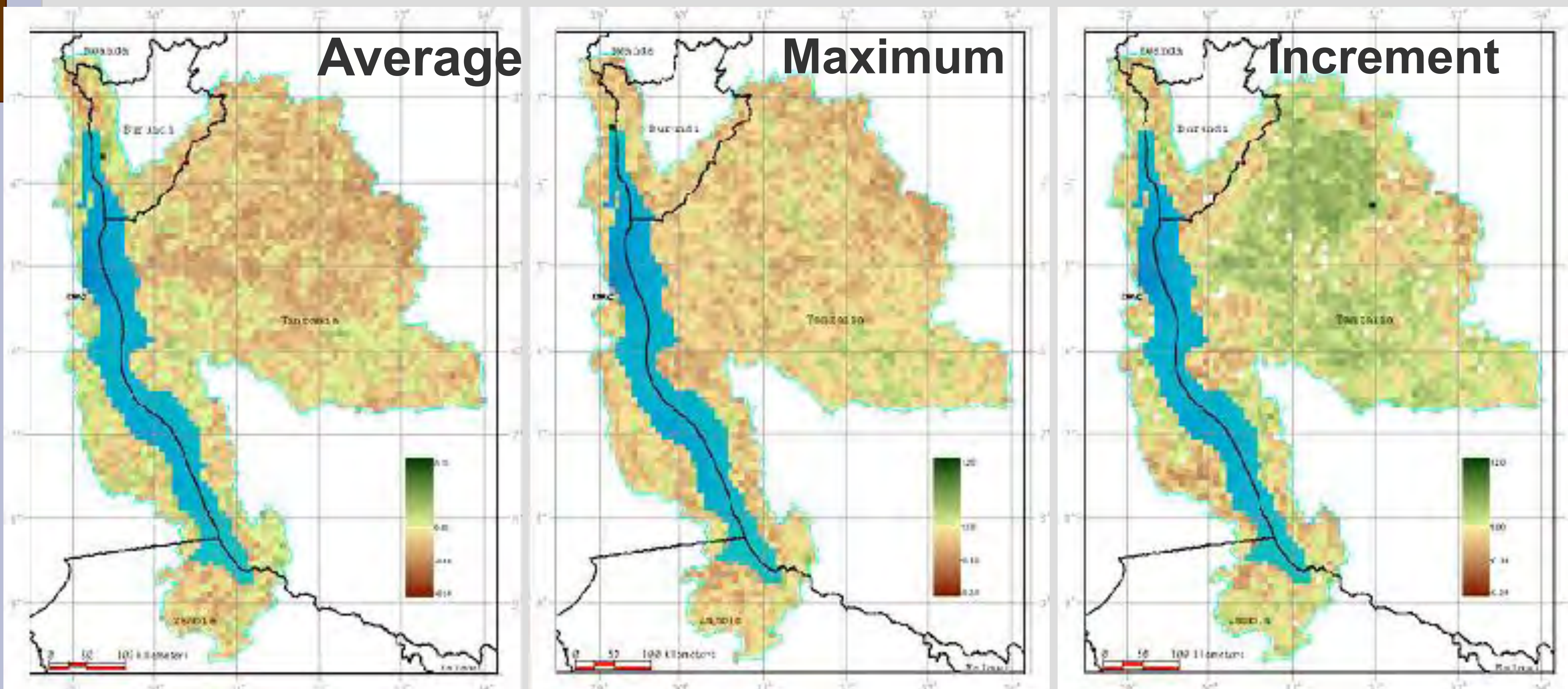
Land degradation hotspots

AVHHR NDVI (8km) normalised trend 1982-2009



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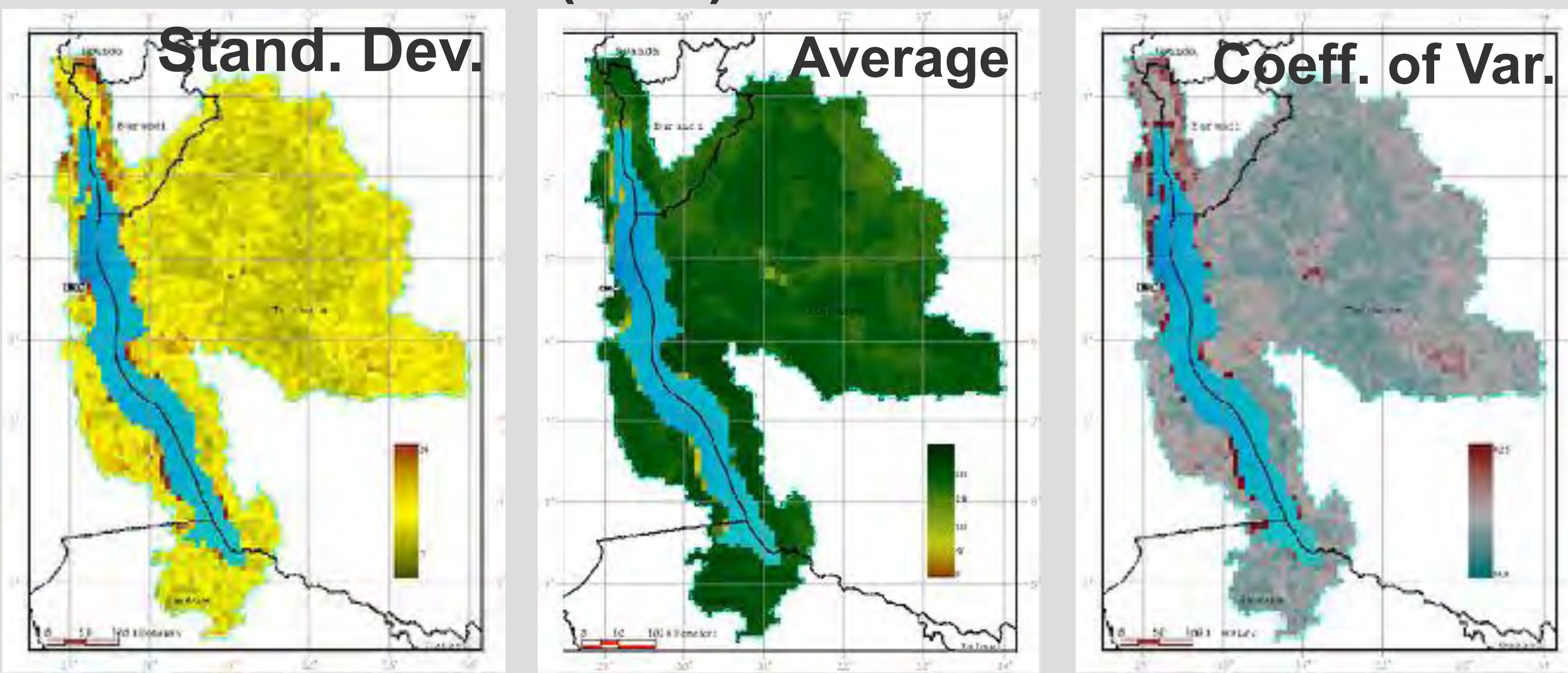
AVHRR NDVI (8km) maximum CoV 1982-2009



Standard Deviation / average = Coefficient of Variation

The Coefficient of Variation (CoV) is a measure of the vegetation year to year stability.
A high CoV is an indication of unstable (degraded) conditions.

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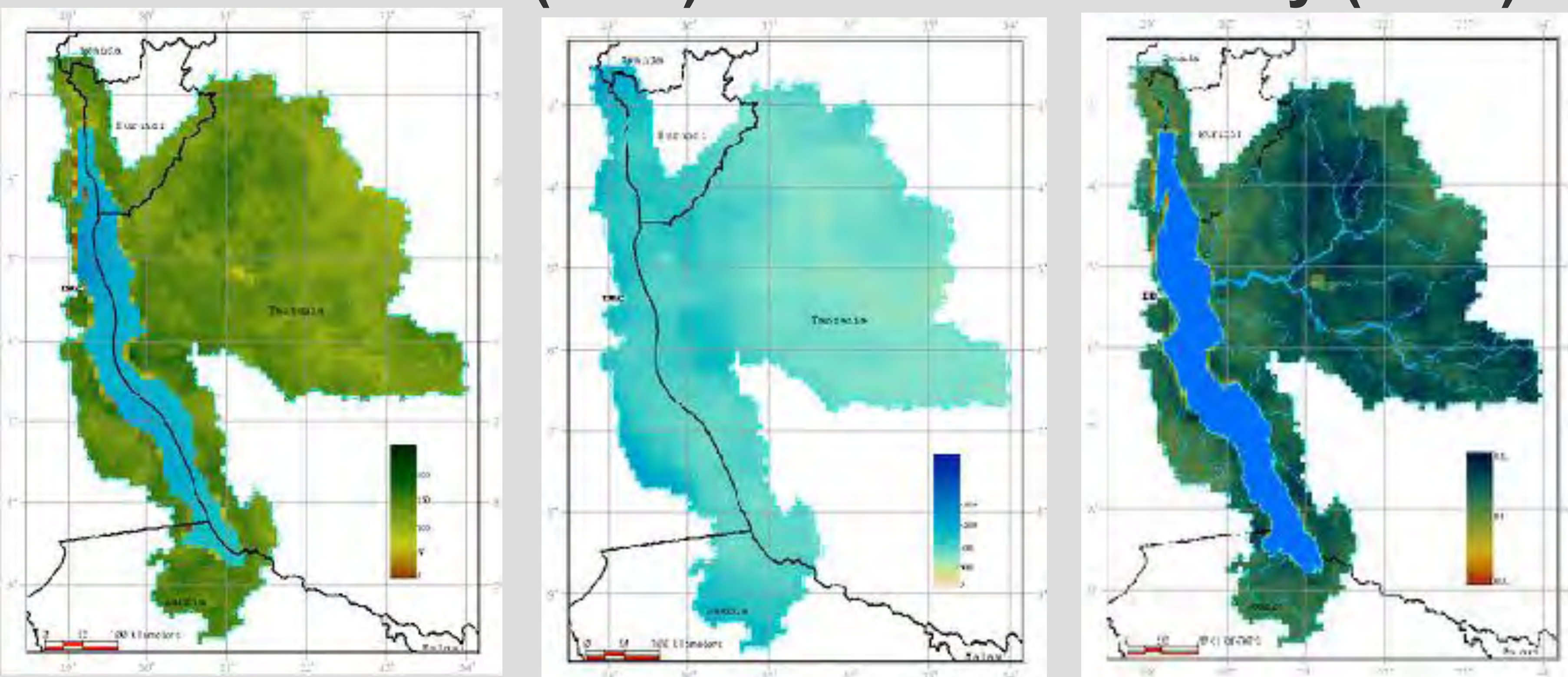
Land degradation hotspots

AVHRR NDVI (8km) Rain Use Efficiency (RUE)



Vegetation growth / Rainfall = Rain Use Efficiency

The Rain Use Efficiency is an attractive index for screening drylands for poor performing (degraded) areas, but is only valid when rainfall is limiting vegetation growth.

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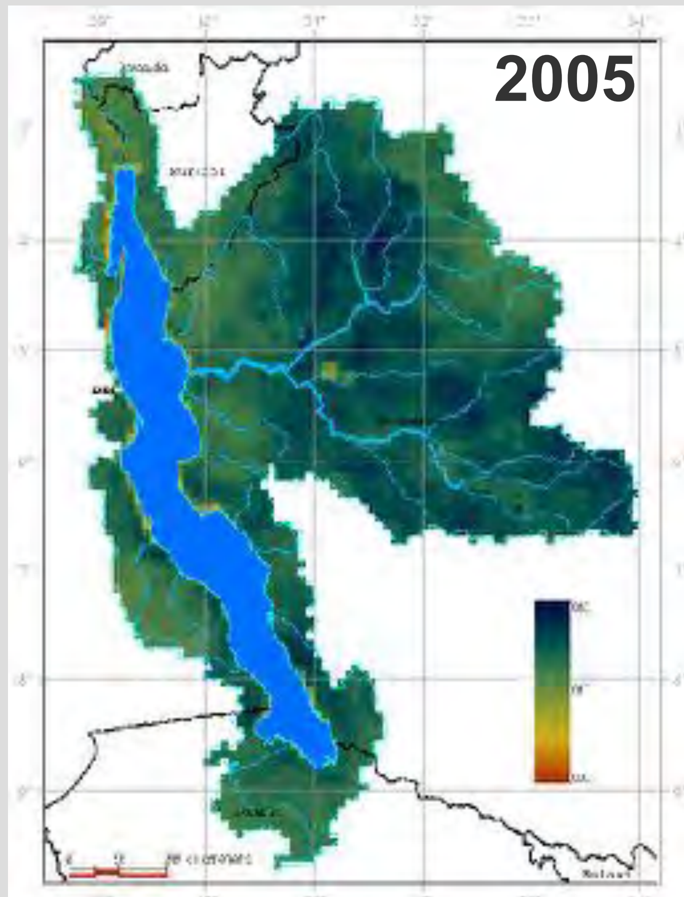
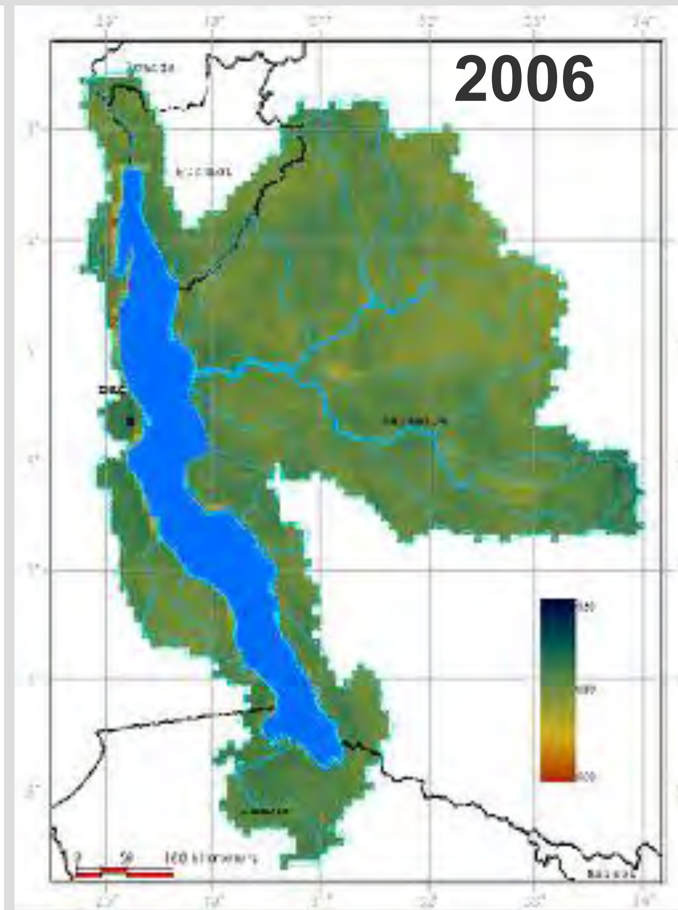
Land degradation hotspots

Rain Normalised NDVI (8km)

The dry year 2005 has a higher Rain Use Efficiency (RUE) than the wet year (2006). This is logical as rainfall in 2006 was much higher than normal, and the vegetation ecosystem is not geared to the 2006 rainfall level. The extra drops in 2006 formed river flow instead of increased vegetation growth. RUE is hence not applicable for studying land degradation without removing wet years from the time series.





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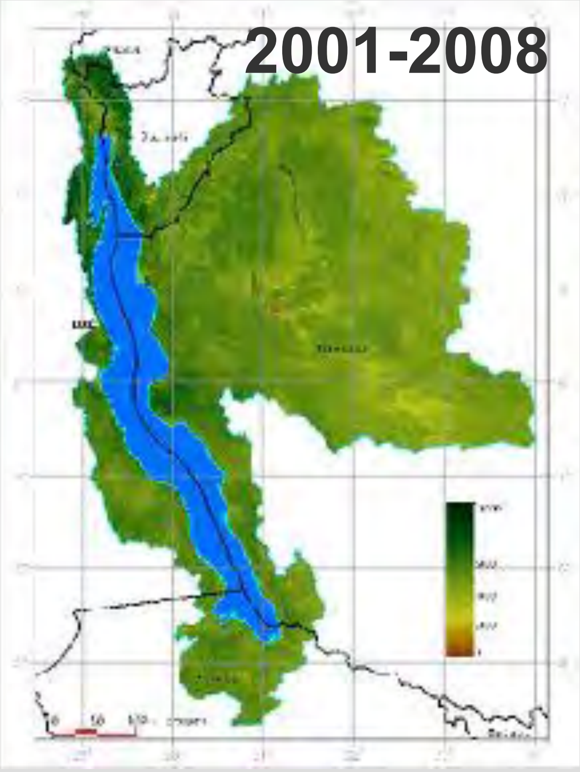
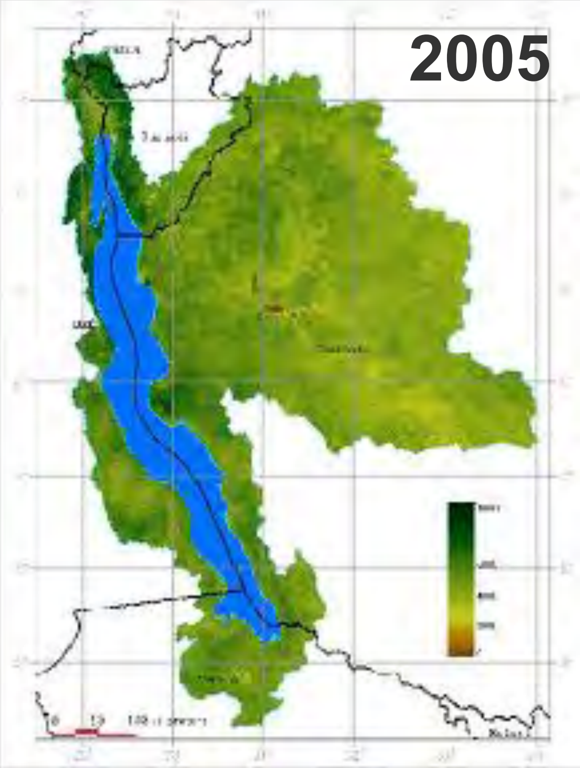
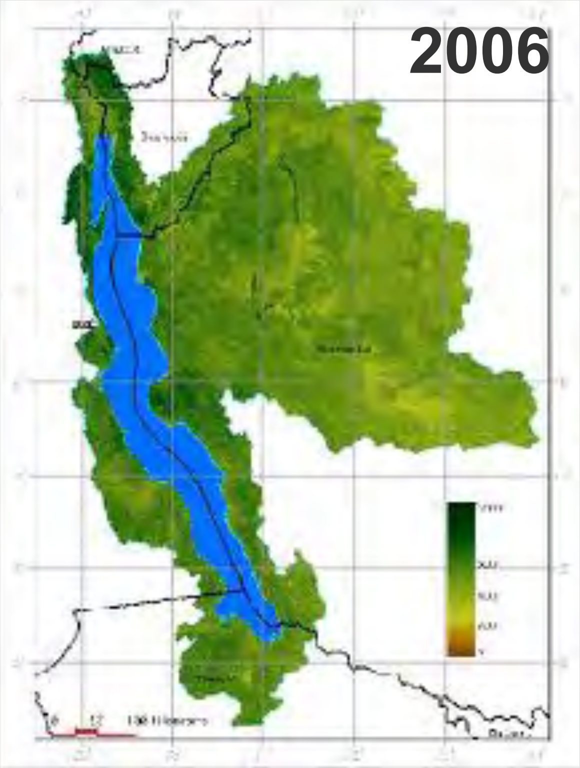
Land degradation hotspots

MODIS EVI (250 m) average vegetation growth







The MODIS sensor has a much higher resolution and a much more consistent quality compared to the AVHRR sensor, but the data is only available from February 2000.

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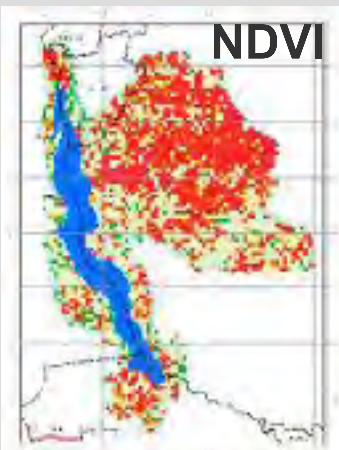
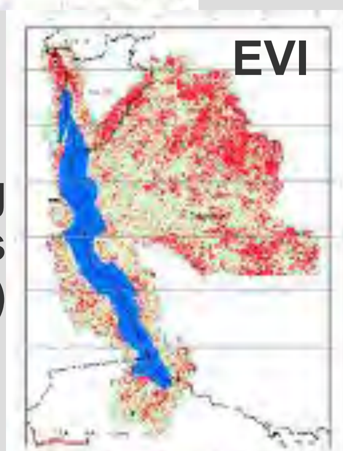
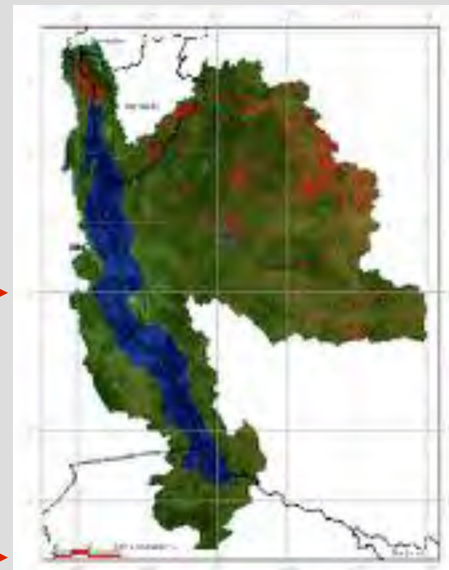
Lake Tanganyika Basin
Land degradation hotspots

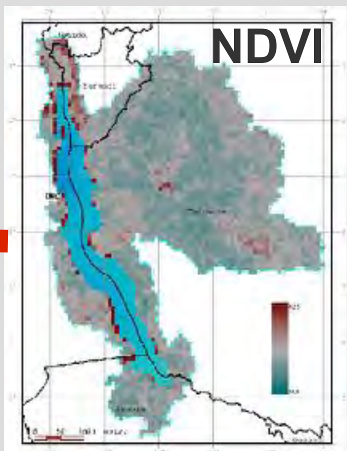
Land degradation hotspot indexing

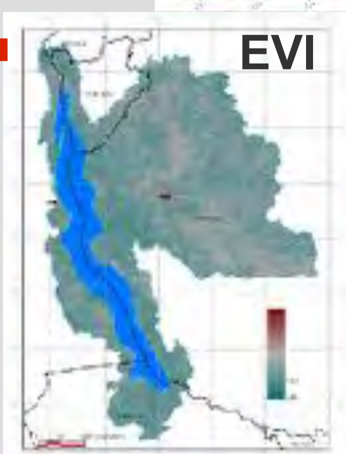




Neg veg Trends ($p<0.13$)







CoV

Compound land degradation index derived by combining trend and CoV analysis of NDVI (1982-2009) and EVI (2001-2008). A goal driven approach seeking the worst affected 5% of the Basin was used to identify hotspots.

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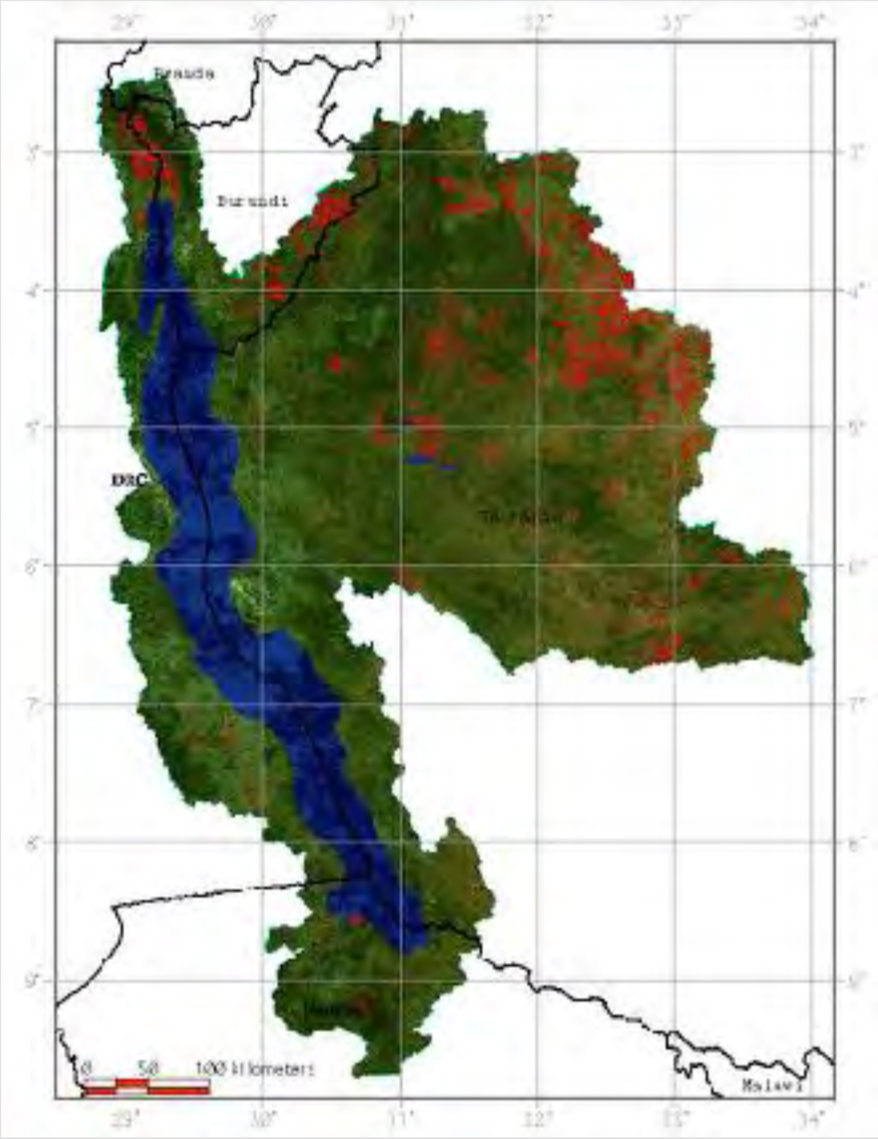
Lake Tanganyika Basin
Land degradation hotspots



	Hotspot area		Neg EVI trend		Neg NDVI trend	
	km^2	%	km^2	%	km^2	%
Burundi	1188	8	3045	22	3523	25
DRC	504	1	2590	6	3200	8
Tanzania	7464	5	19650	12	68100	42
Zambia	199	1	1050	6	4362	27
Rwanda	1	0	94	9	0	0

Per country statistical summary of the land degradation assessment (negative trend values represent $p<0.1$). The map shows the potential hotspot areas (red column).

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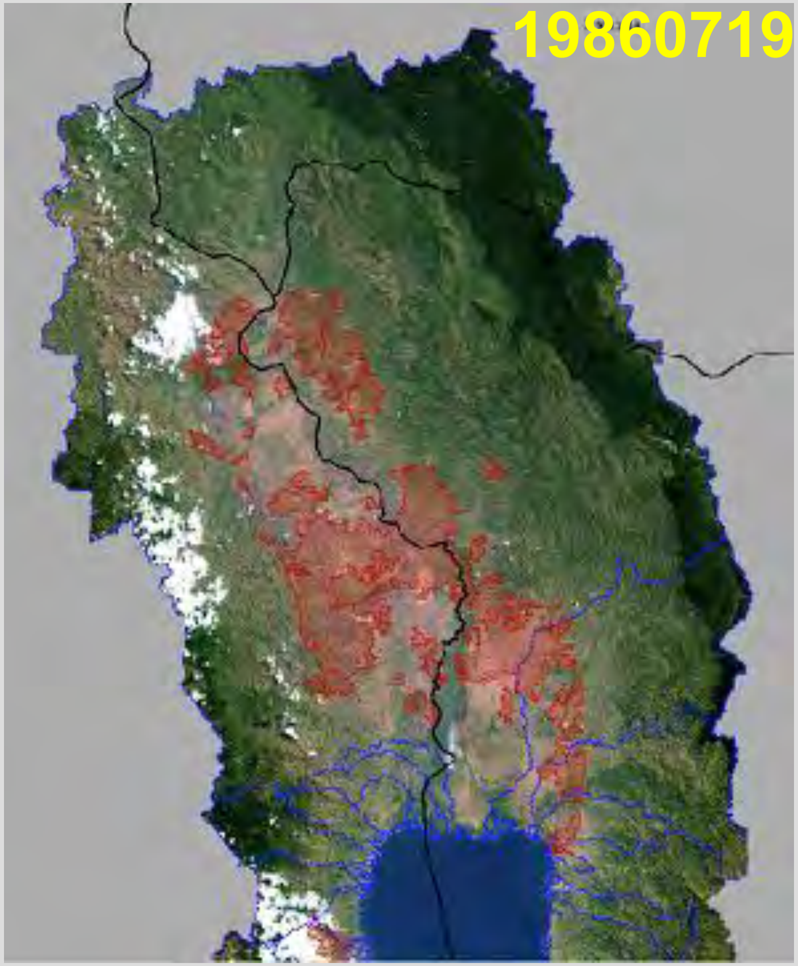
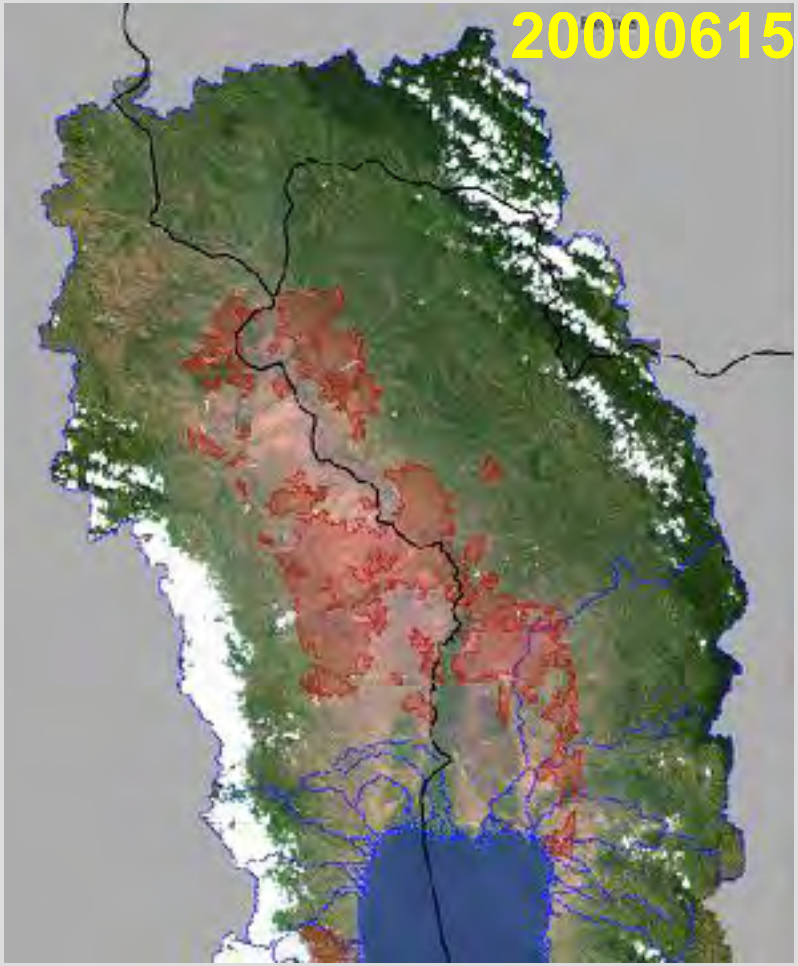
Lake Tanganyika Basin
Land degradation hotspots





Landsat images over Rusizi River showing the potential hotspot areas identified from the compound index based on time-series analysis of NDVI and EVI.

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Lake Tanganyika Basin
Land degradation hotspots

19860719 20000615 20050715

These Landsat satellite images show Rusizi River Basin where the River crosses from DRC and Burundi into Rwanda. The Red areas are those identified as potentially degraded from the time series analysis of the AVHHR-NDVI and MODIS EVI data. The Landsat images are in 30 m spatial reoslution. On the 2005 image to the right the Rusizi River as extracted from the topographic data is included. In most places the blue line follws the river much better than the national boundaries – extracted from a global 1: 1 million data set.

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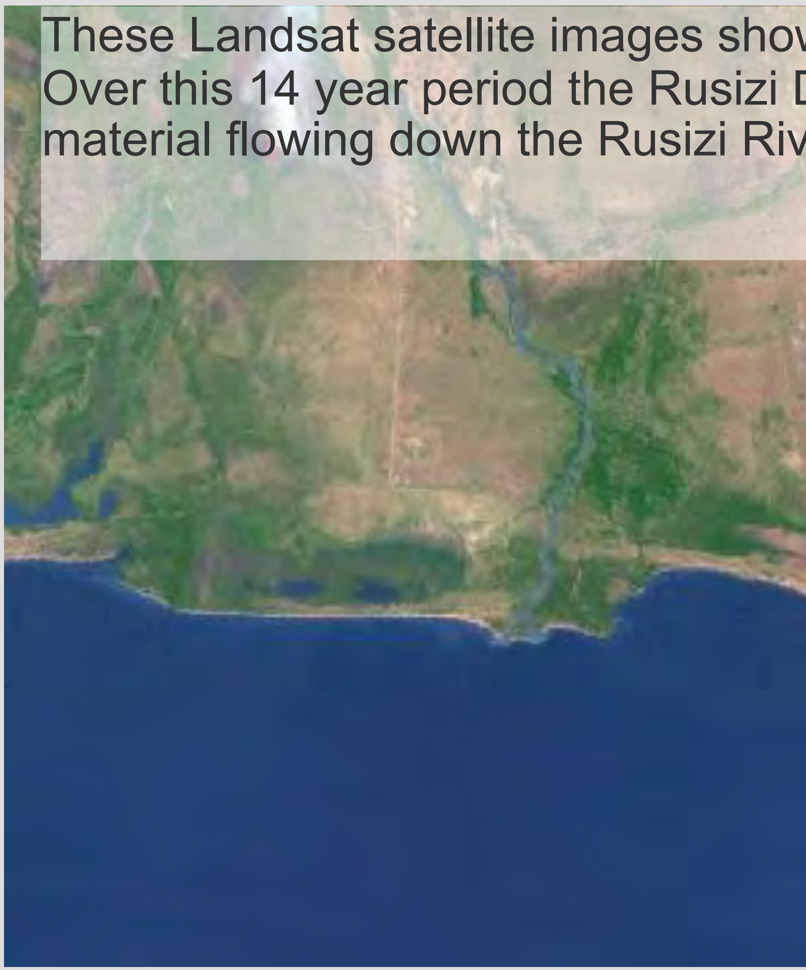
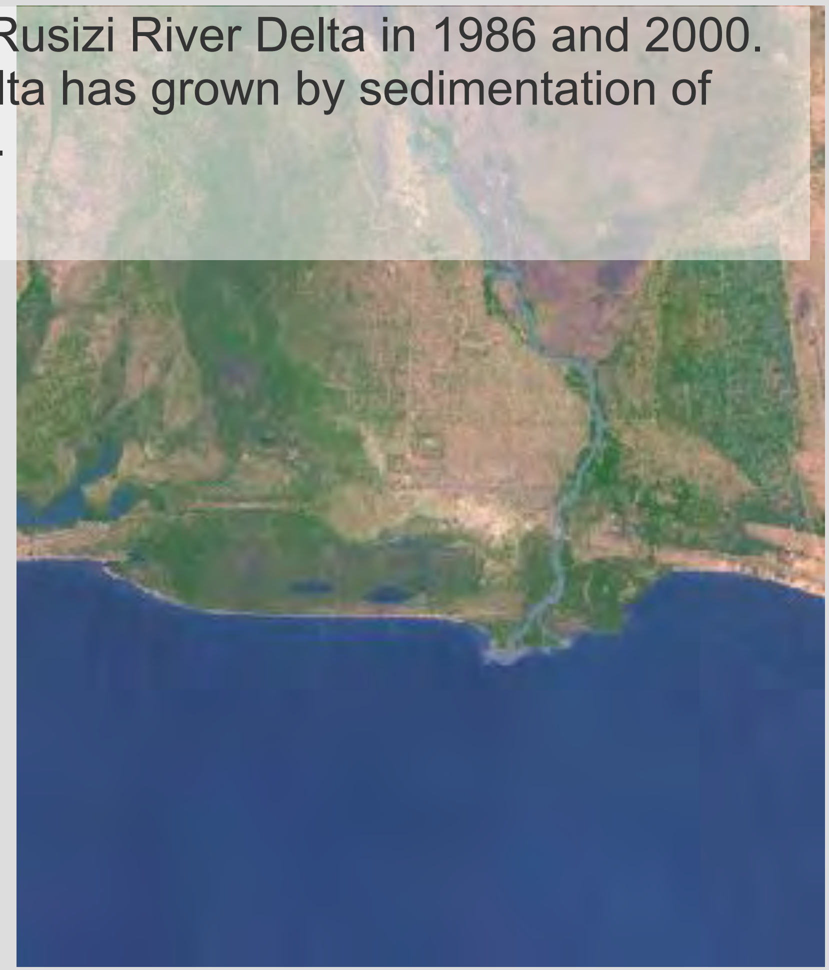
Land degradation hotspots

These Landsat satellite images show Rusizi River Delta in 1986 and 2000. Over this 14 year period the Rusizi Delta has grown by sedimentation of material flowing down the Rusizi River.

19860719



20000615



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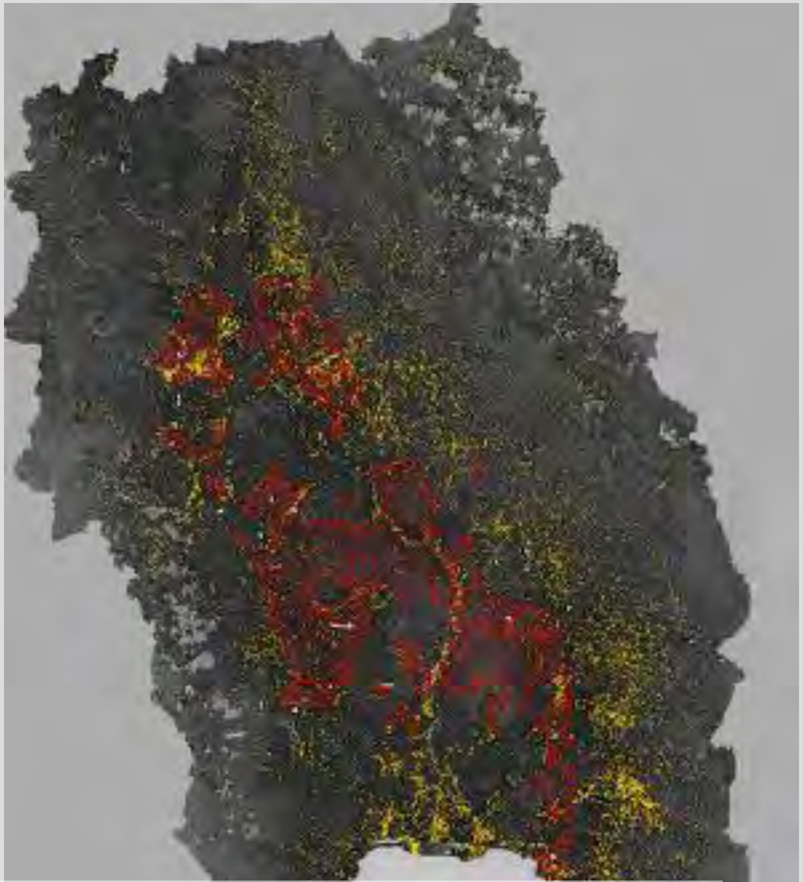
Land degradation hotspots



The image to the left shows the soil surface with the vegetation ”removed”, the spectral properties of the soil in the Rusizi Delta was then used to try to find soil with a similar spectral signal in the Rusizi watershed – the image to the right.

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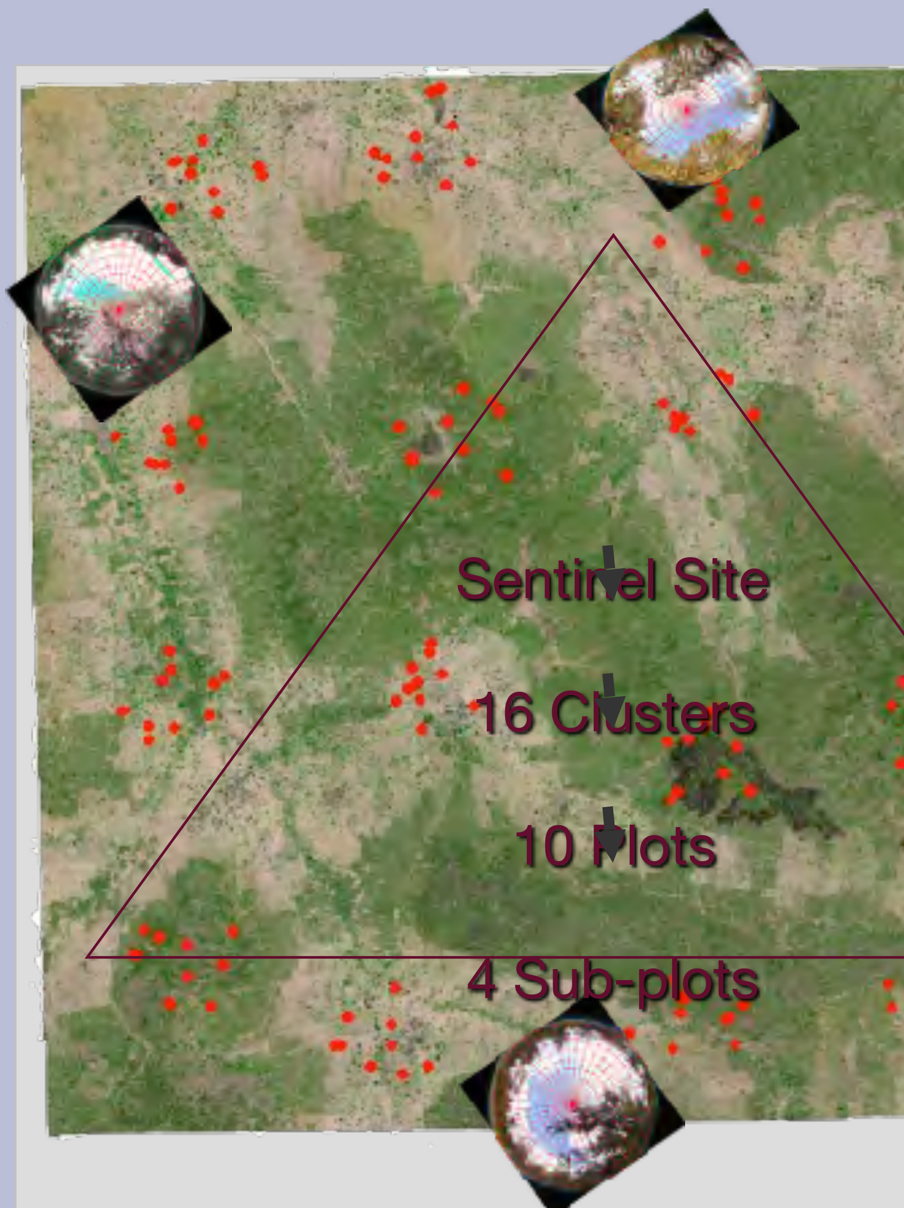
Land degradation hotspots



Small scale and patchy clearing of forests and a fragmented landsacpe of smallholder farmers is characteristic for many African landscape. In such complex landscapes it is diffucult to use low (AVHRR) and moderate (MODIS) resolution satellite images for capturing land degradation. The use of more high resolution images, like Landsat, SPOT or ASTER are called for. The next phase of ICRAFs efforts in the LTRIMP is to apply time series of Landsat images for mapping changes in land cover at a spatial resolution of 30 to 60 m. At present we have students collecting the ground data for calibrating the high resolution data. They sample the landscape for vegetation cover and soil erosion conditions using a random hierarchical apporach, and a strict field proptocol. The results will be presented and disseminated in country workshops later this year.

- The End -

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