

Lake Victoria

geoinformatics based maps and models for regional scale
planning and management

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GIS as a decision support tool

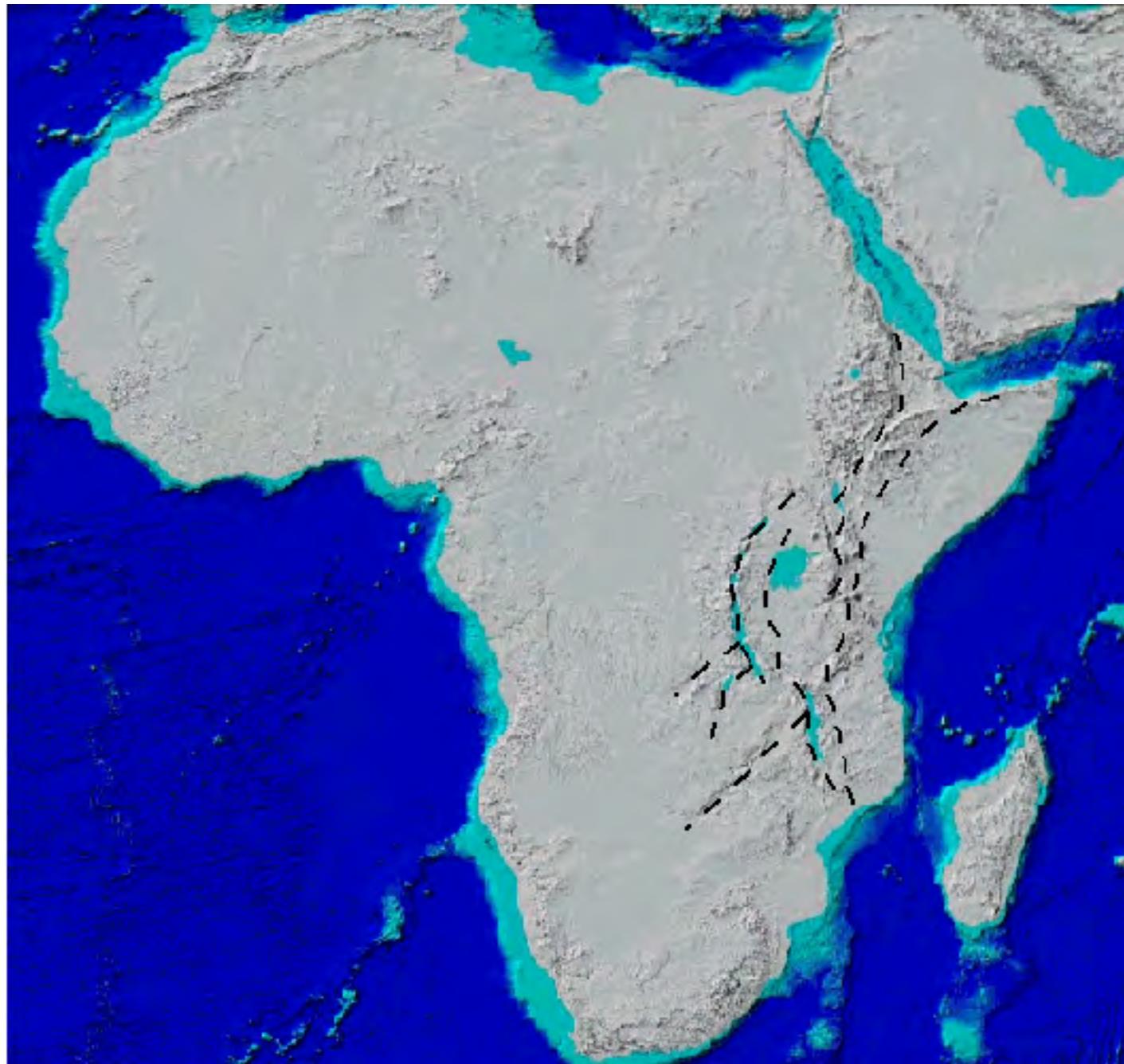
1. Data driven modeling

- Scientific
- Linear
- Physical meaning
- Capacity
- Solution not always found

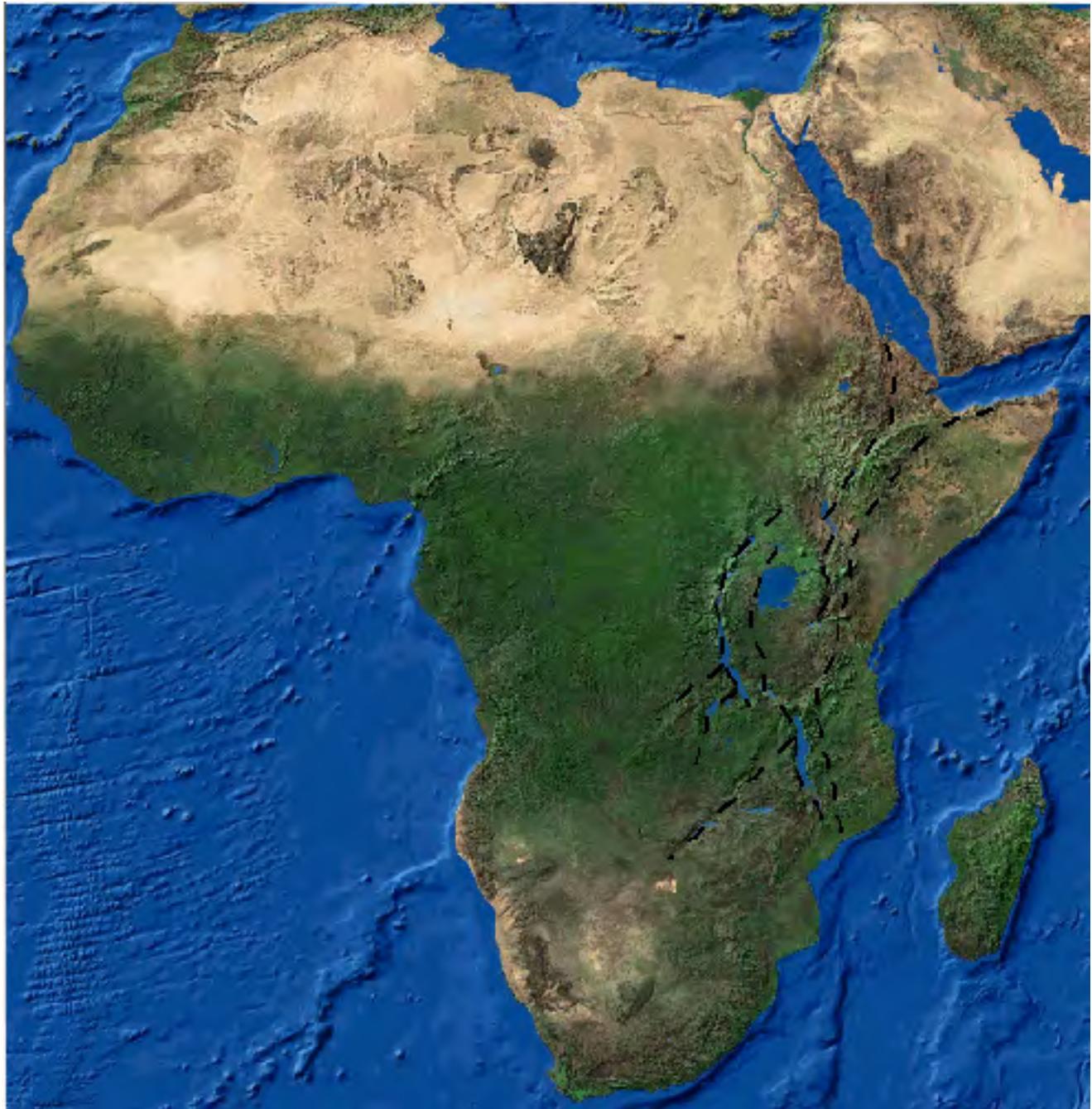
2. Goal driven evaluation

- 1. Participatory
- 2. Iterative
- 3. No/low physical meaning
- 4. Suitability index
- 5. Solution always found

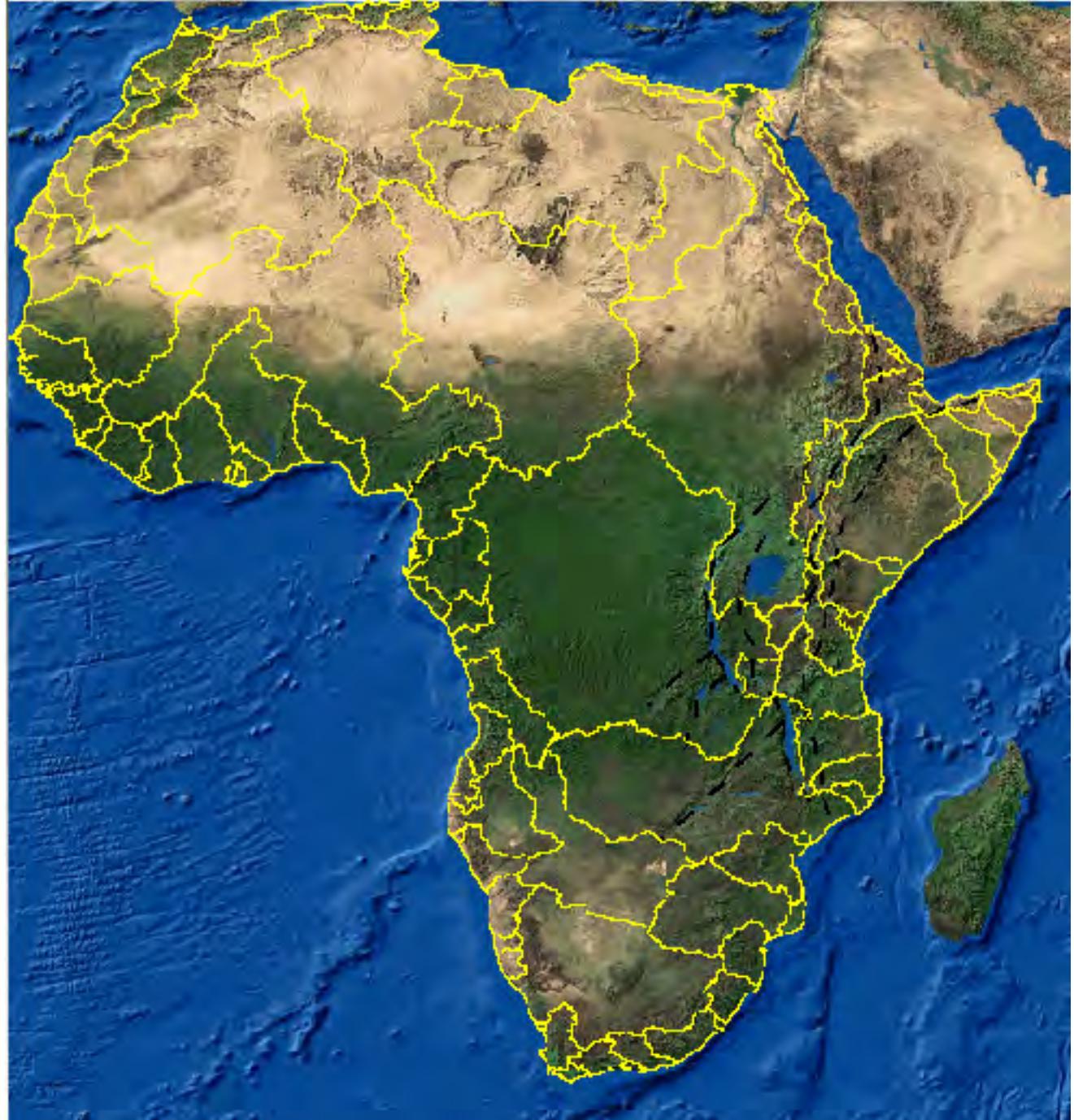
Lake Victoria
and the
Rift valley



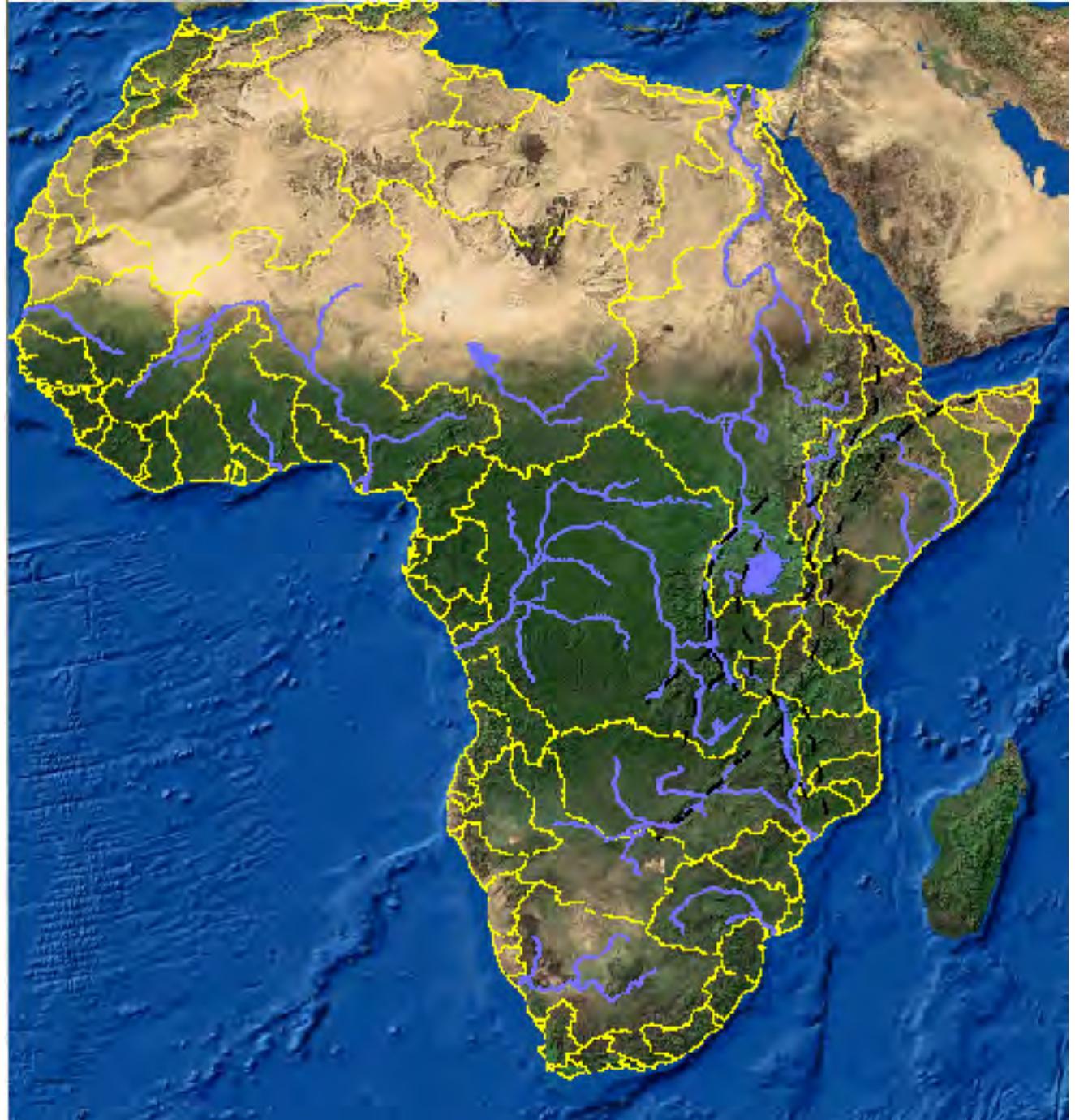
Lake Victoria and the Rift valley

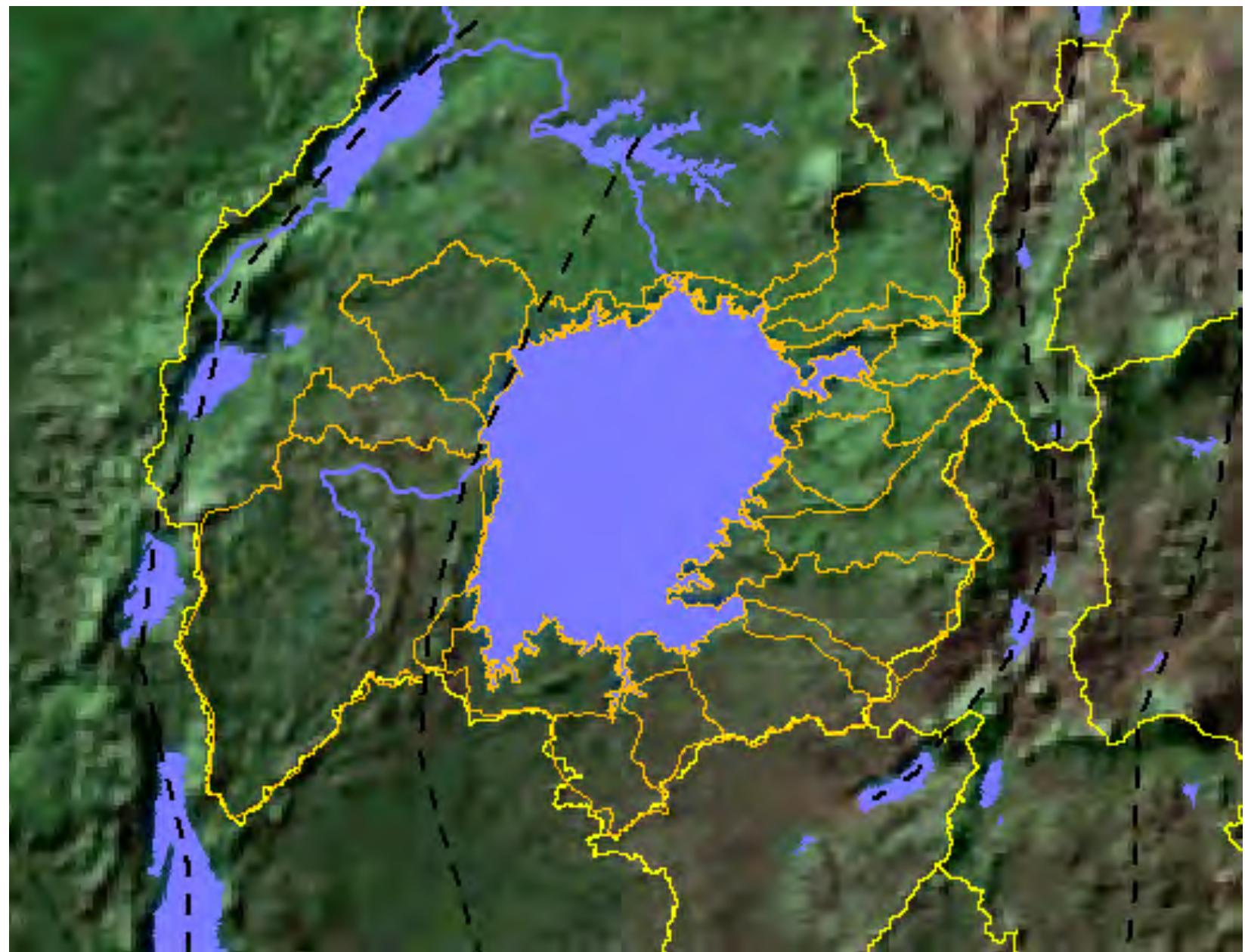


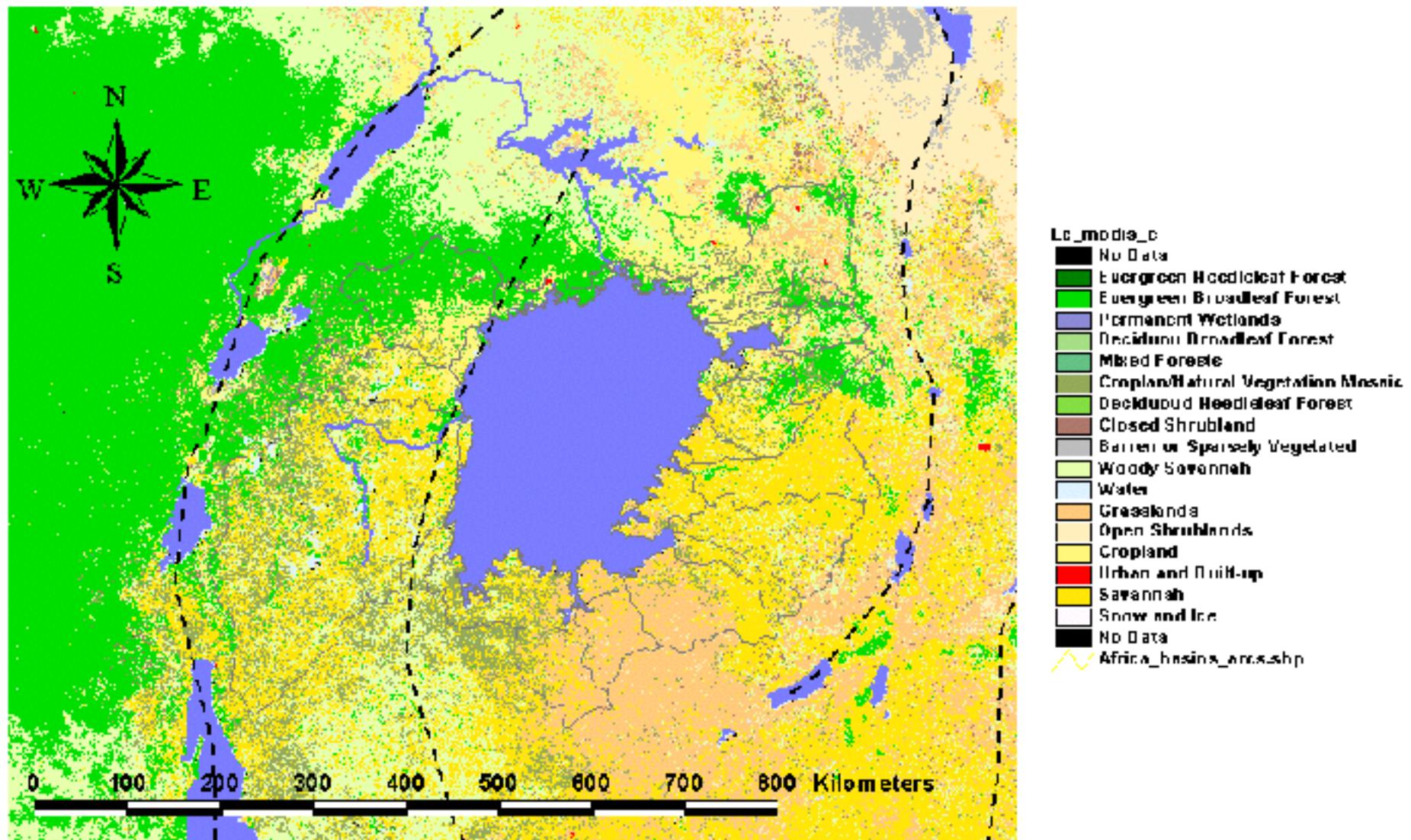
Lake Victoria
and the
Rift valley
African
River basins

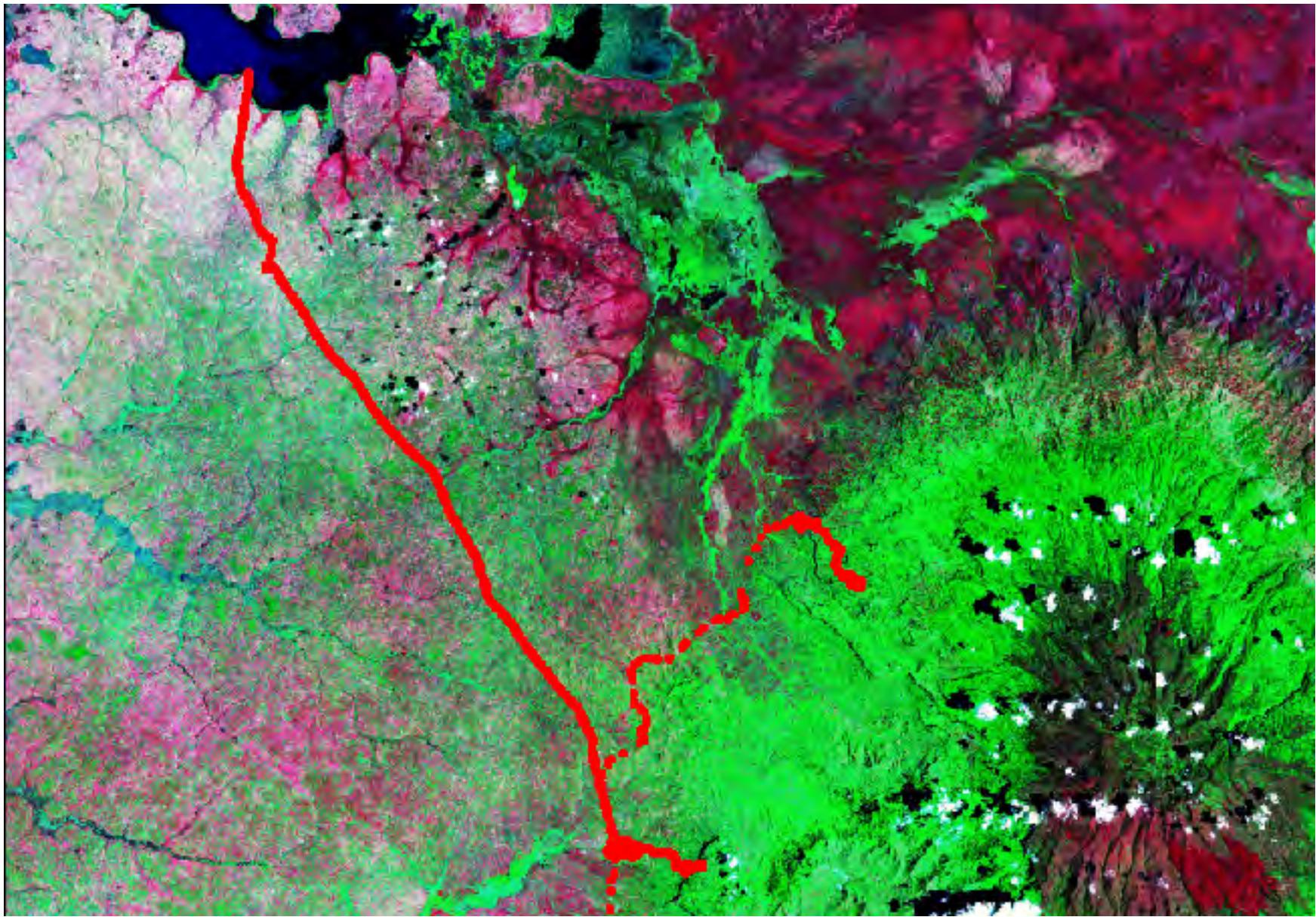


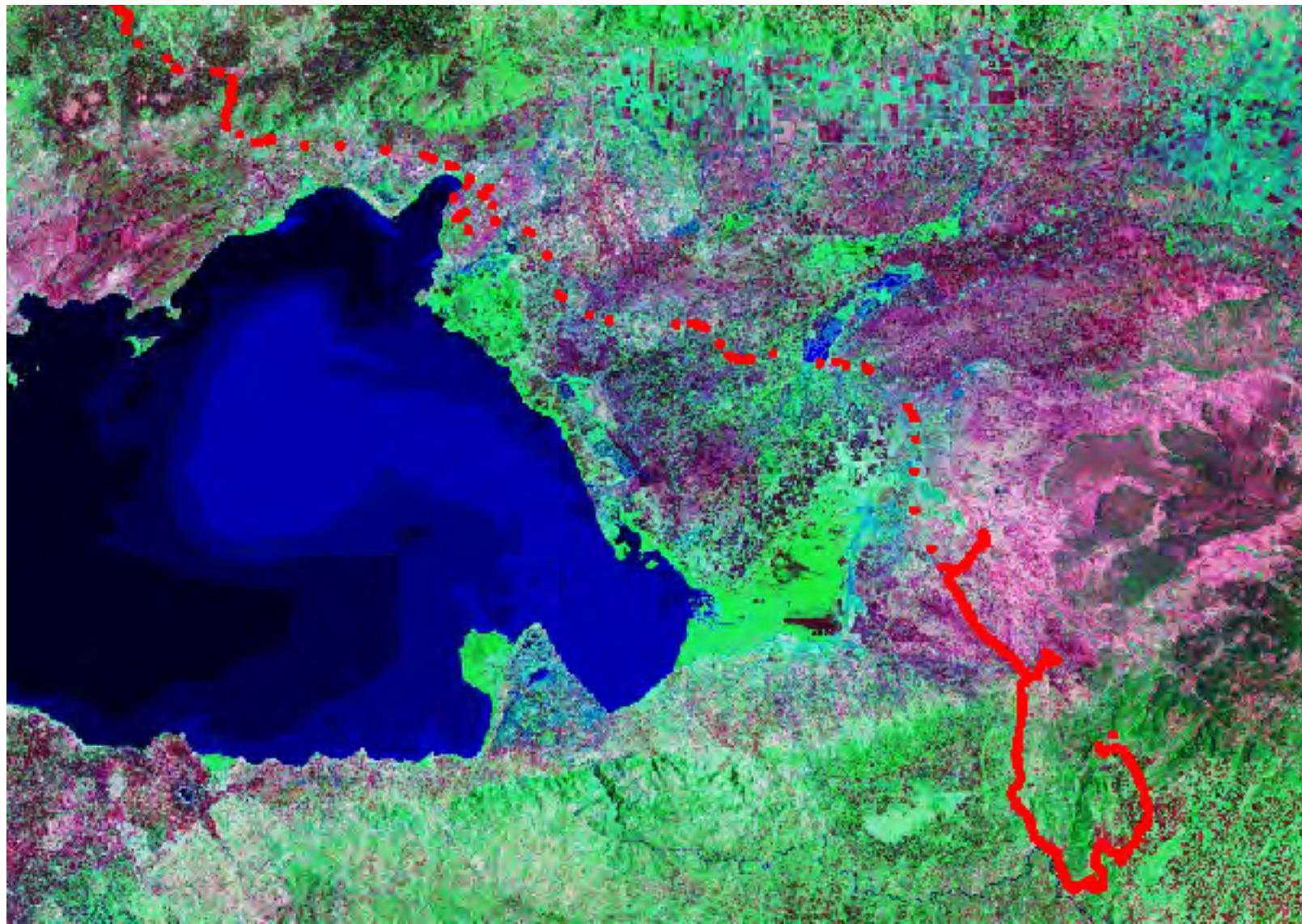
Lake Victoria
and the
Rift valley
River basins
and
Rivers

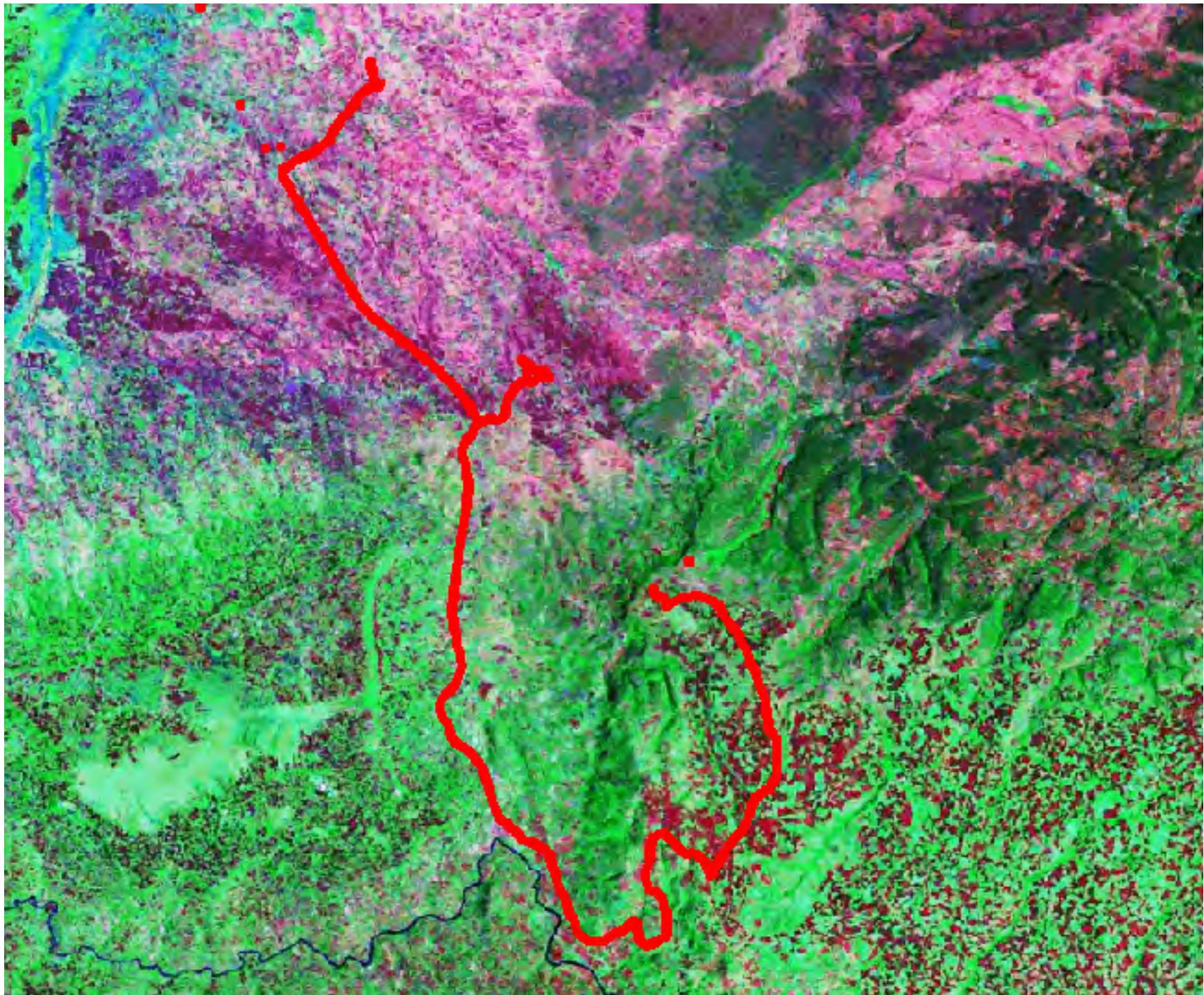












Temperature

Precipitation

Evapotranspiration

Length of growing season

Farming system

Soil type, fertility and erosion

Hydrology

Topography

Land use/cover

Bathymetry

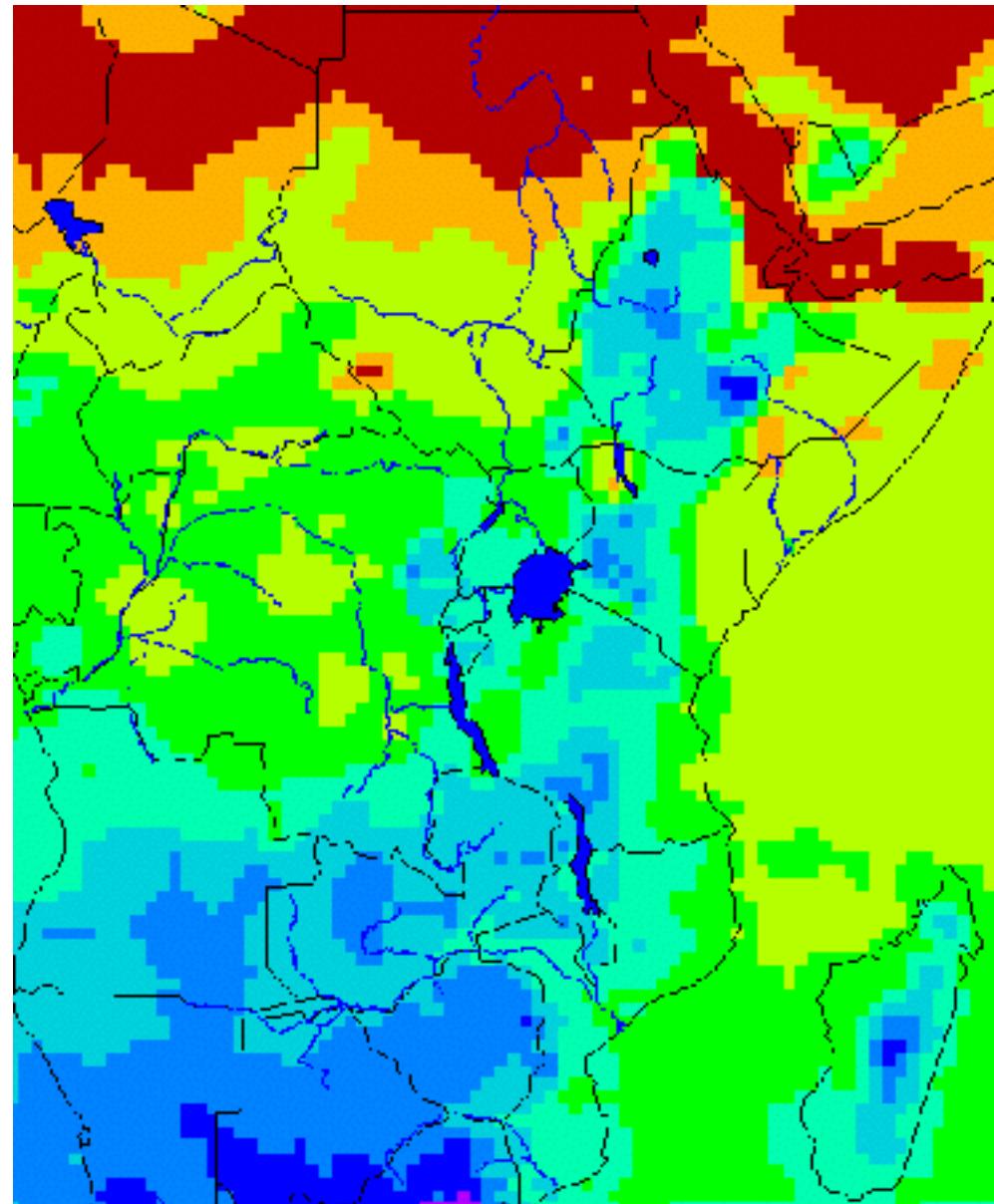
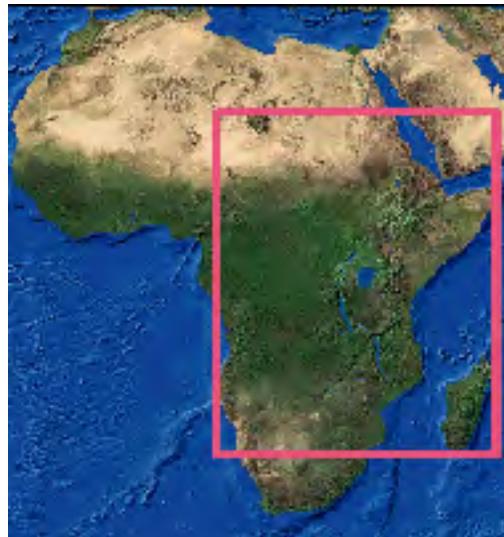
Infrastructure (market and market access)

Socioeconomic data

The Geoinformatics
data that is available

Temperature data

Illustrating some of
the temperature data
that is available



Temperature data

List of available
temperature data for
studies in the Lake
Victoria Basin.

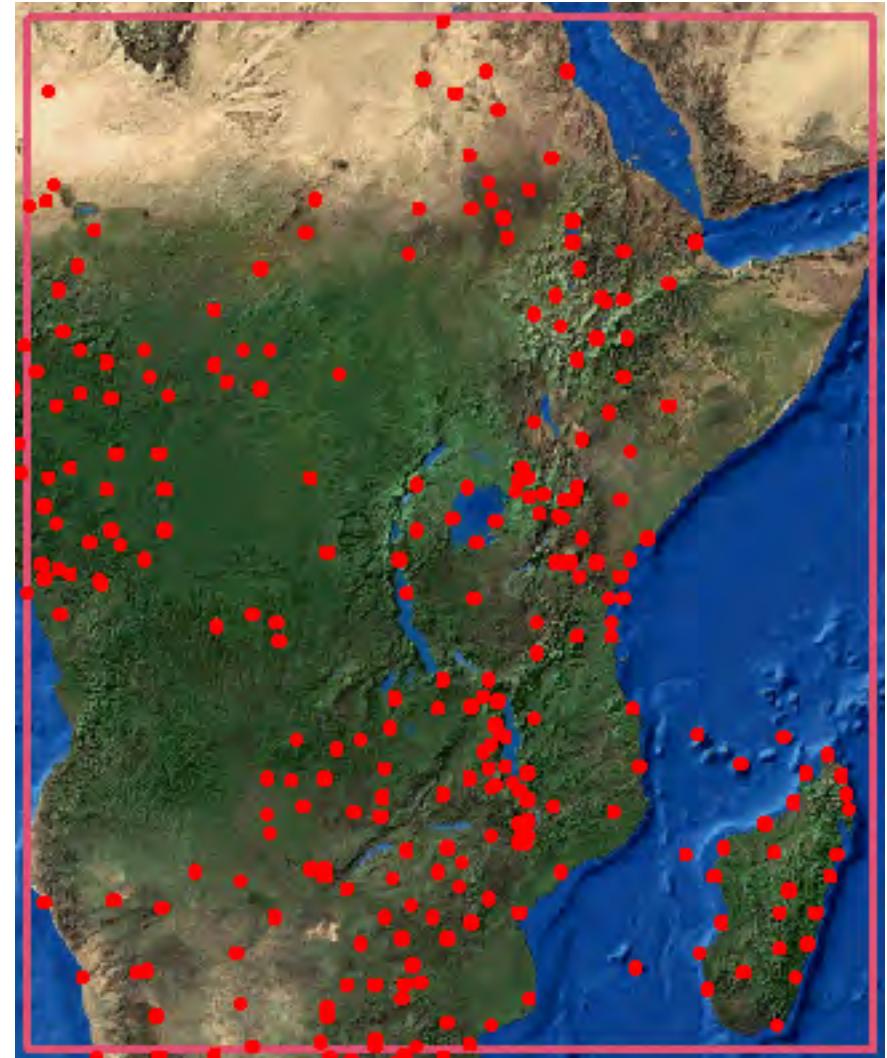
Available data (i.e. data that is already captured)

1. Monthly Climate station data going back more than 100 years
2. Daily climate station data from around 1977
3. Ground temperature estimations from Remote Sensing (TERRA MODIS from 2000)
4. Climate statistics map (50 km resolution – the one you saw!)

Temperature data

Temperature station
data with daily values
already captured.

Daily data (freely available)



Temperature data

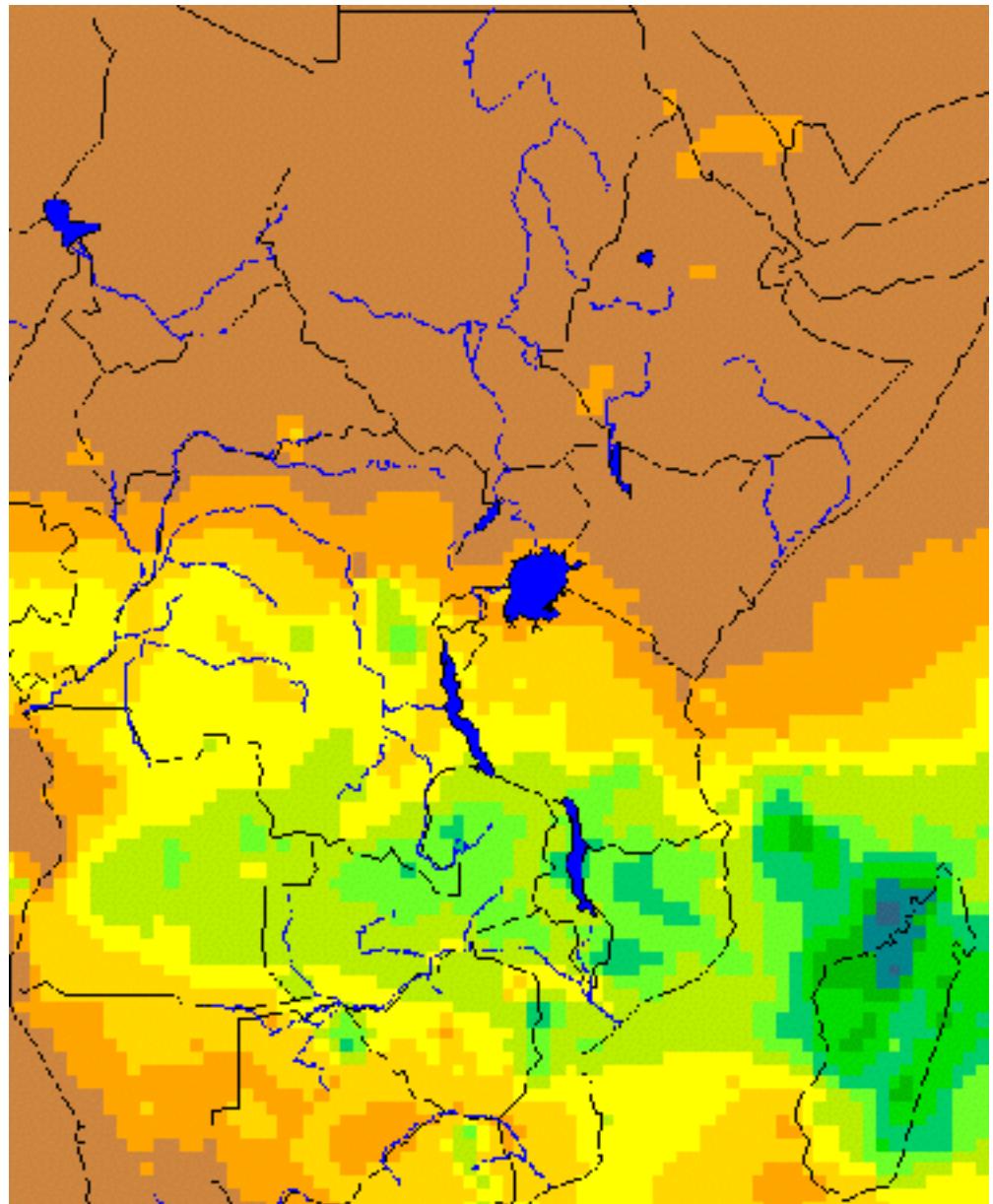
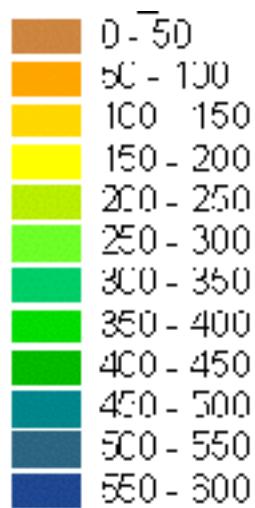
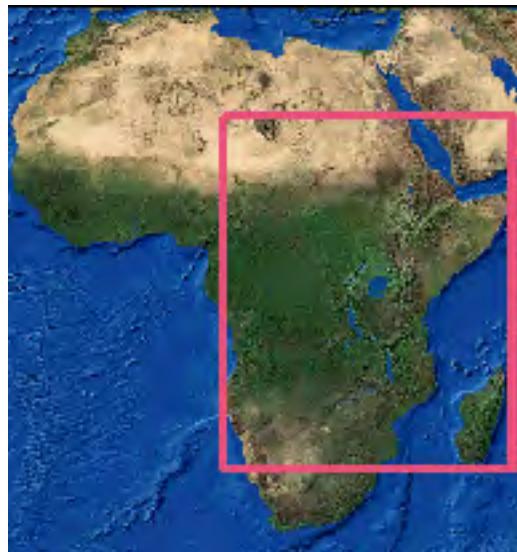
Can be improved by:

- 1.Including more ground stations
- 2.Making use of Digital Elevation Models for geostatistical interpolations (e.g. sunny and shady side of mountains)
- 3.Making use of Remote Sensing Data

The highly varying
topography of the Lake
Vic Basin demands a
refinement of the Africa
wide temperature
databases available!

Rainfall data

Illustrating some of
the Rainfall data that
is available



Rainfall data

List of available
rainfall records for
studies in the Lake
Victoria Basin.

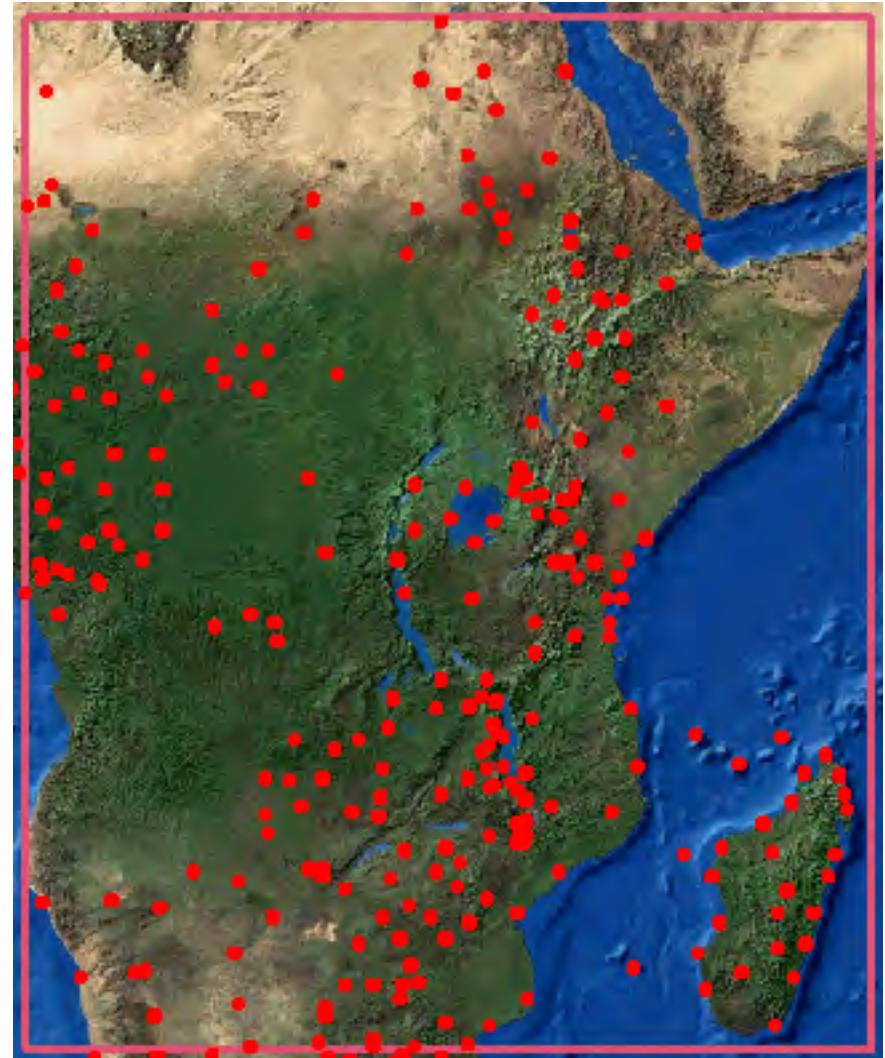
Available data

1. Monthly Climate station data going back more than 100 years
2. Daily climate station data from around 1977
3. Rainfall estimates from METEOSAT and ground based data, 10day composites May 1995 to present (8 km resolution)
4. Rainfall estimates from METEOSAT and ground based data, daily data 1998 To present (8 km resolution)
5. Climate statistics map (50 km resolution – the one you saw!)

Rainfall data

Rainfall station data
with daily values
already captured.

Daily data (freely available)



Rainfall data

Can be improved by:

- 1.Including more ground stations
- 2.Making use of Digital Elevation Models (elevation and aspects as independent variables) in geostatistical interpolations
- 3.Using NOAA-AVHRR vegetation index as a proxy for rainfall over dry areas with poor data coverage (goes back to 1982)

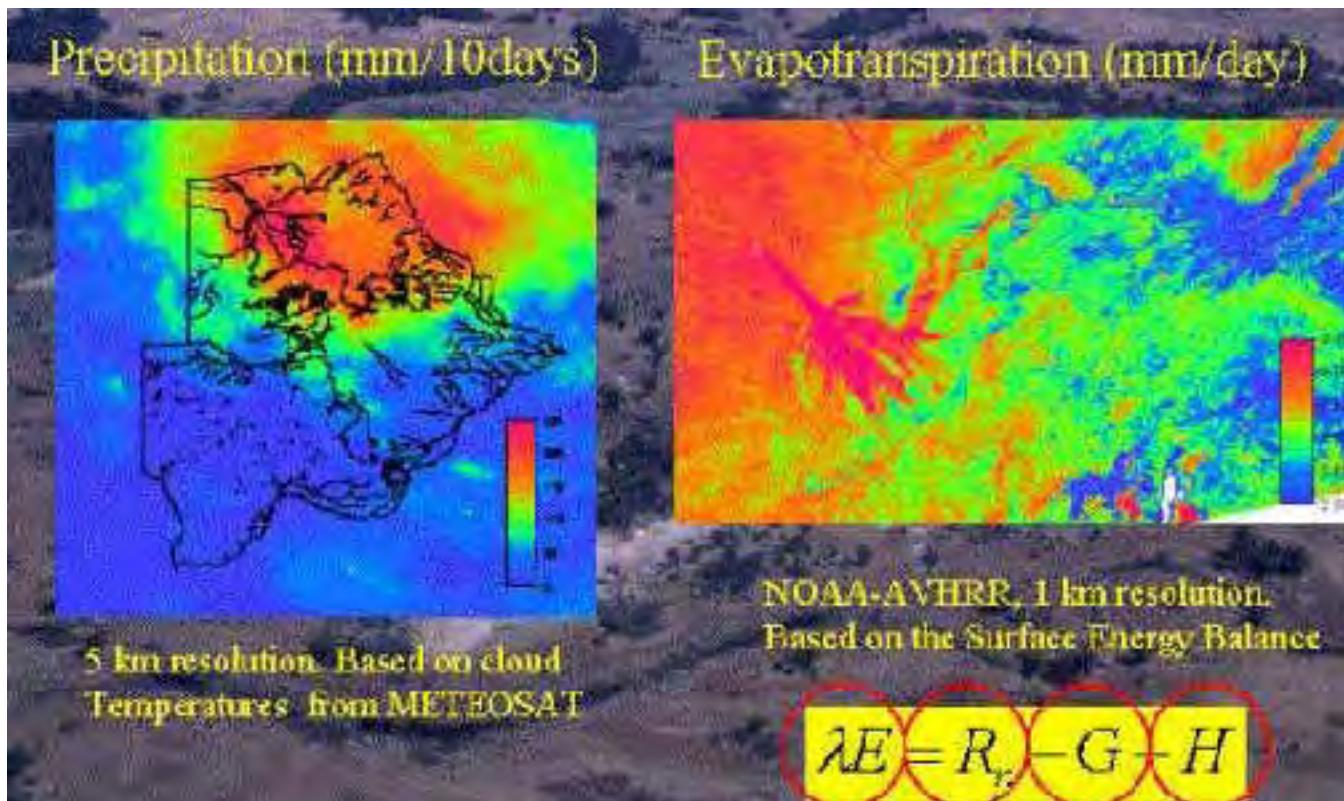
Evapotranspiration data

Available data

- 1.Scattered pan type evapotranspiration field data
- 2.Evapotranspiration estimates from NOAA-AVHRR and ground based data, daily values from 1996 to present (8 km resolution)

Evapotranspiration data

Remote sensing for estimating spatial distribution of precipitation and evapotranspiration



Evapotranspiration data

Can be improved by:

Combining Remote sensing data with field data for accurate point measurements of surface energy balance (evapotranspiration)



Net radiometre



Microclimate station

Length of growing season

Available data

Temperature

Precipitation

Evapotranspiration...

...and

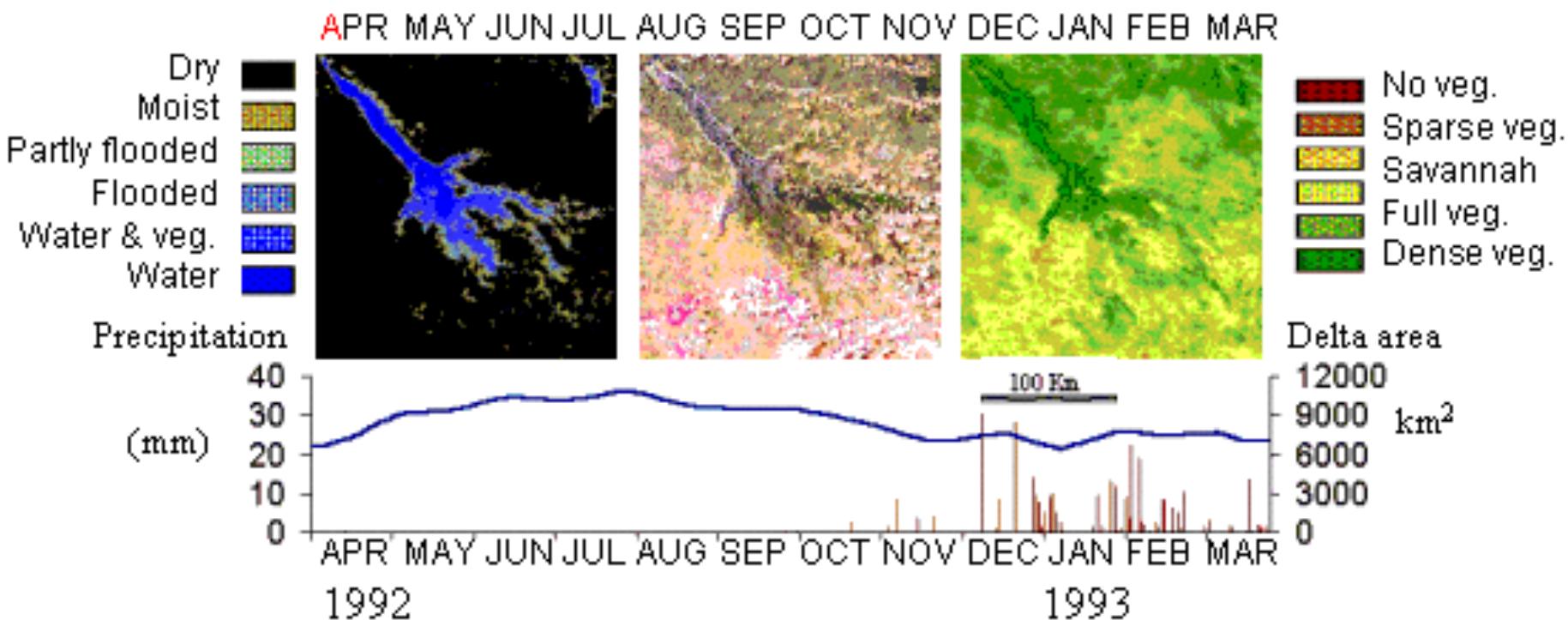
Insolation
(computed
from DEM)

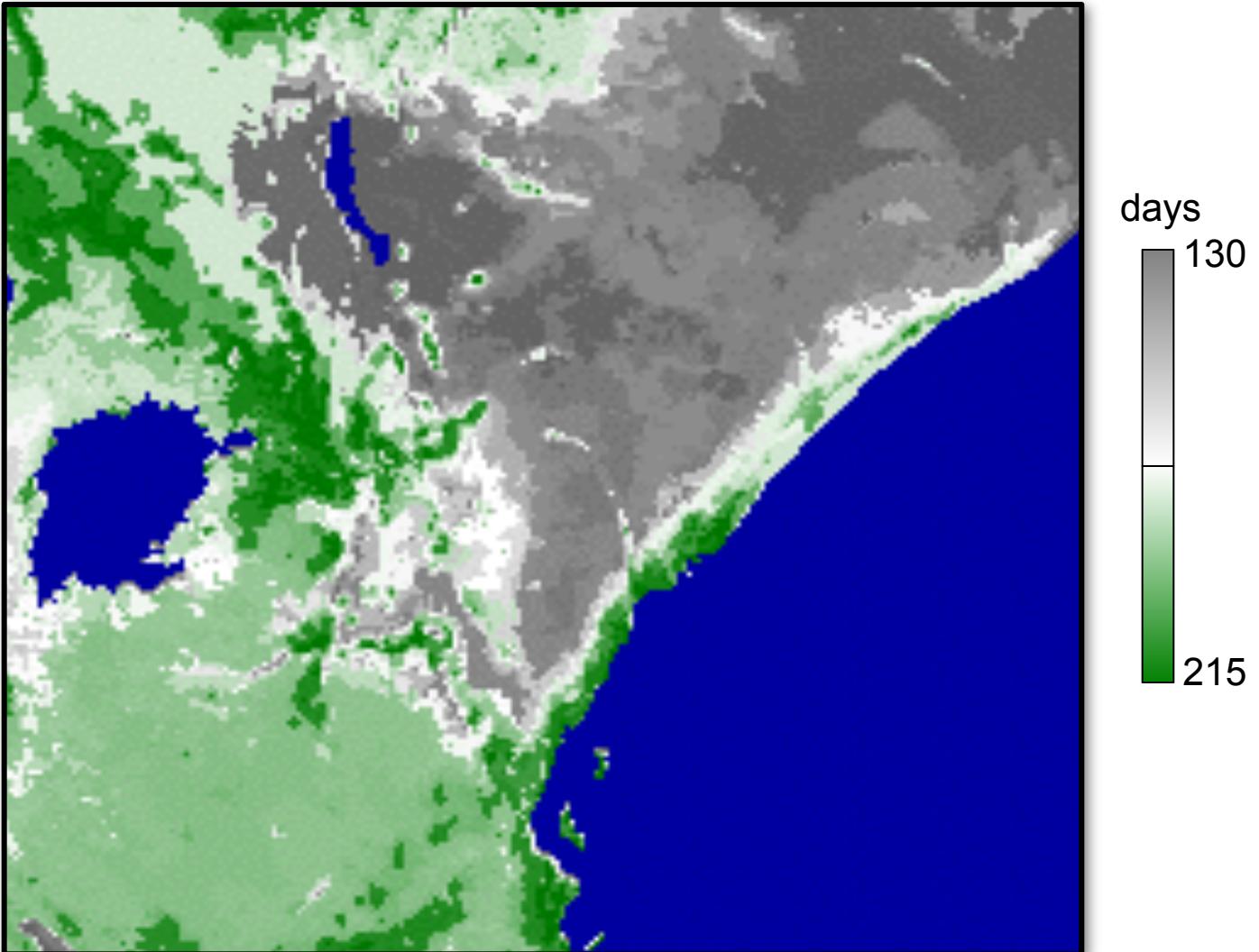


Length of growing season

Can be improved by:

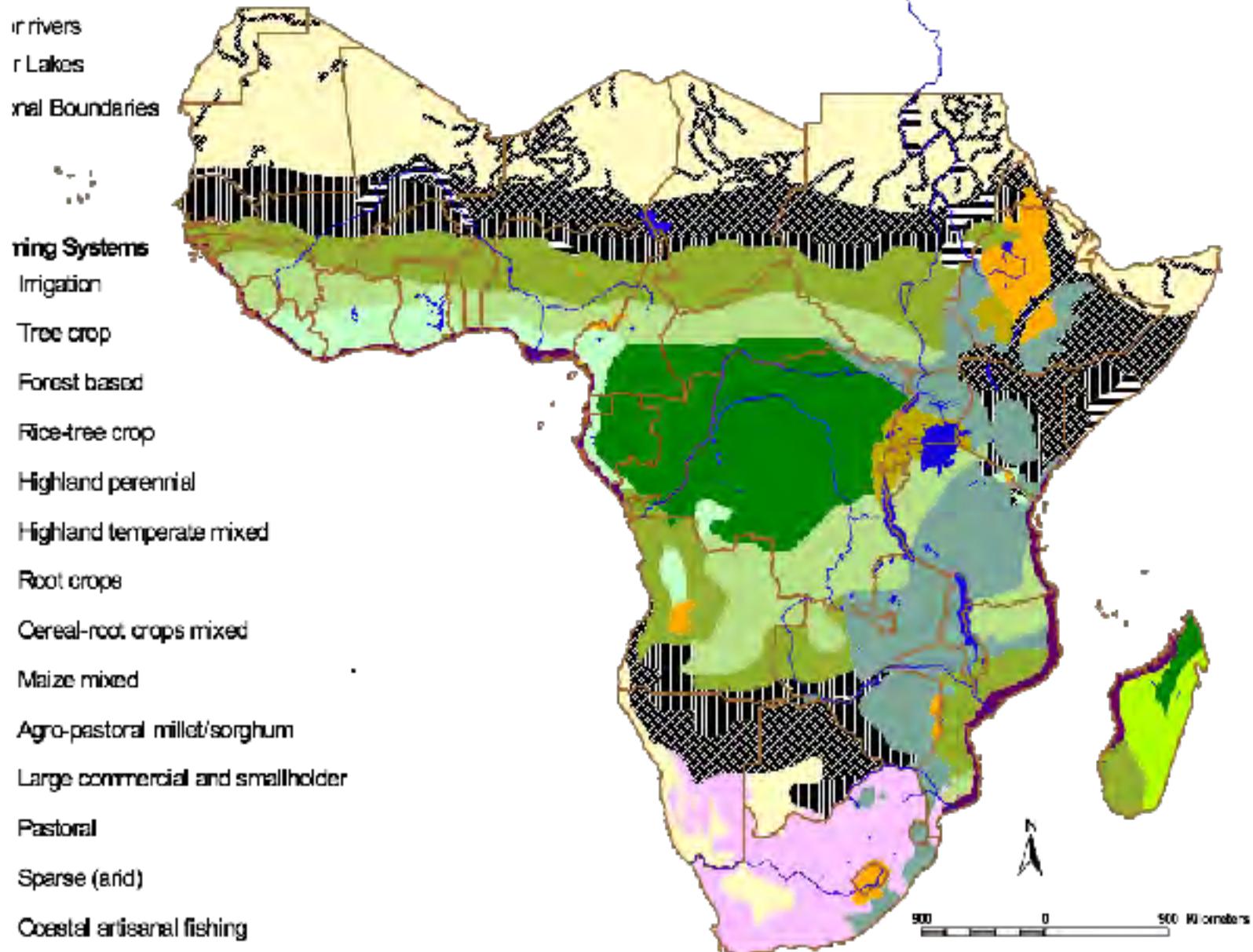
1. Vegetation dynamic maps for Remote Sensing (NOAA-AVHRR and TERRA-MODIS)





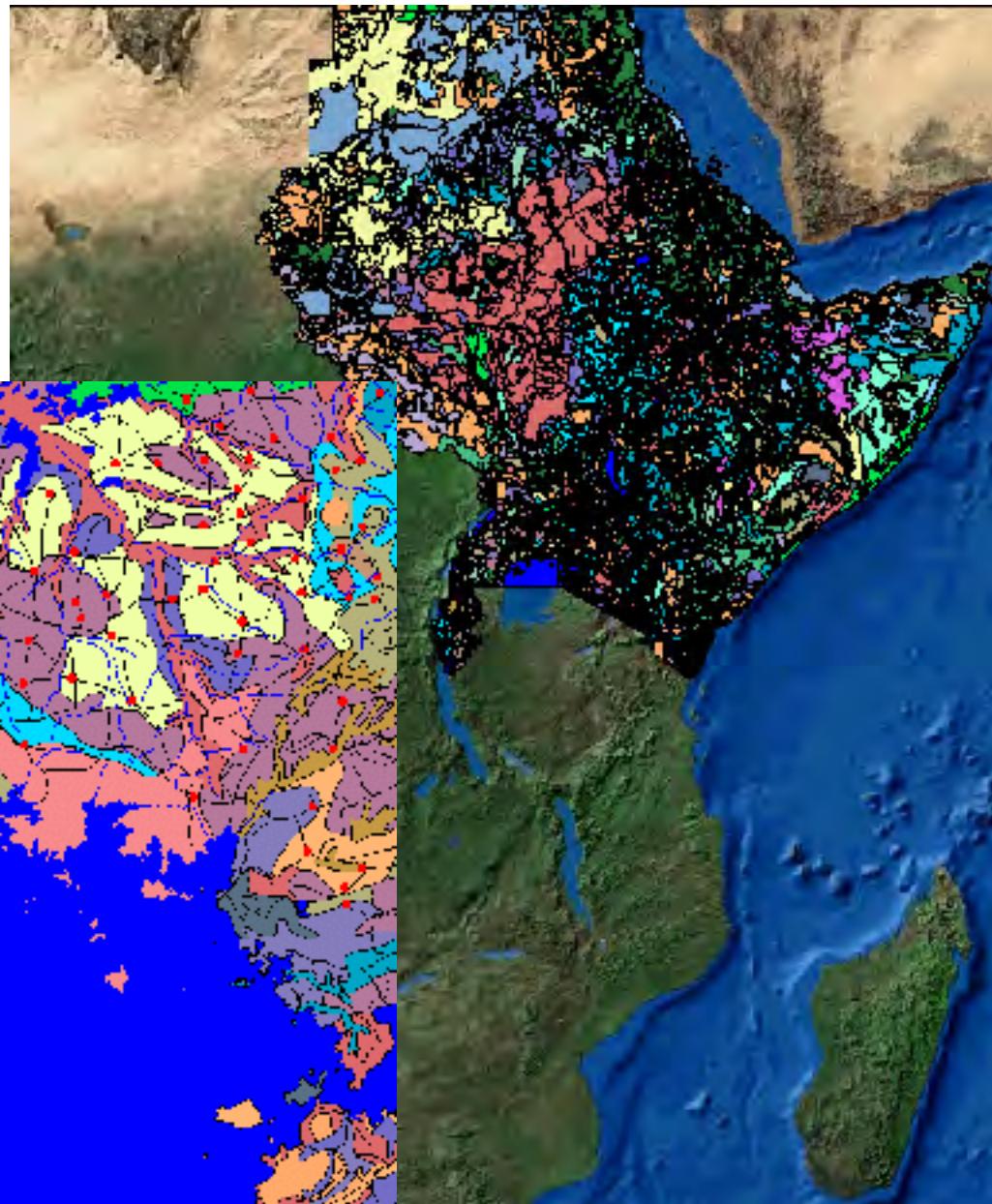
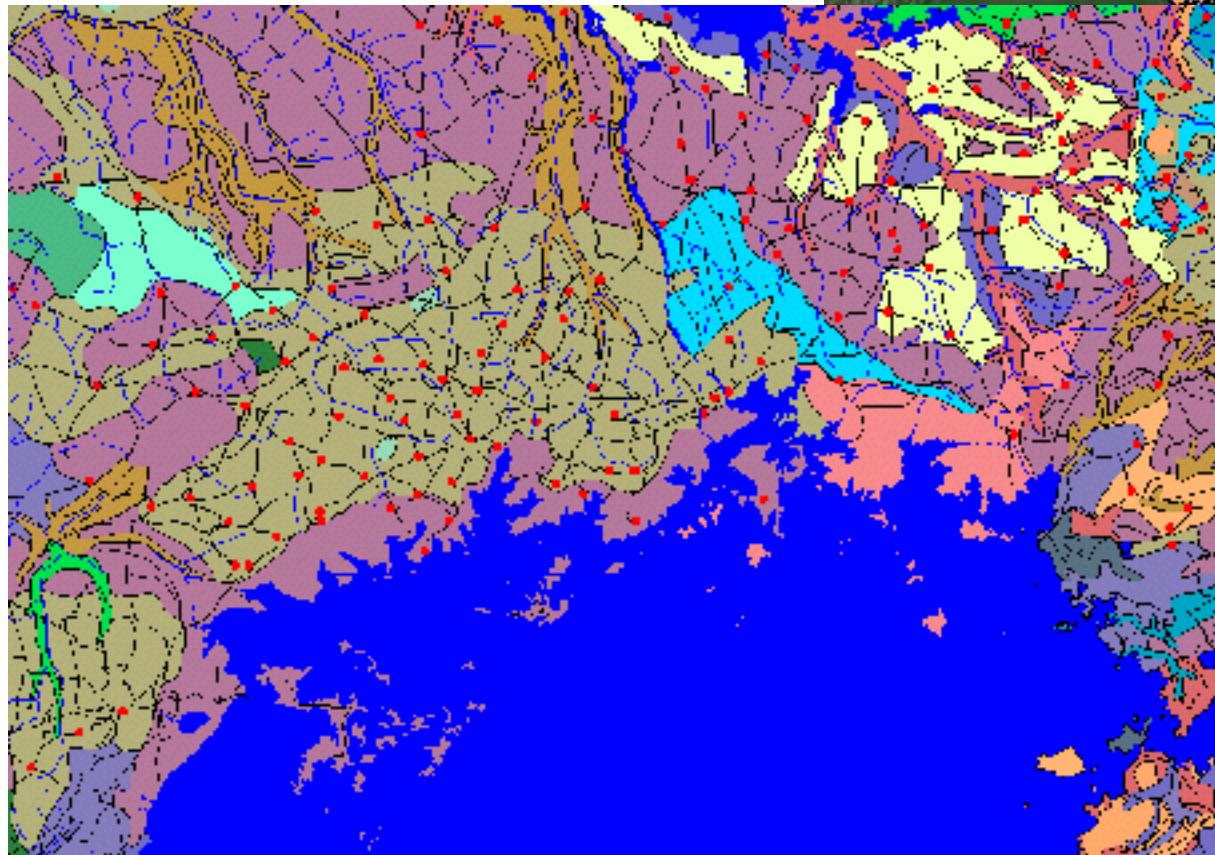
Estimated lengths of the photosynthetically active period in Kenya
from long-term (1982-97) Advanced Very High Resolution Radiometer
(AVHRR) data.

Farming systems



Soil type, fertility and erosion

FAO Soil map



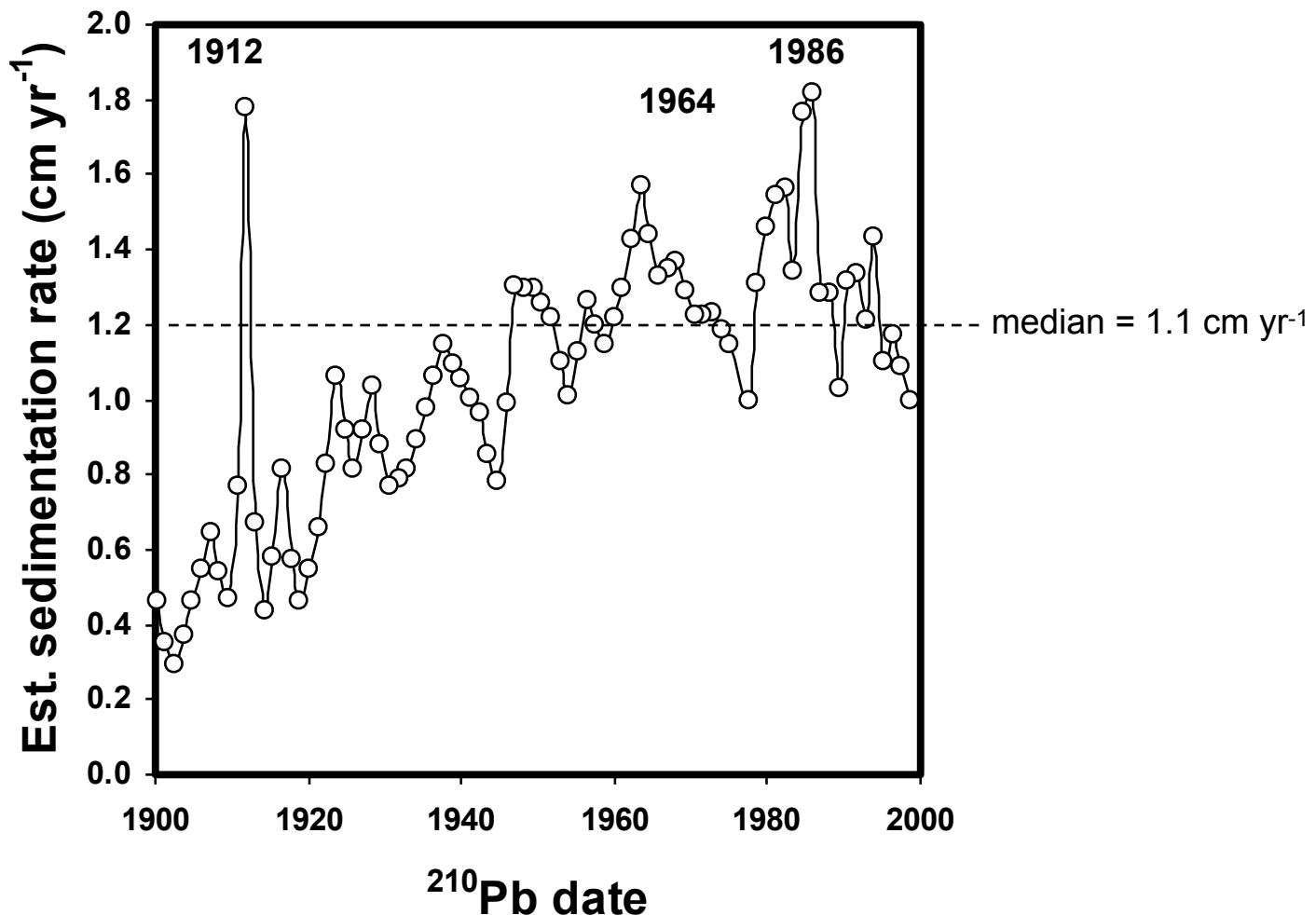
Soil type, fertility and erosion

Available data

- 1.FAO soil map and derivates incl. soil depth (1: 1 million)
- 2.Geological map (partial coverage - SADC countries and Ethiopia) (1: 1 million)
- 3.Country specific more large scale maps
- 4.Soil profile and sample data, and other baseline data

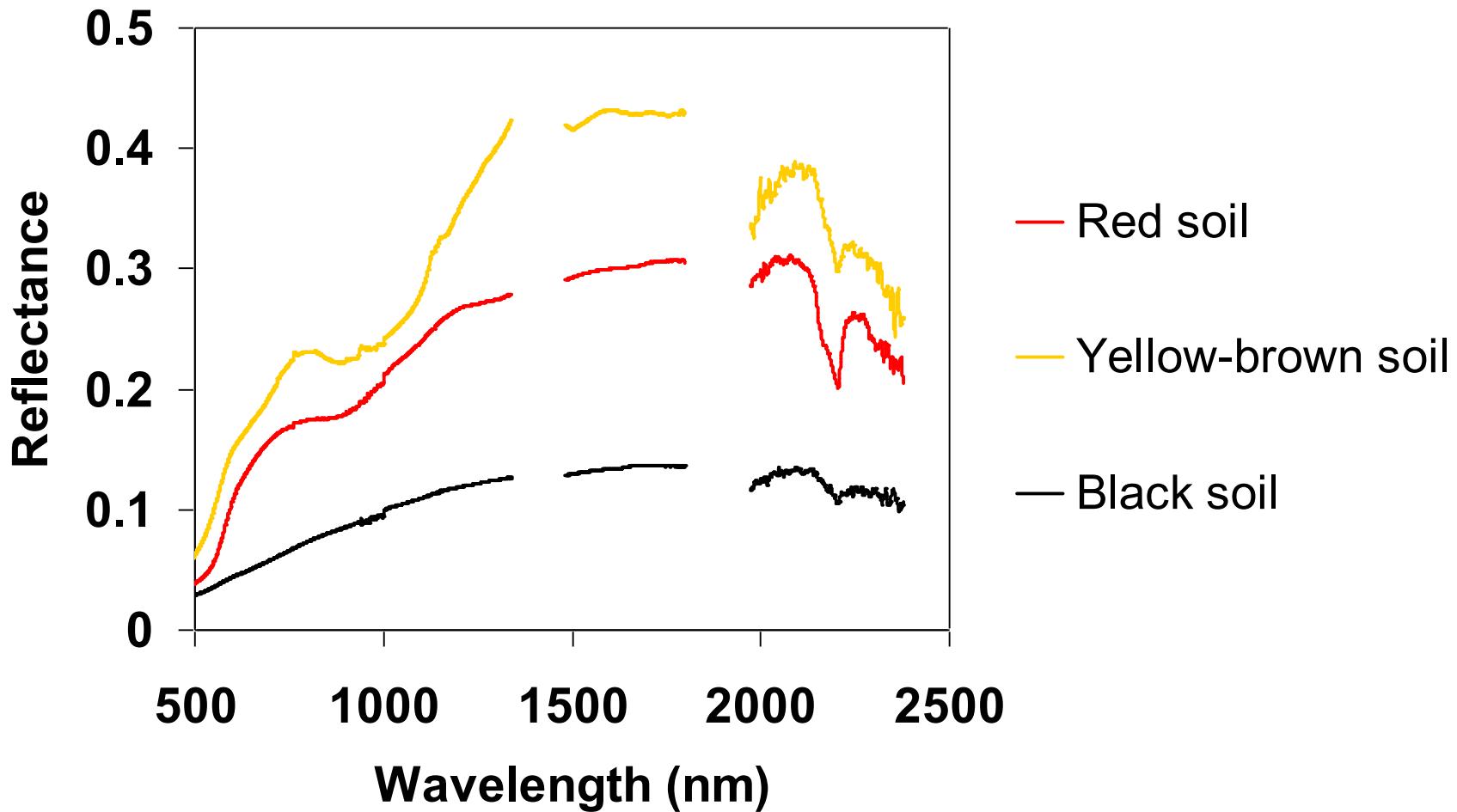
Soil type, fertility and erosion

Probable changes in sedimentation rates in the Nyando River Basin over the last 100 years



Soil type, fertility and erosion

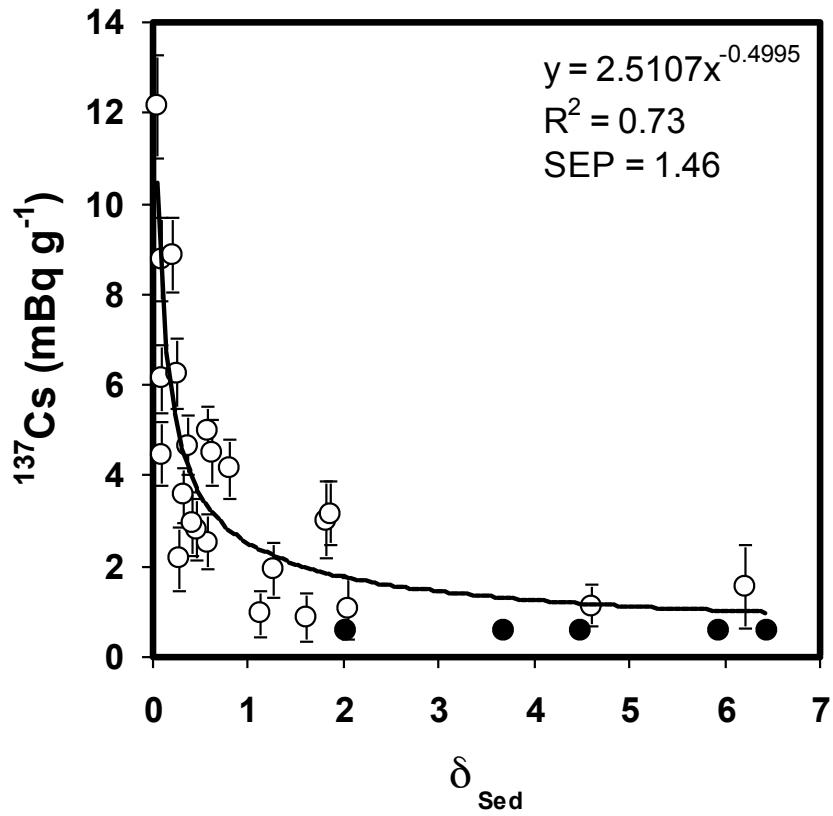
Field spectrometry - Western Kenya Soils



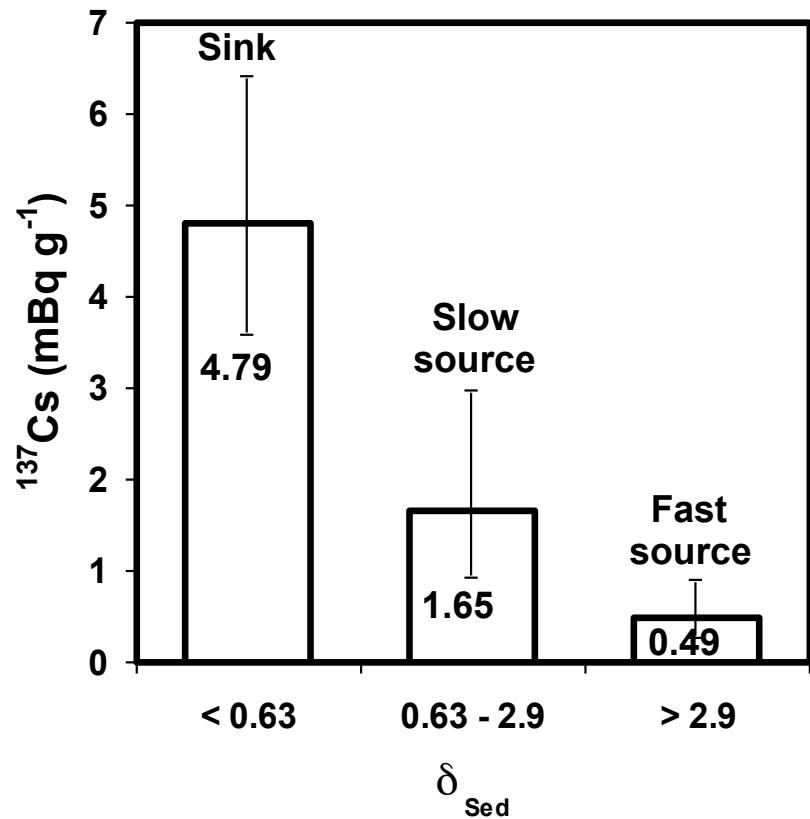
Soil type, fertility and erosion

Relationship between sediment-standardized reflectance (δ_{Sed}) and ^{137}Cs inventories of soils

Power function

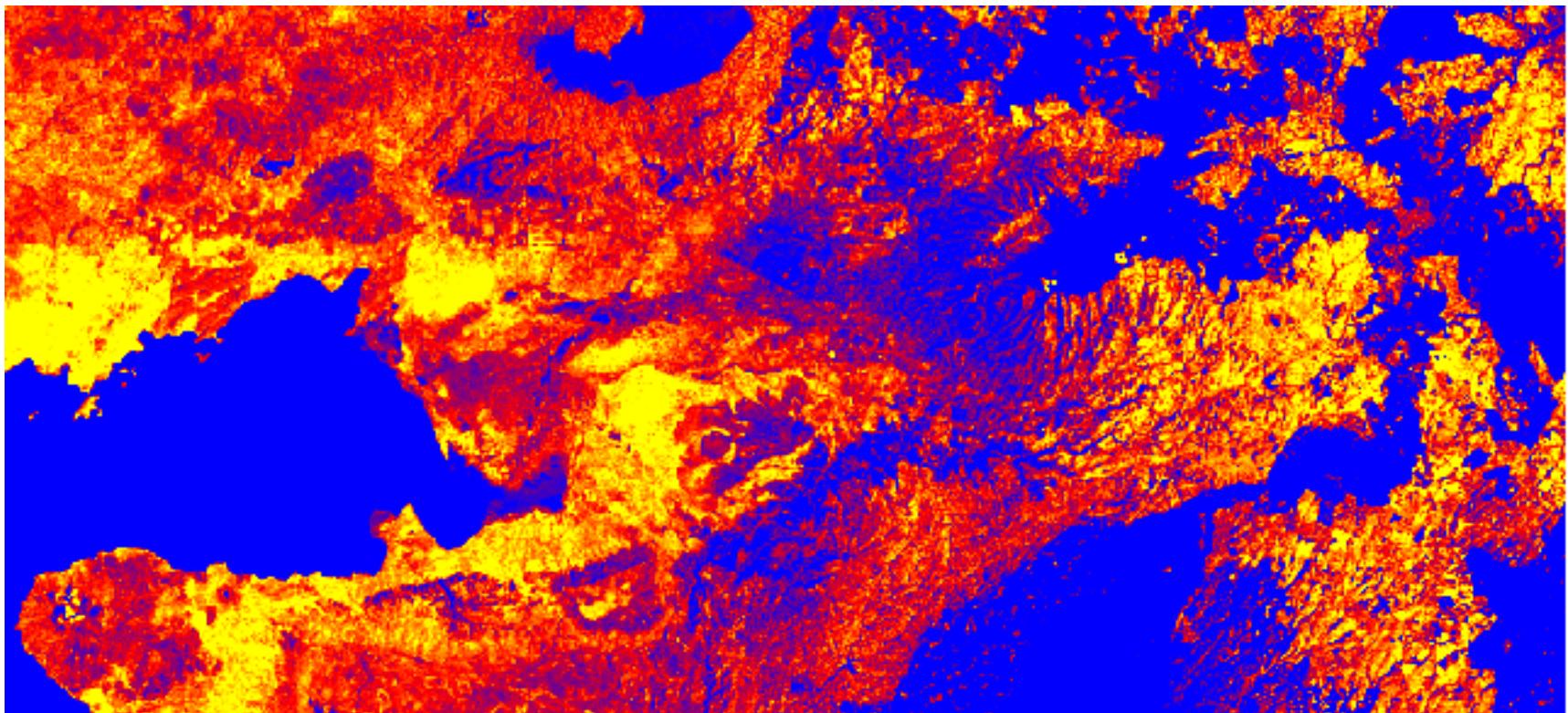


Erosion Phase Interpretation



Soil type, fertility and erosion

Soil fertility and erosion can be mapped from spectral soil properties derived from Remote Sensing data



Indicative distribution of sediment source potential in the Nyando River Basin.
(Interpretation based on Landsat ETM+ satellite image, Feb. 2000)

Soil type, fertility and erosion

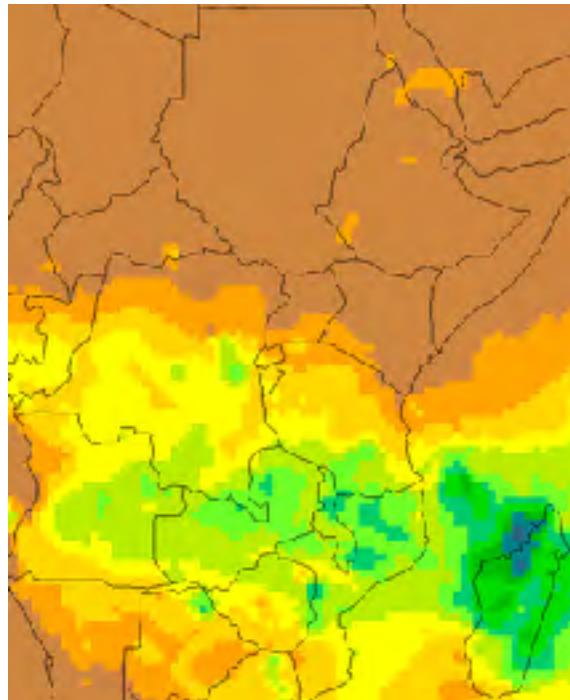
Can be improved by:

1. Making use of archived soil profiles (new methods for scanning can be used for effective fertility analysis)
2. Assembly and quality control of soil samples and other baseline data
3. Erosion-transport-sedimentation surveys (incl. community based erosion pits)
4. Ground surveys and Remote Sensing for mapping Soil Fertility from soil reflectance properties (EO-1 Hyperion, Landsat ETM, TERRA MODIS)

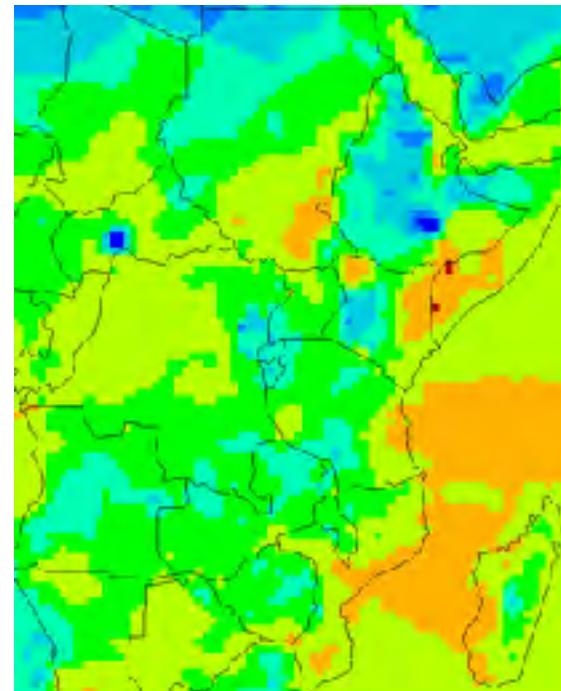
Hydrology

Vertical water balance

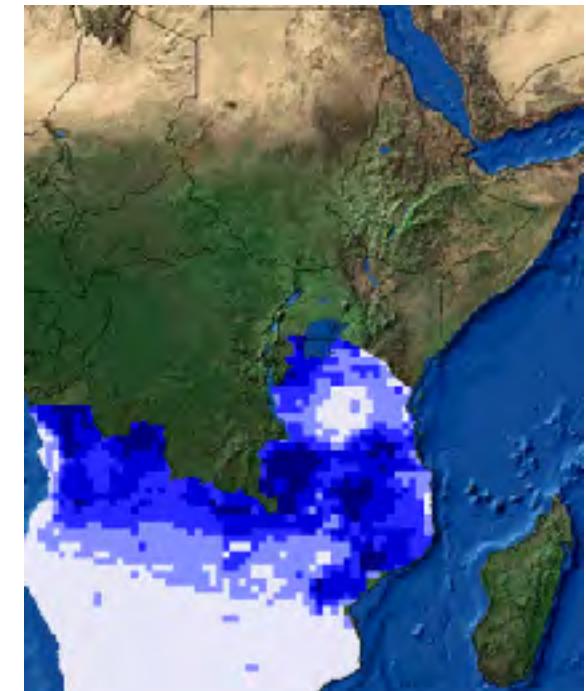
Rainfall



- Evapotranspiration =

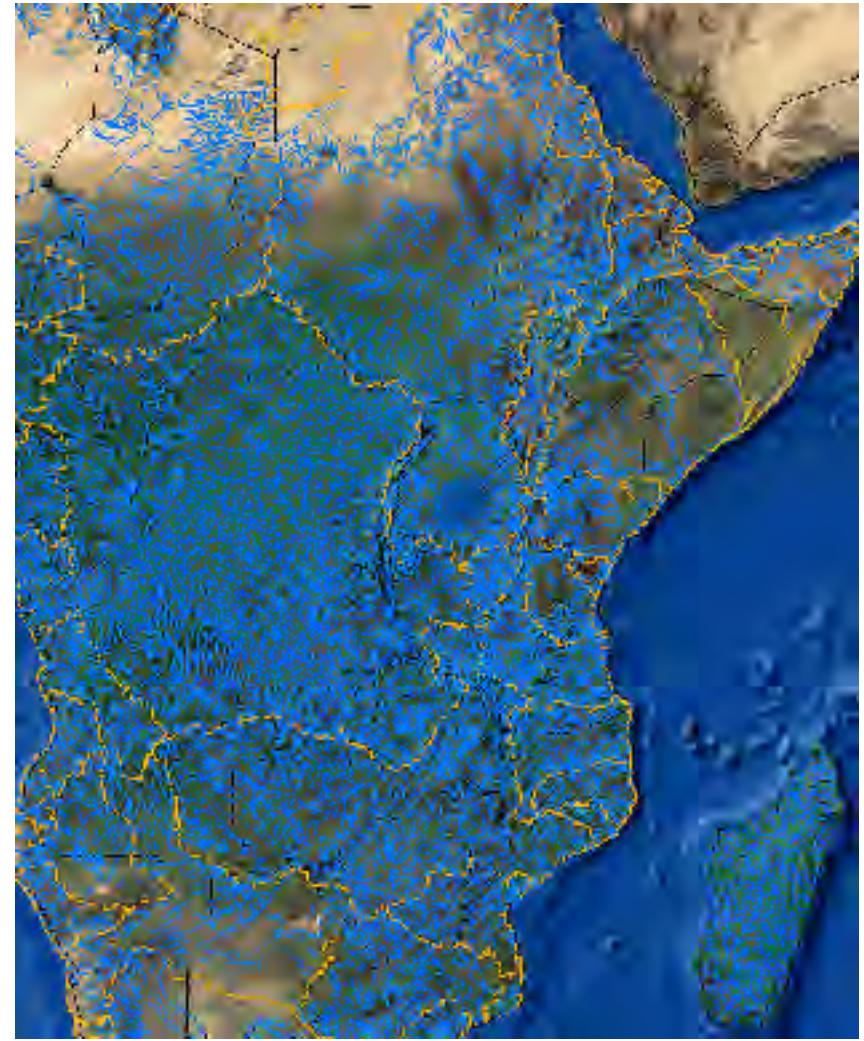


Net recharge



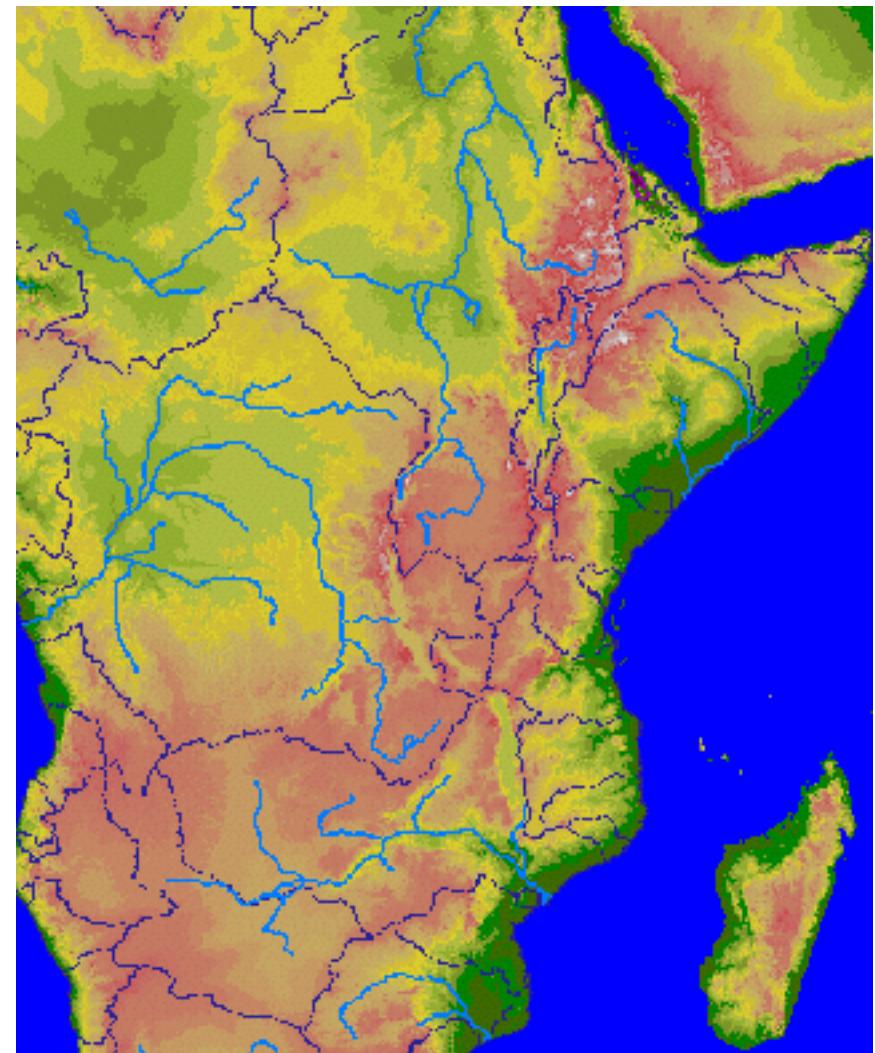
Hydrology

Runoff in basins, forming a lot of small streams ...



Hydrology

... forming large rivers. But the DEM is too poor for modeling.



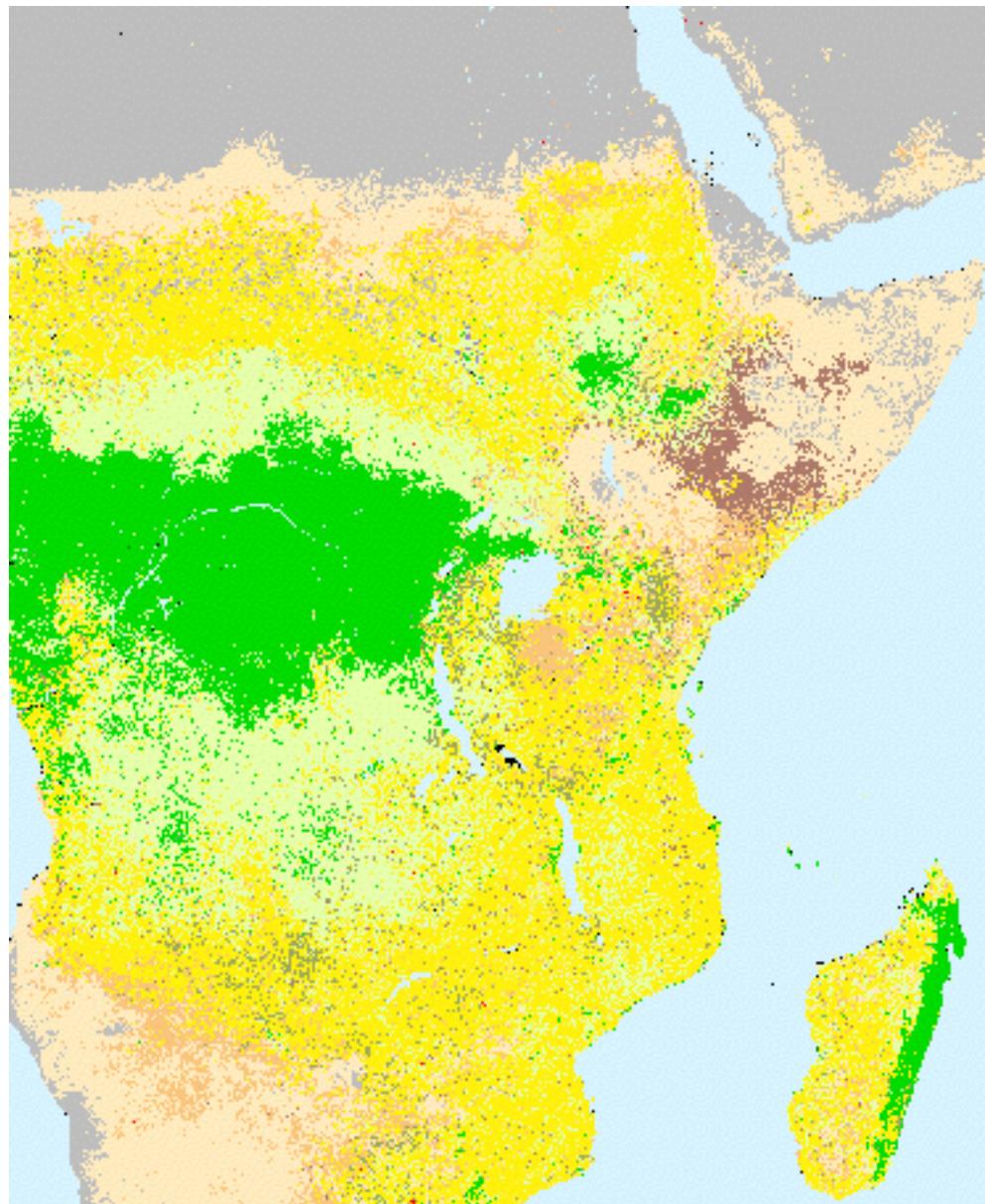
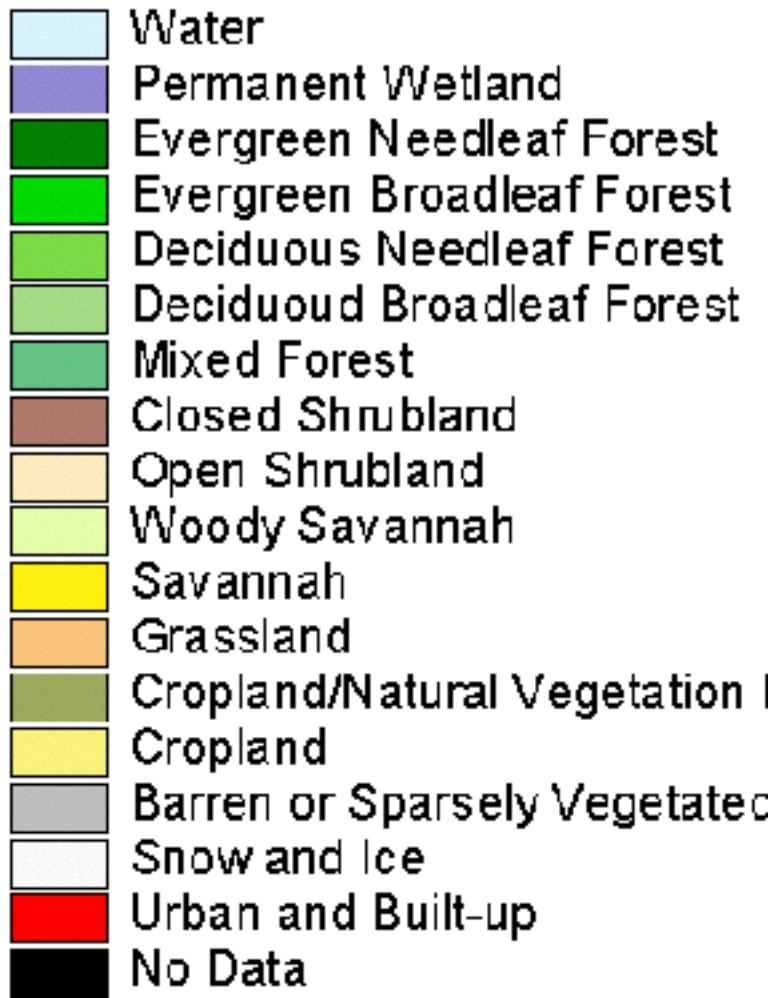
Hydrology

Can be improved by:

1. Assembly and quality control of runoff records
2. New DEM derived from Remote Sensing (SRTM, or stereo pairs of TERRA-ASTER Images)
3. Better estimates of precipitation and evapotranspiration
4. Better estimates of soil hydraulic properties (incl infiltration capacity)

Land use/cover

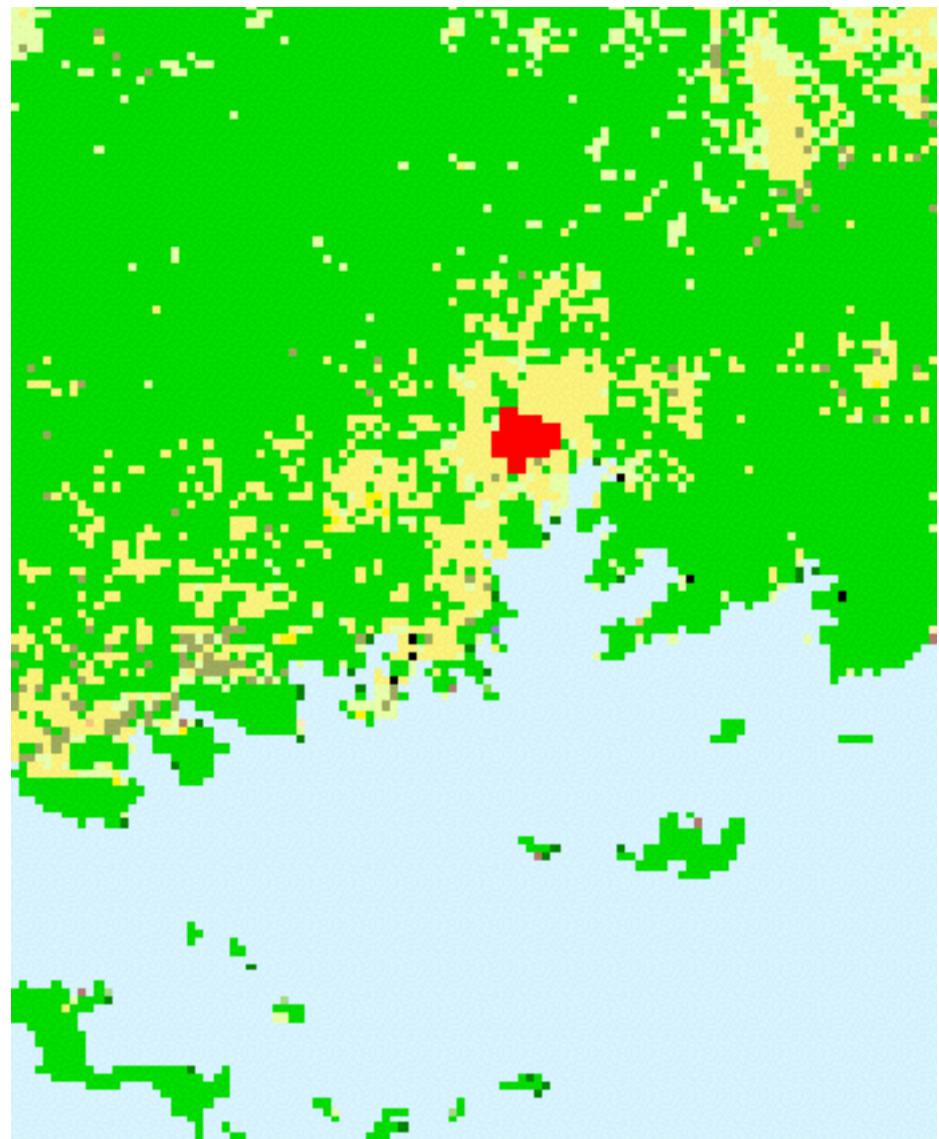
TERRA MODIS by NASA



Land use/cover

Detail over Entebbe

Water
Permanent Wetland
Evergreen Needleleaf Forest
Evergreen Broadleaf Forest
Deciduous Needleleaf Forest
Deciduous Broadleaf Forest
Mixed Forest
Closed Shrubland
Open Shrubland
Woody Savannah
Savannah
Grassland
Cropland/Natural Vegetation I
Cropland
Barren or Sparsely Vegetated
Snow and Ice
Urban and Built-up
No Data



Land use/cover

Available data

- 1.Global land cover classification from NOAA-AVHRR (1993)
- 2.Global land cover classification from TERRA-MODIS (2000/01)
- 3.Global tree cover from TERRA MODIS (2000)

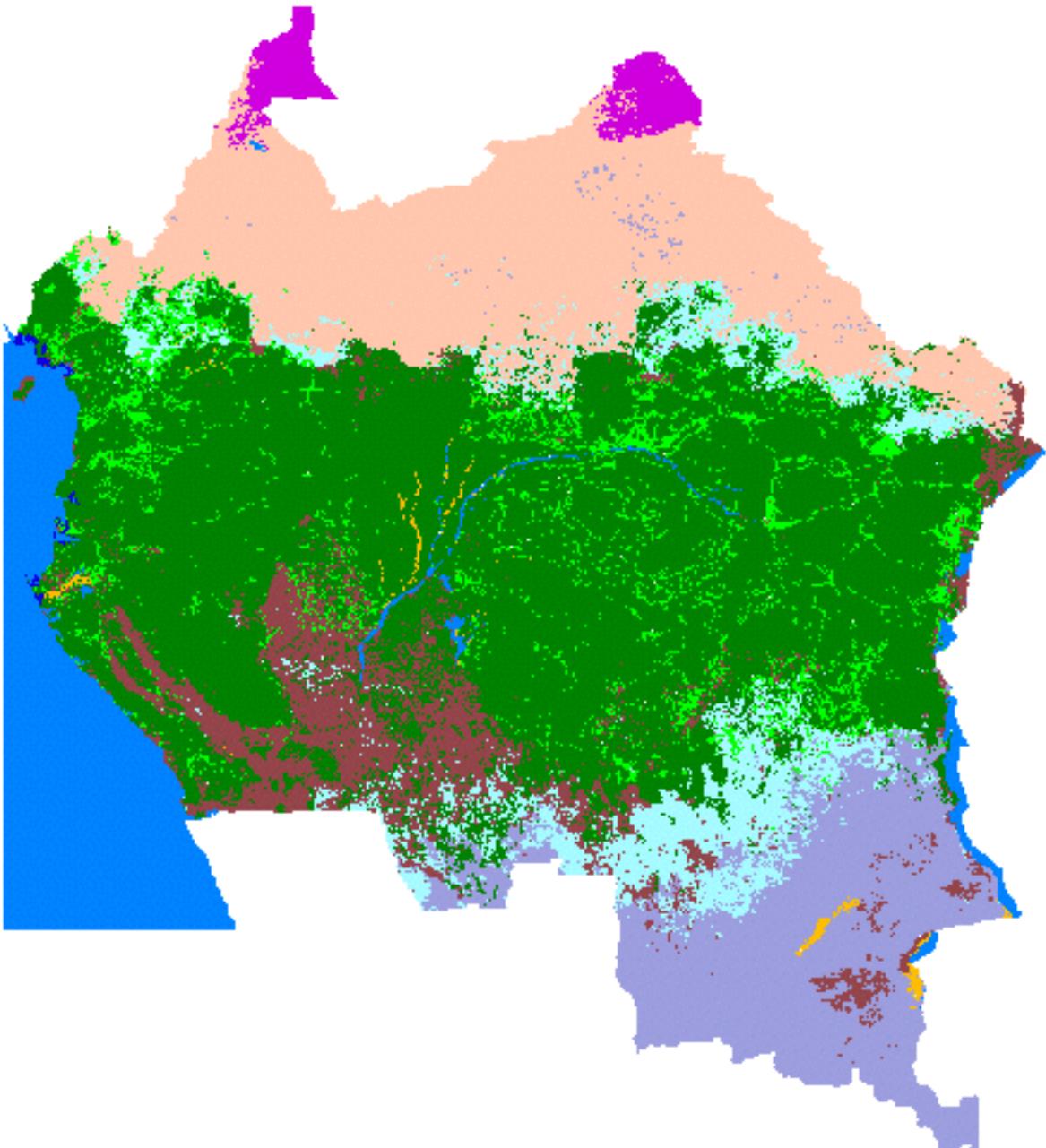
4.FAO Africover

- 5.More detailed maps over selected regions
- 6.Country specific datasets, including biomass projects in several countries

Land use/cover

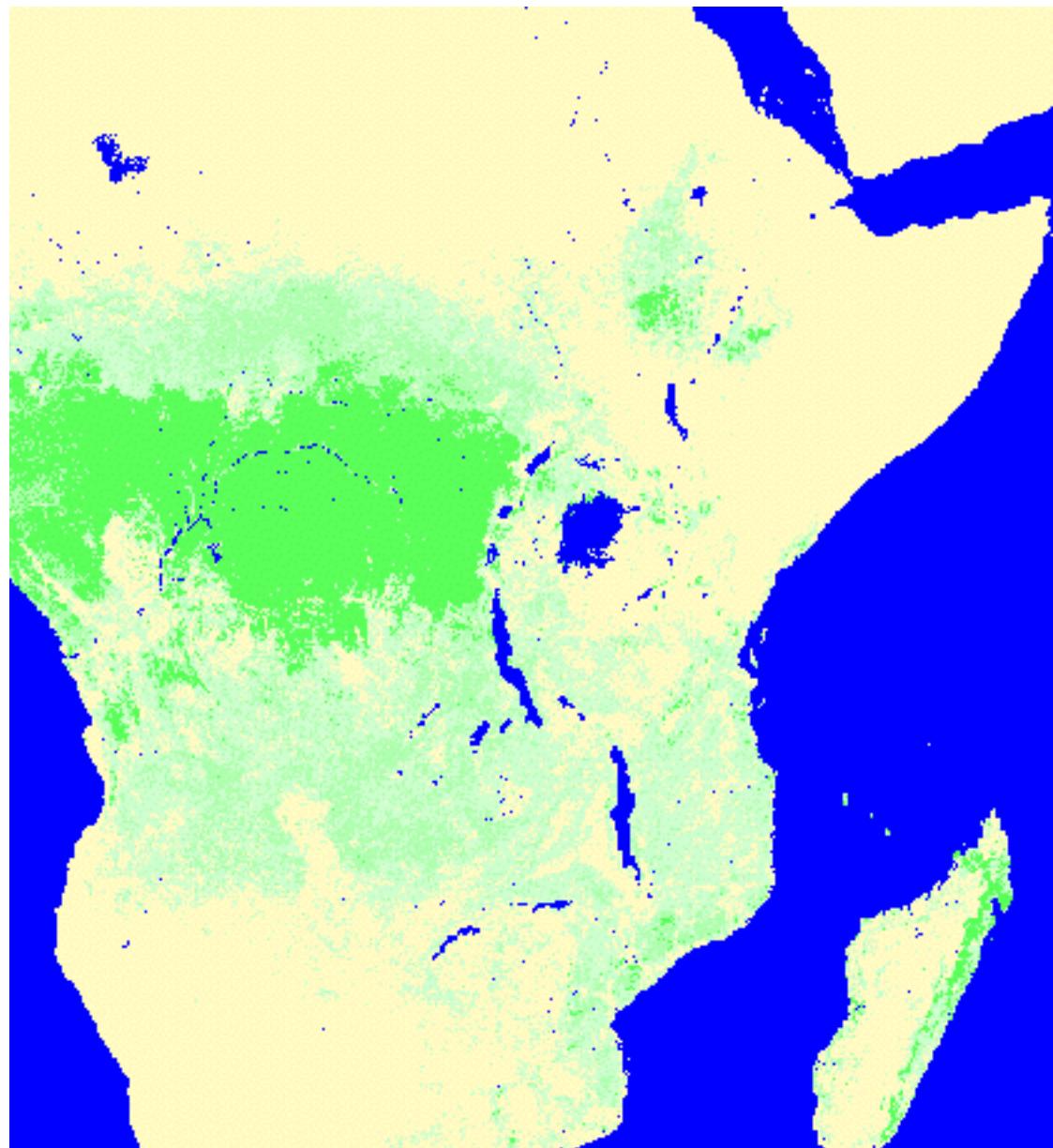
CARPE
Vegetation map

- Dense moist forest
- Secondary forest
- Forest/ savanna mos.
- Woodland
- Woodland & tree sav.
- Grasslands
- Mangroves
- Swamp grassland
- Shrubs and steppe
- Water
- Ocean



Land use/cover

TERRA MODIS
tree cover
(annual update)

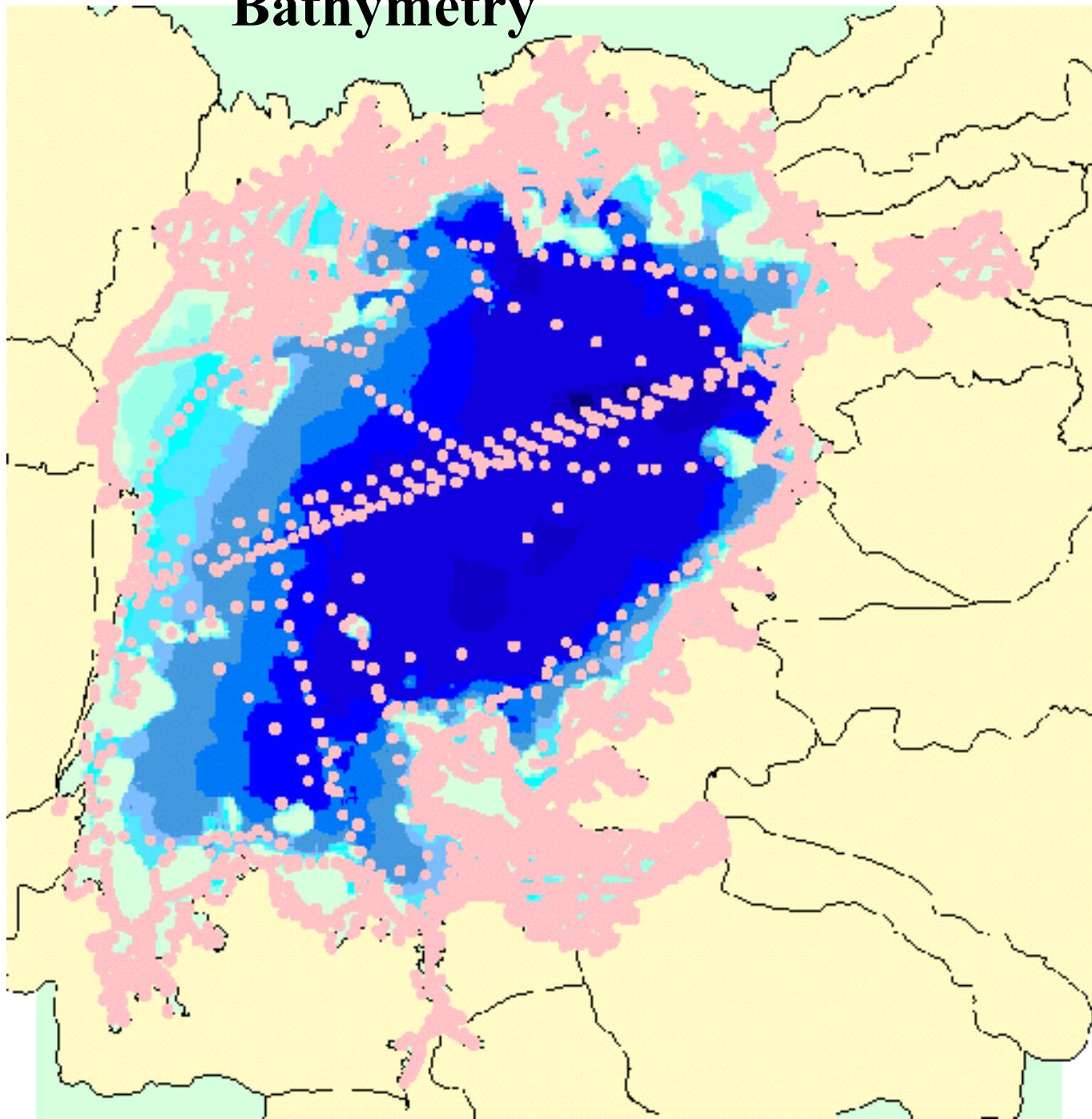


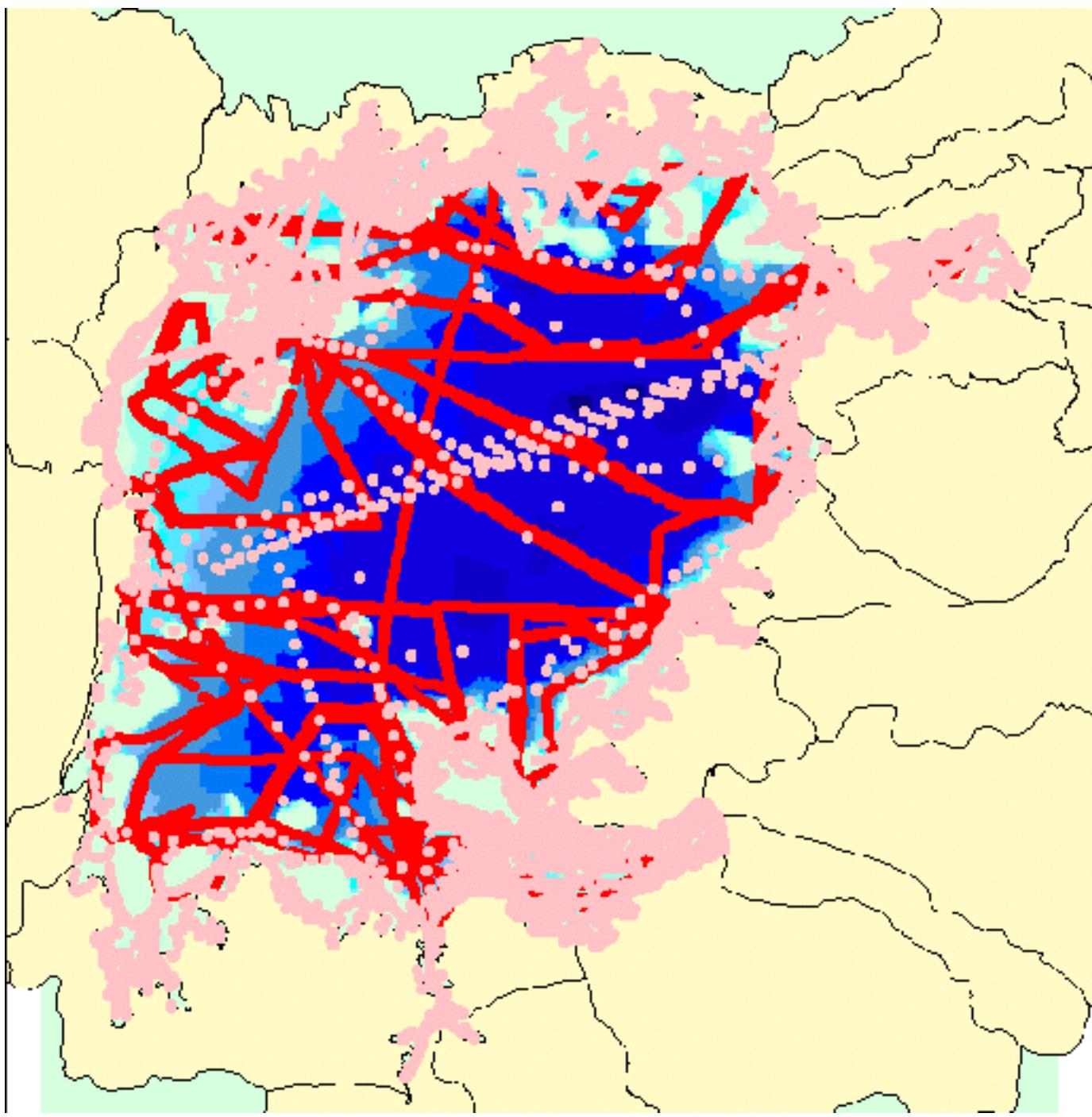
Land use/cover

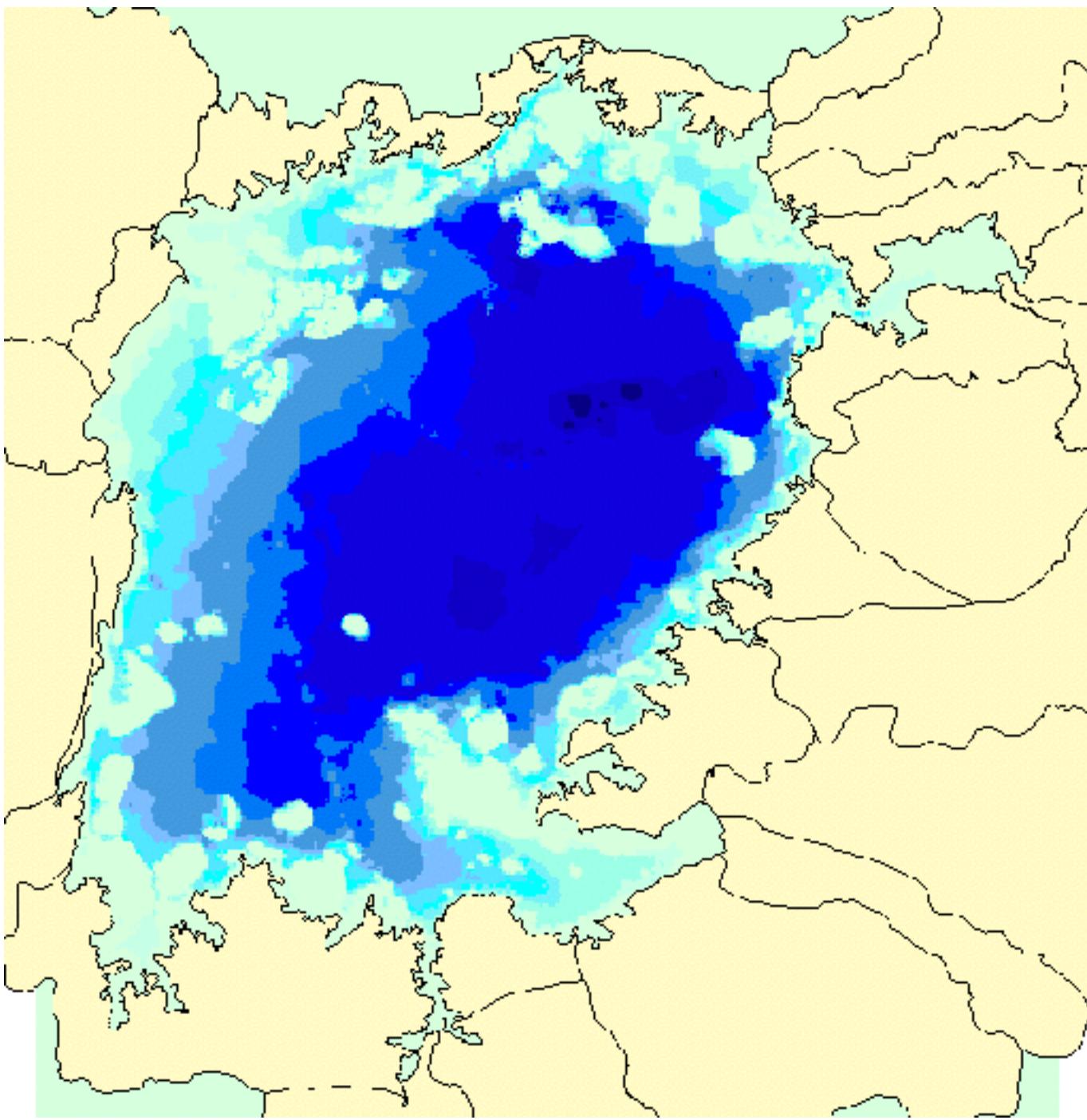
Can be improved by:

- 1.Existing maps
- 2.Remote Sensing snapshots (Landsat (E)TM) and timeseries (NOAA-AVHRR, TERRA_MODIS) combined with GIS data (soil, climate, elevation, slope, aspect, infrastructure). I.e. certain crops only exists in narrow ranges of temperature and soils etc.

Bathymetry



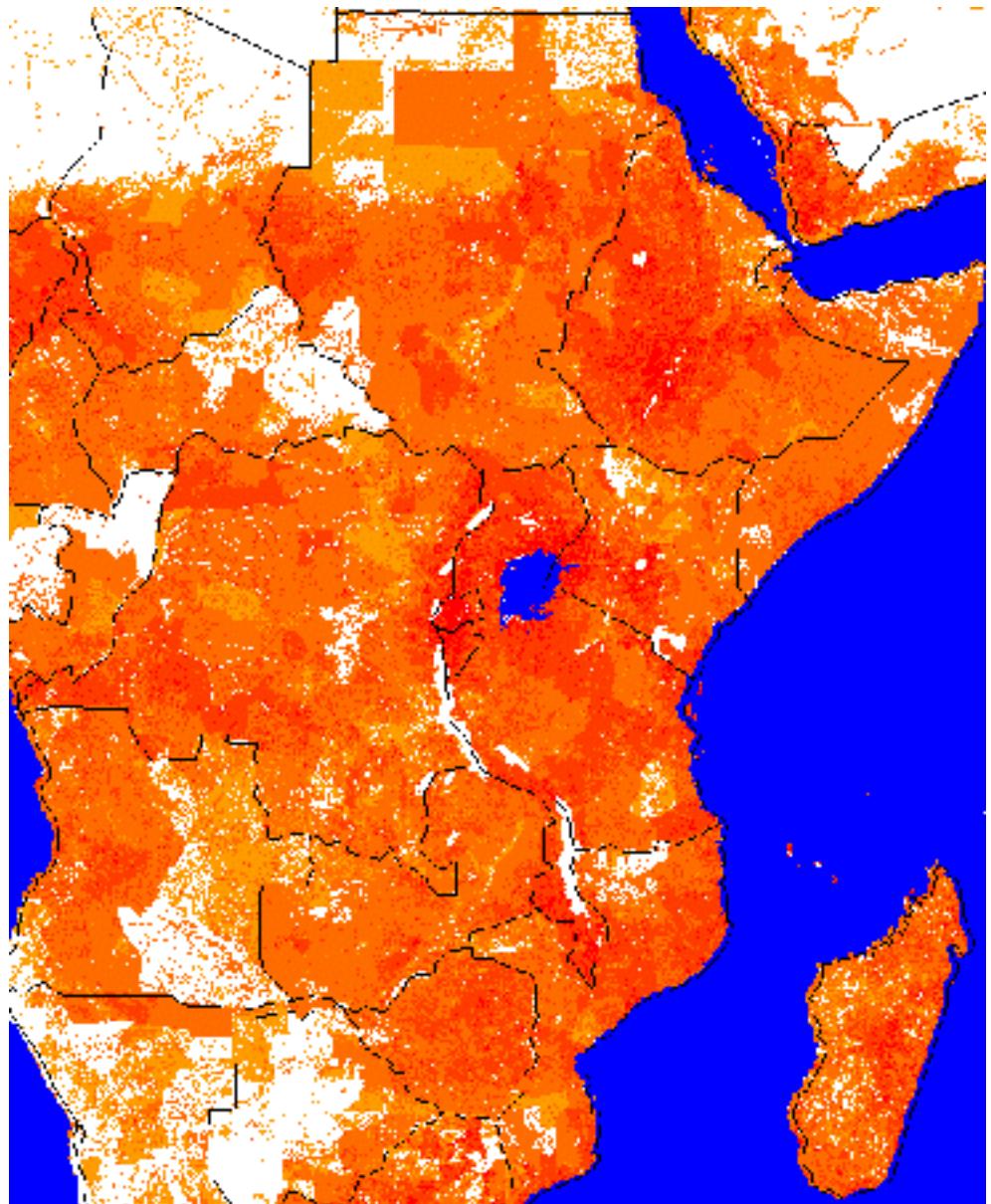




Population and socio-economic data

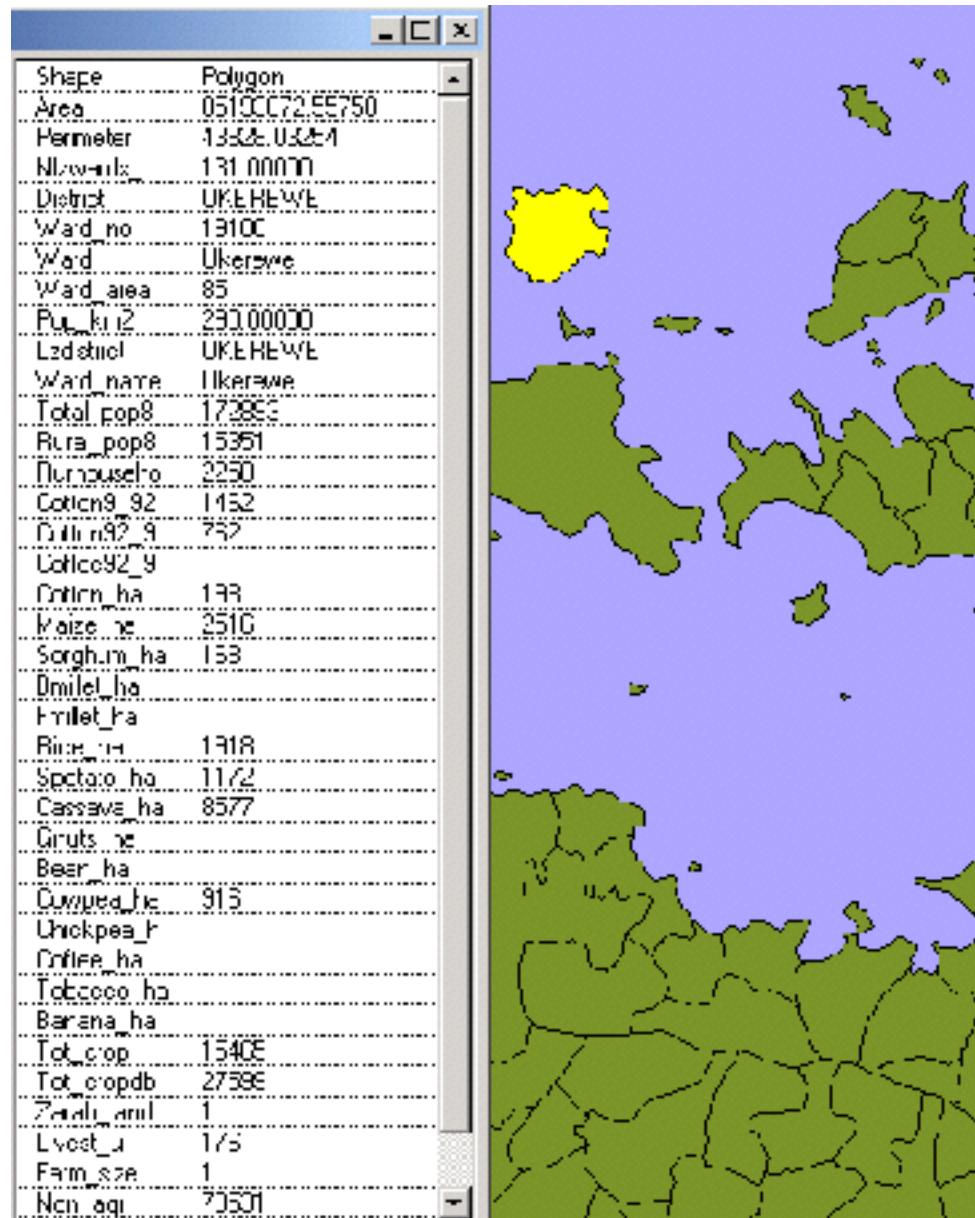
Available

1. Estimations of population densities going back to the 1960s
2. FAO
3. CIESIN
4. LANDSCAN (shown)
5. Socio-economic data down to ward level (varying between countries)



Population and socio-economic data

Socio-economic data down to ward level in some countries.



Population and socio-economic data

Can be improved by:

- 1.Census
- 2.Assembly and quality control of official data
- 3.Very High resolution Remote Sensing techniques
- 4.Statistical methods for distributing lumped data to spatial datasets (e.g. of land cover, population etc)

Remote Sensing data

Available data

- 1.1 full coverage Landsat ETM (30 m resolution) (2000)
- 2.1 full coverage Landsat TM (30 m resolution) (1980-2000)
- 3.6 full coverages TERRA MODIS composite scenes (500 m resolution) (2000/01) (the animation you saw)
- 4.93 full coverage NOAA-AVHRR composites (1 km resolution) (1993/96)
- 5.2 JERS radar composite scenes (100 m resolution) (1996/97)

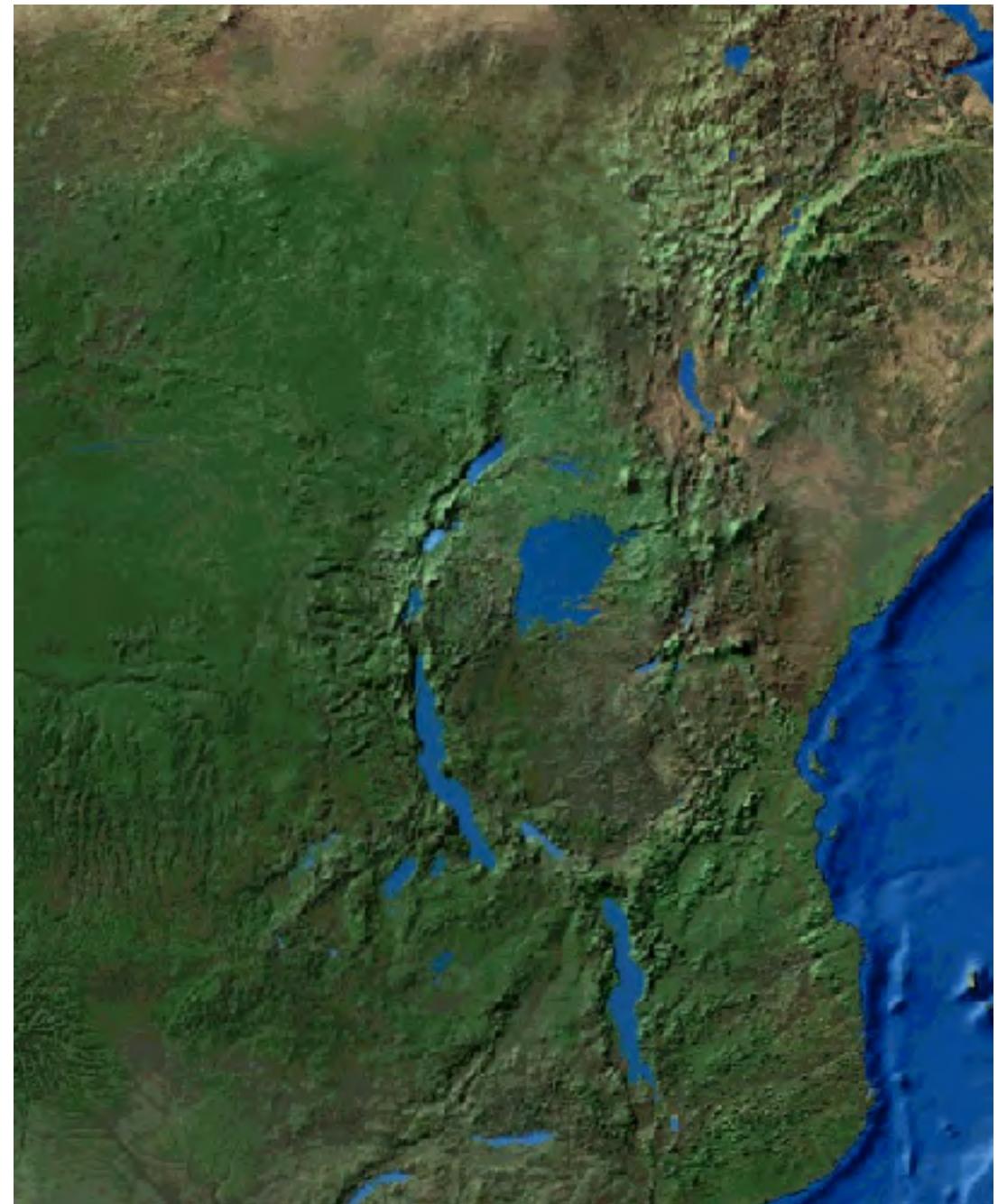
Remote Sensing: TERRA MODIS



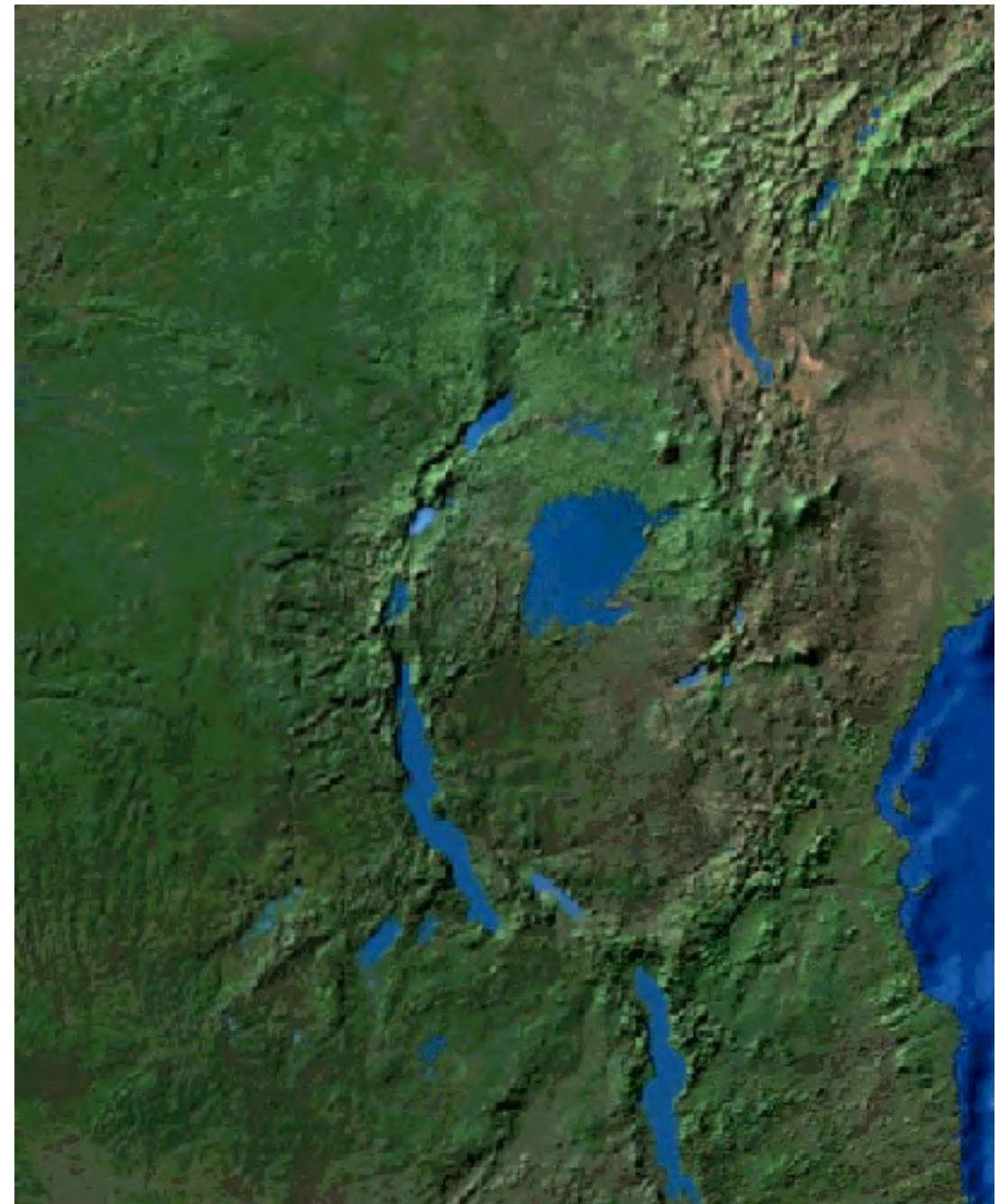
Remote Sensing: TERRA MODIS



Remote Sensing: NOAA AVHRR



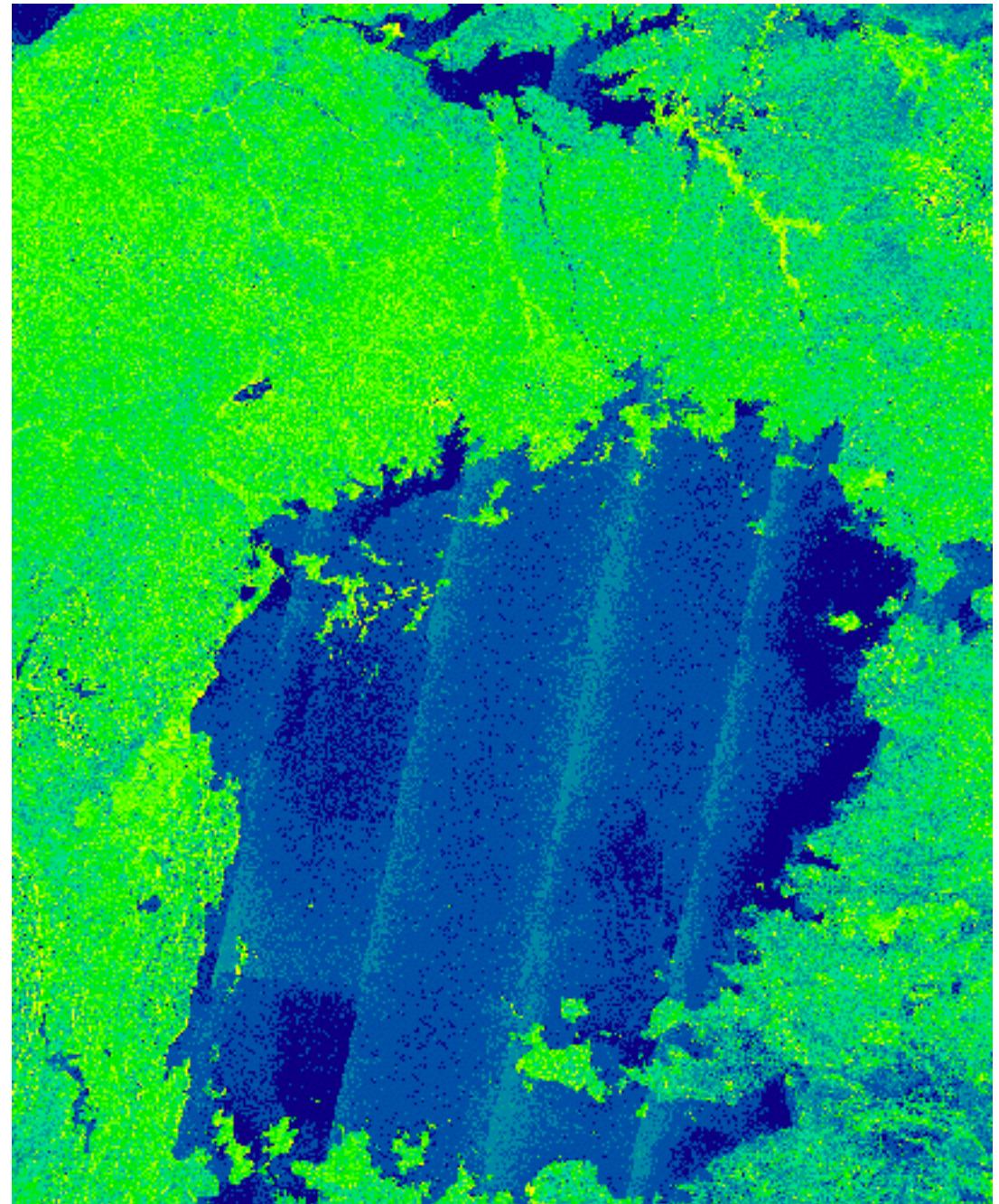
Remote Sensing: NOAA AVHRR



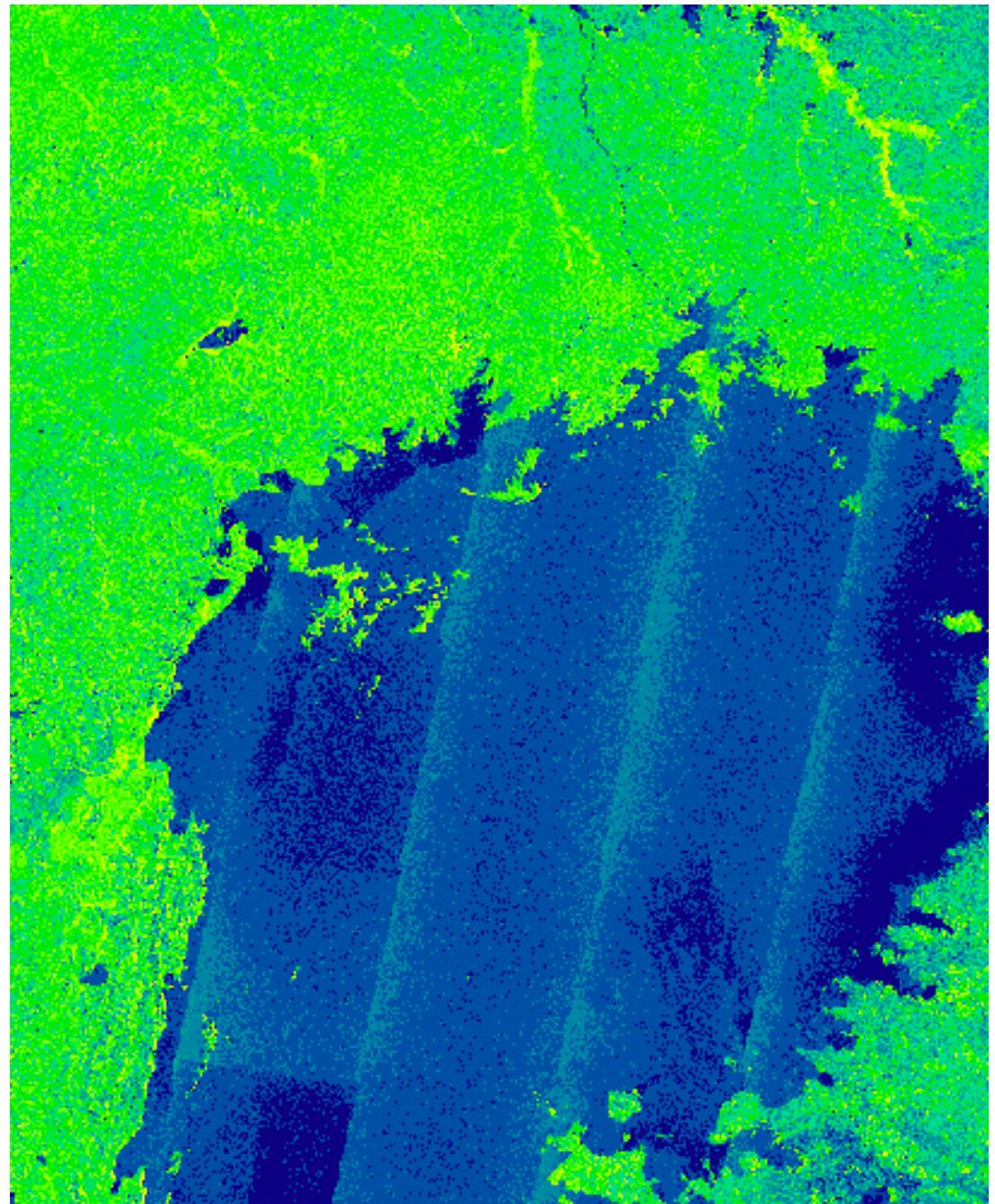
Remote Sensing:

JERS SAR

“Sees” through clouds

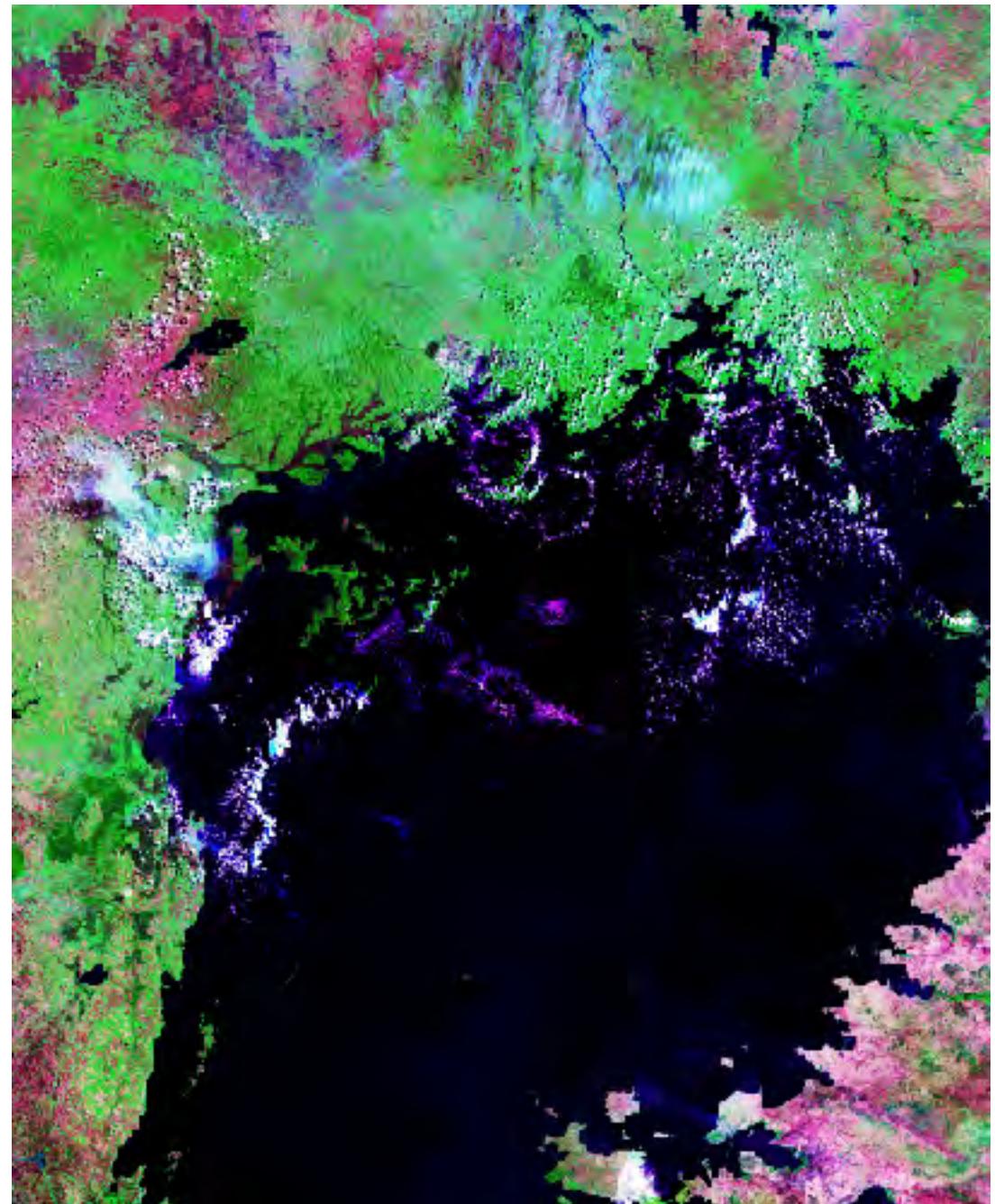


Remote Sensing: JERS SAR

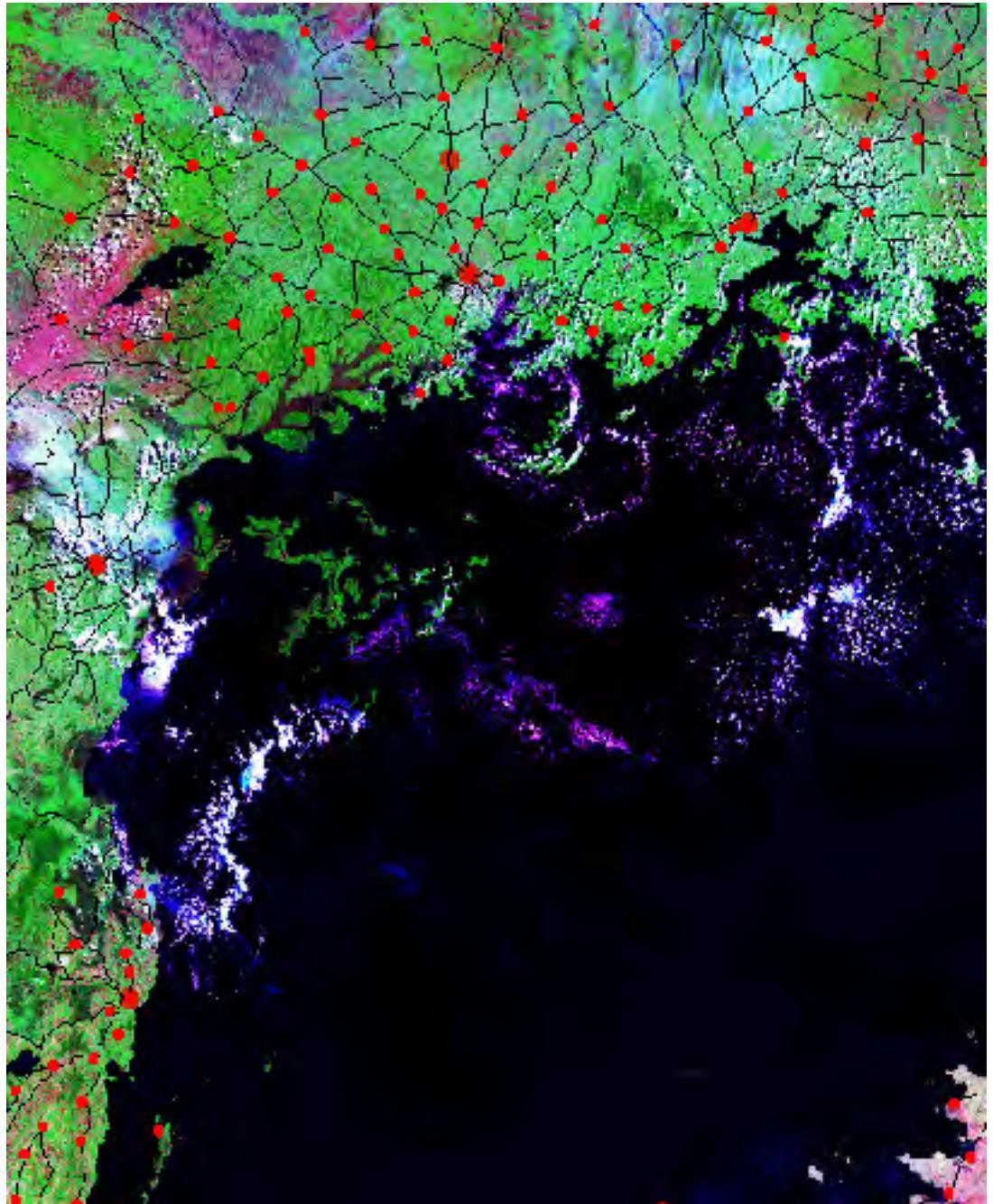


Remote Sensing:

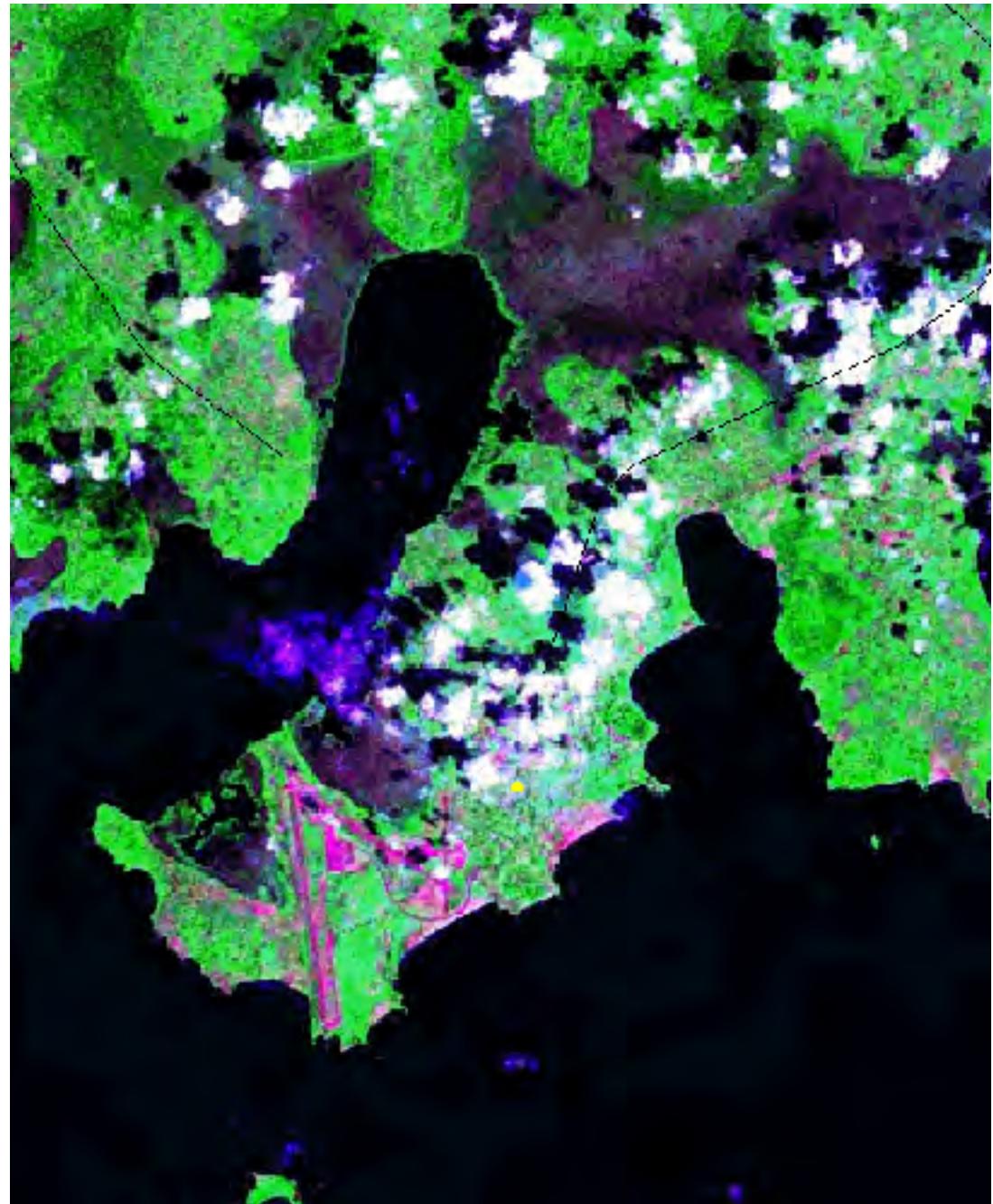
Landsat TM



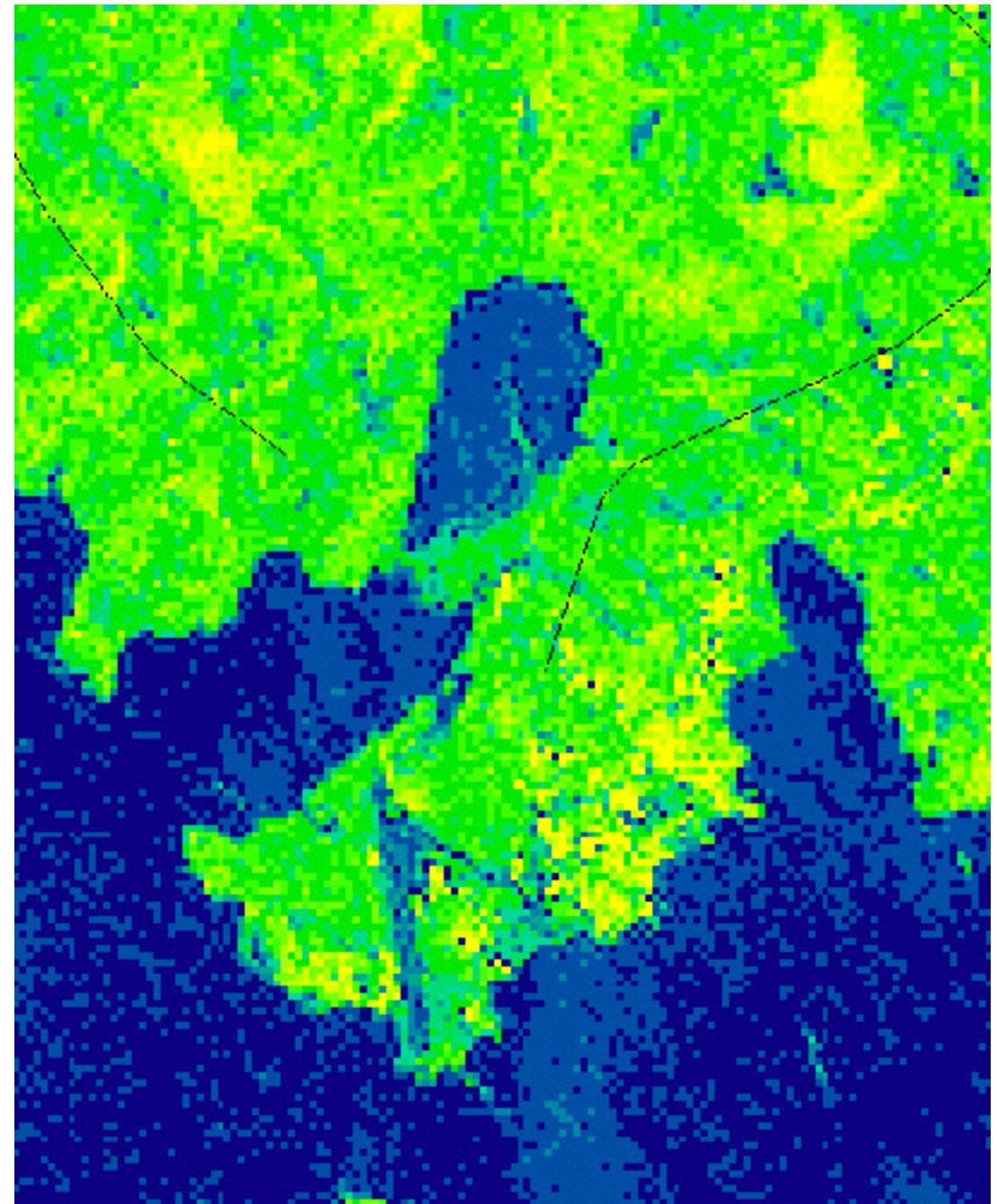
Remote Sensing:
Landsat TM
Infrastructure from DCW
(for all ASARECA
countries)



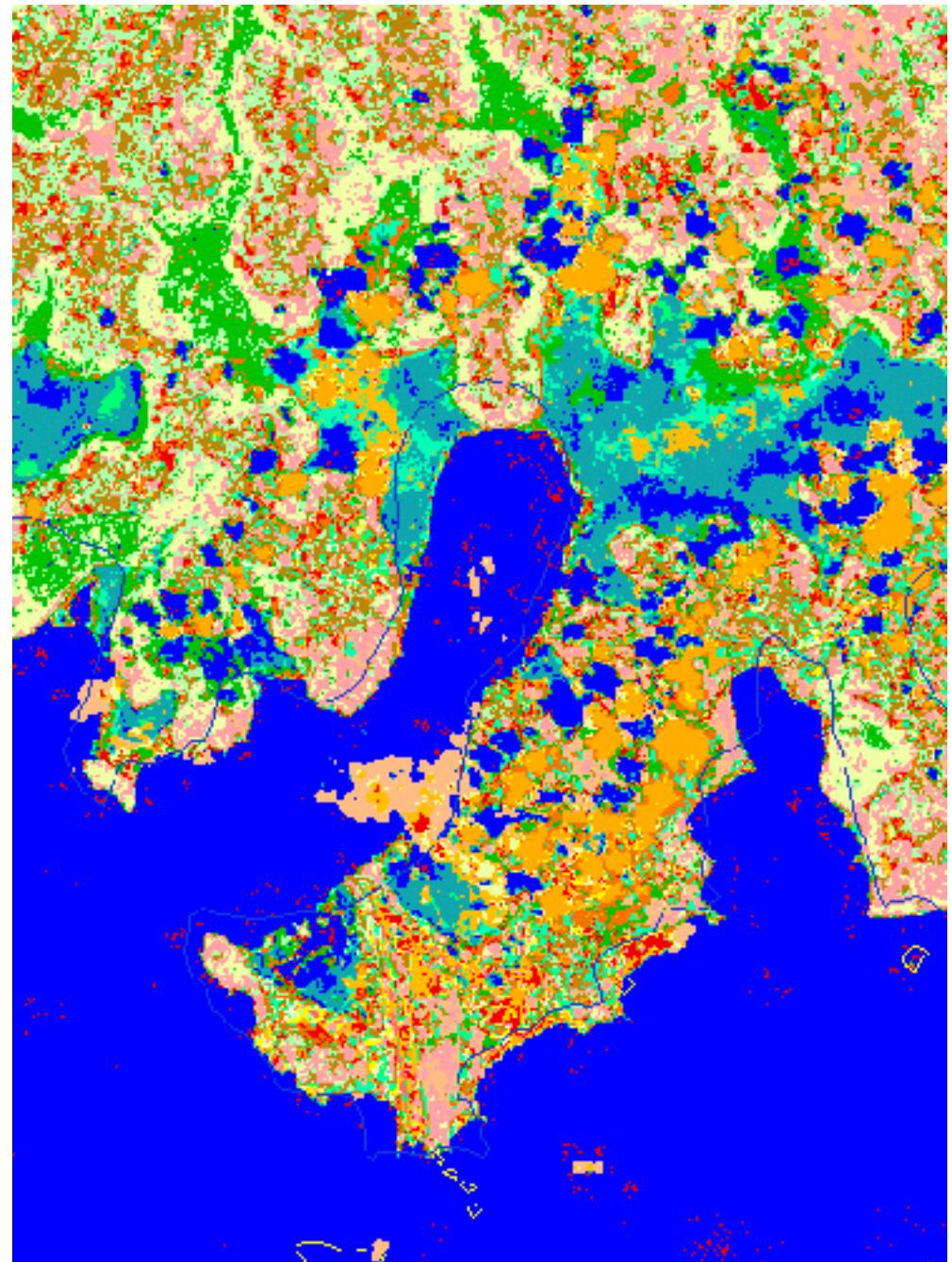
Remote Sensing:
Landsat TM
Entebbe airport



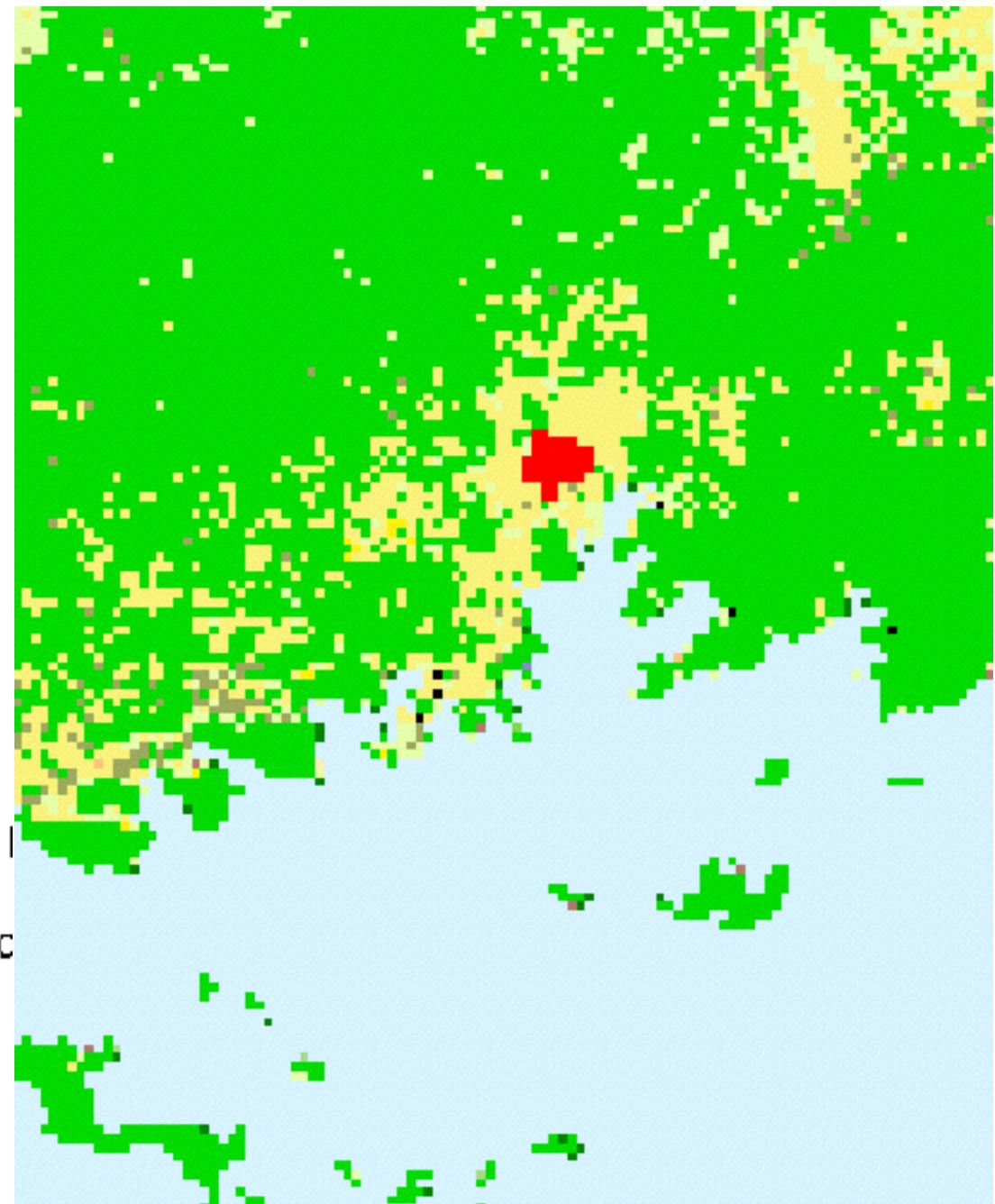
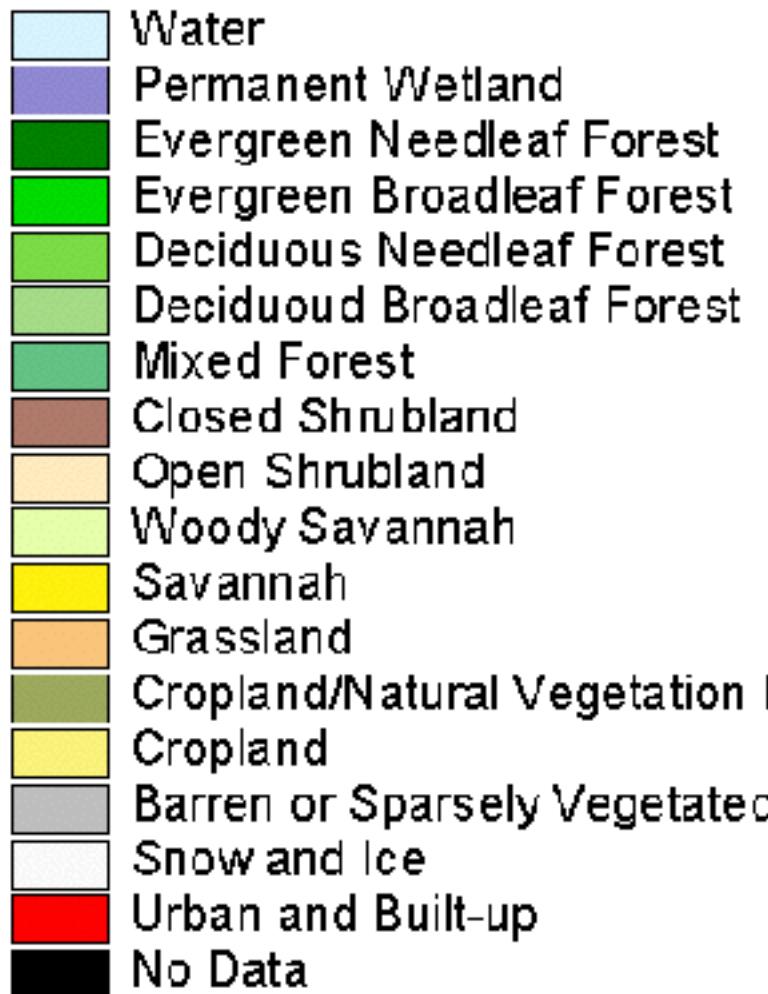
Remote Sensing:
JERS SAR
Entebbe airport



Remote Sensing:
Landsat TM
Classification (uncoded)

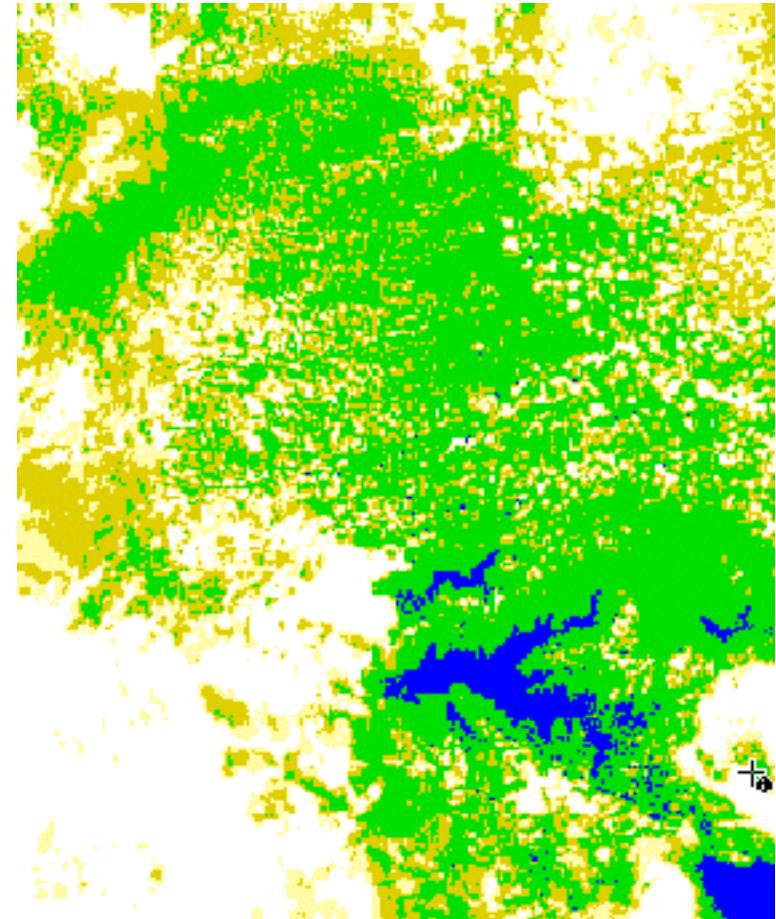
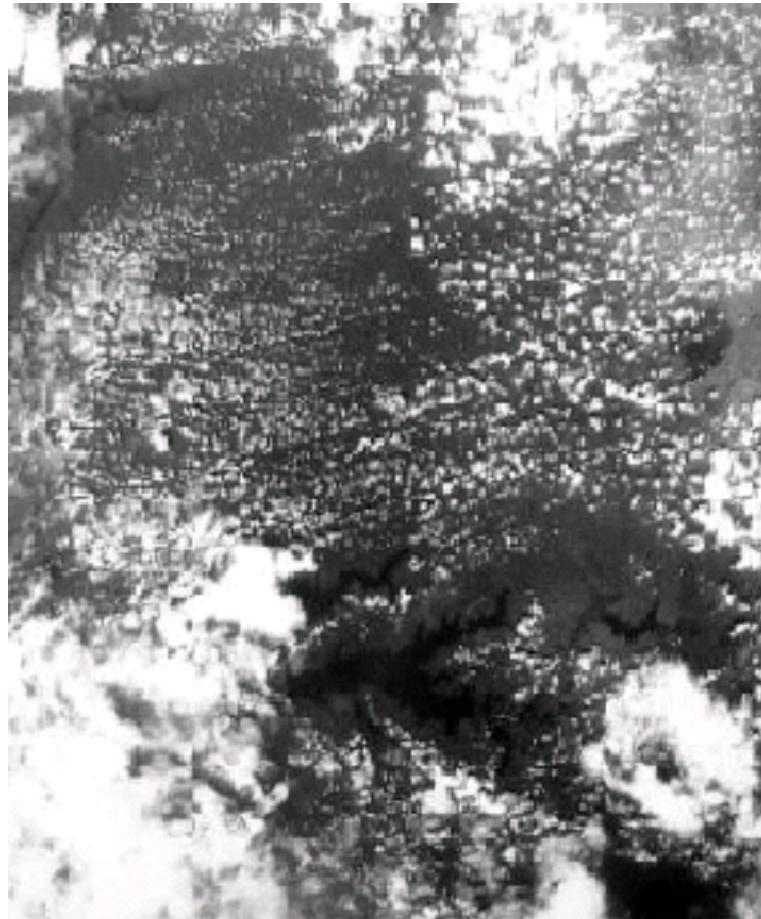


TERRA Landcover



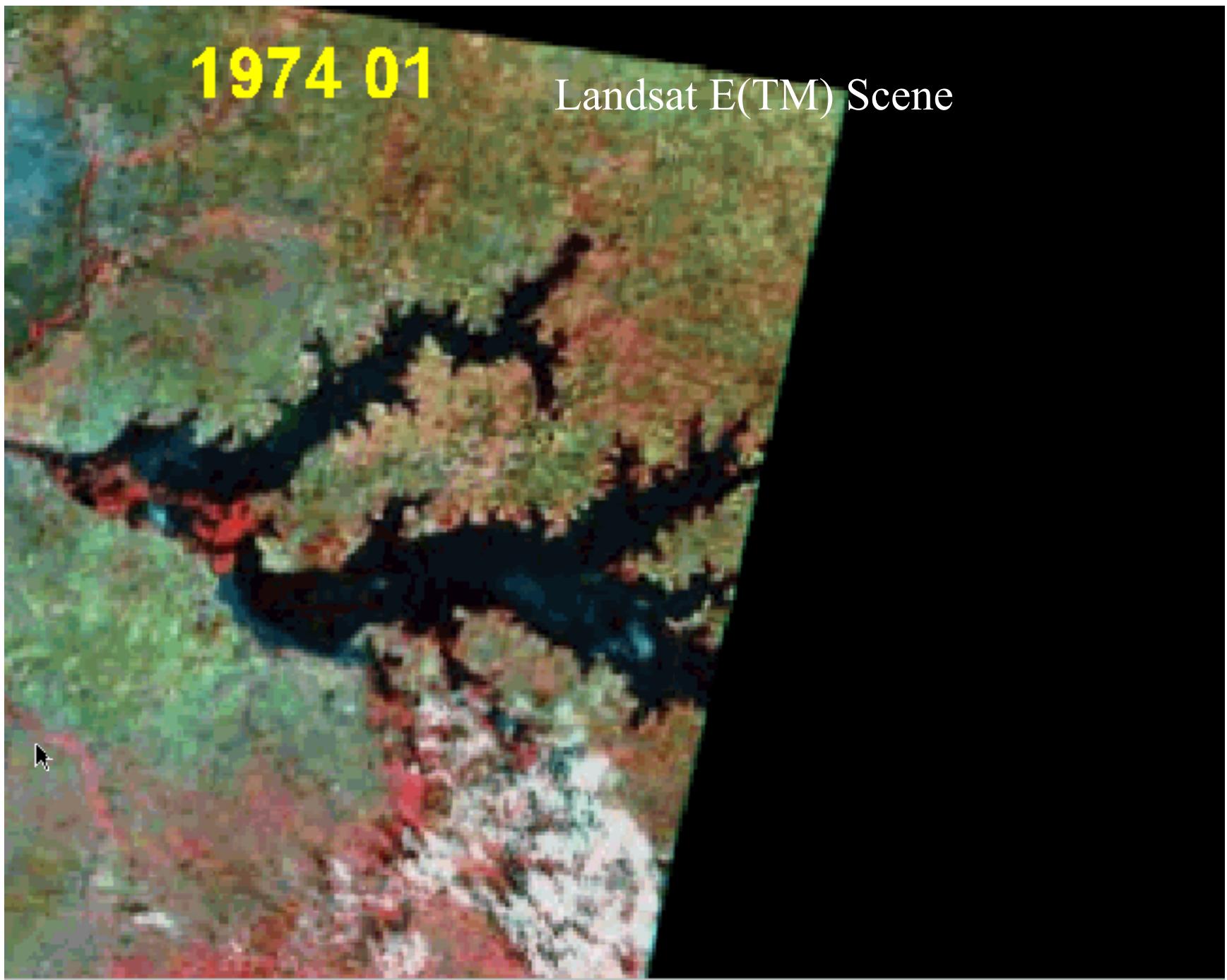
Lake Kyoga, Uganda – example of change studies from remote sensing

Lake Kyoga from CORONA 1963-10-29



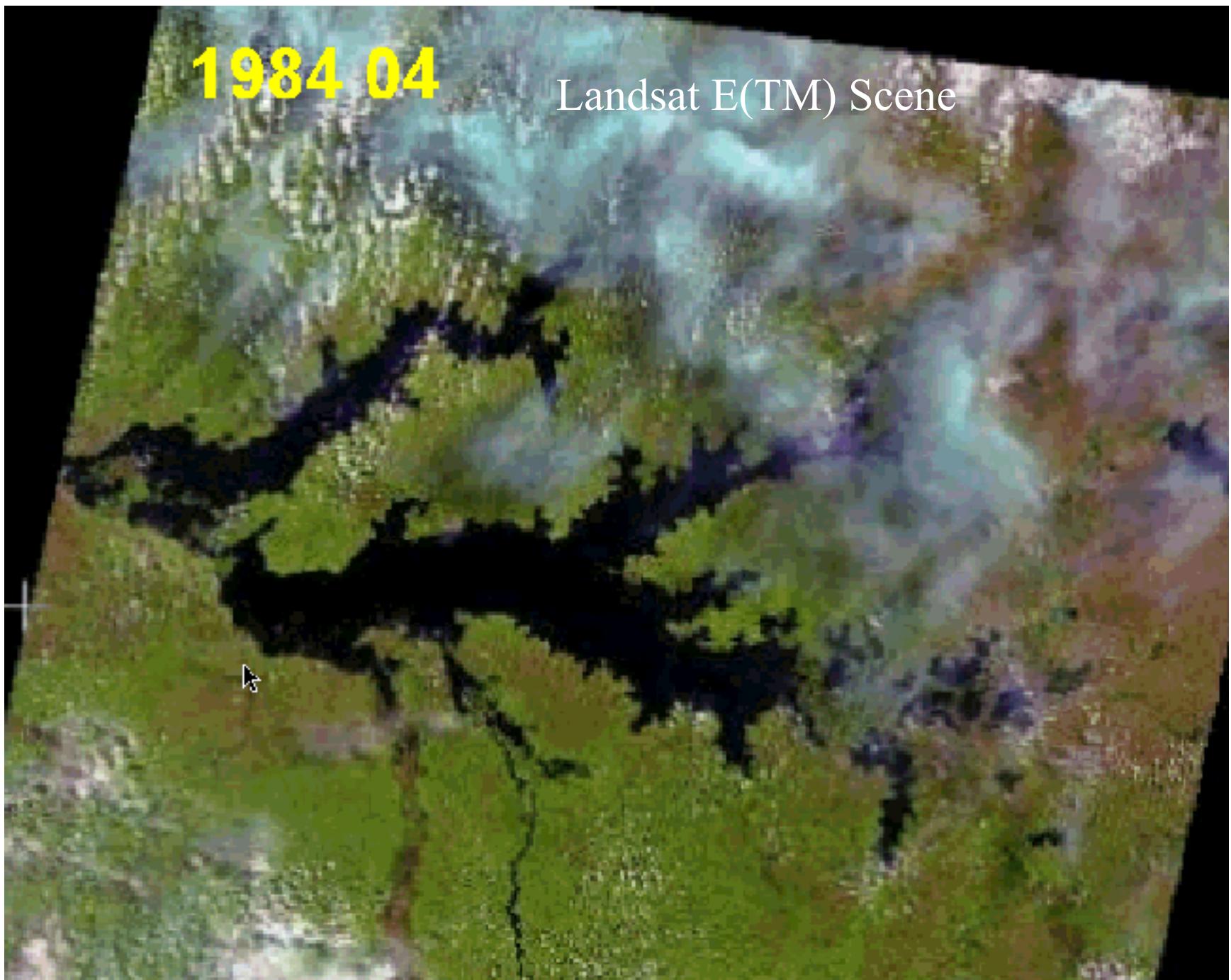
1974 01

Landsat E(TM) Scene



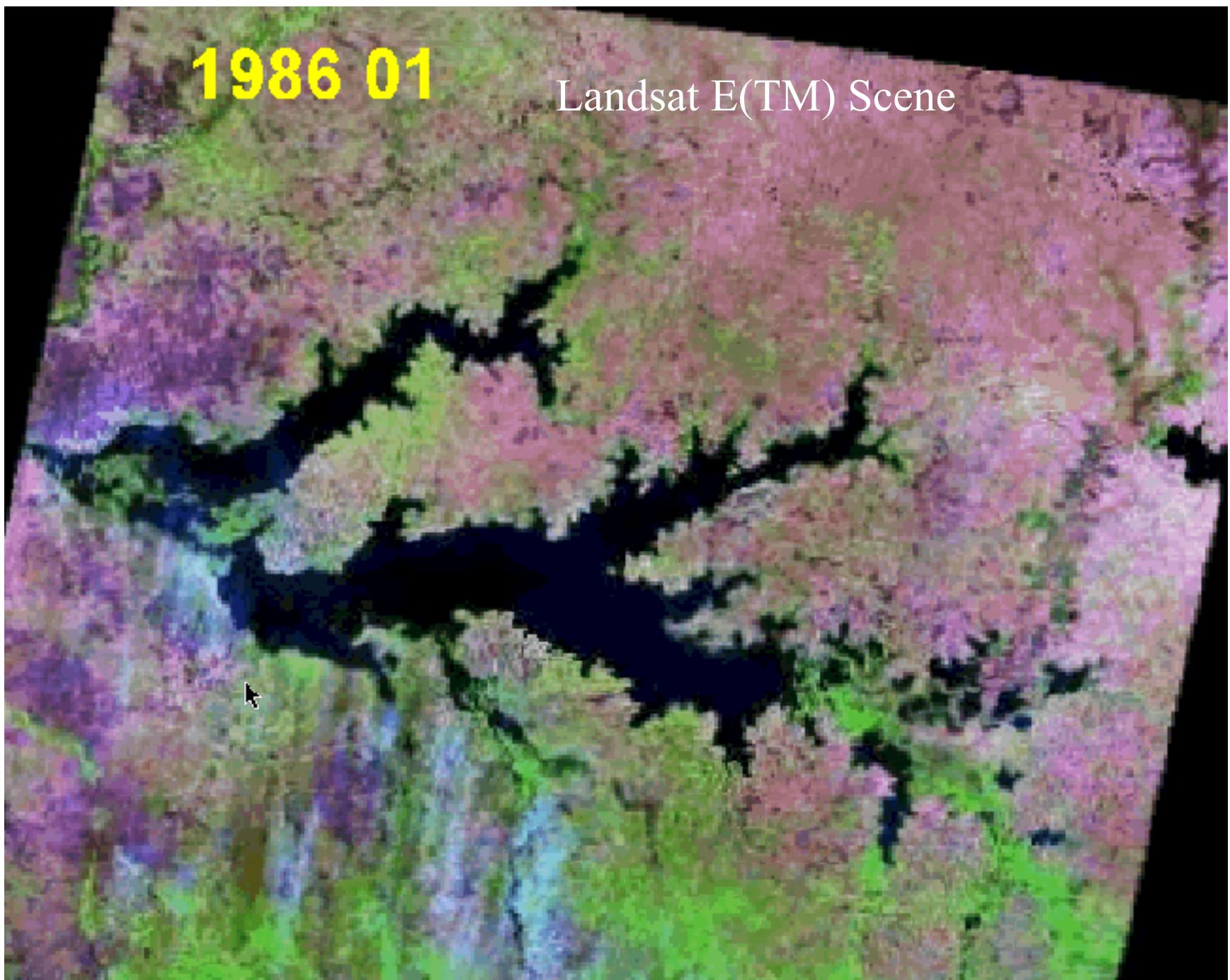
1984 04

Landsat E(TM) Scene



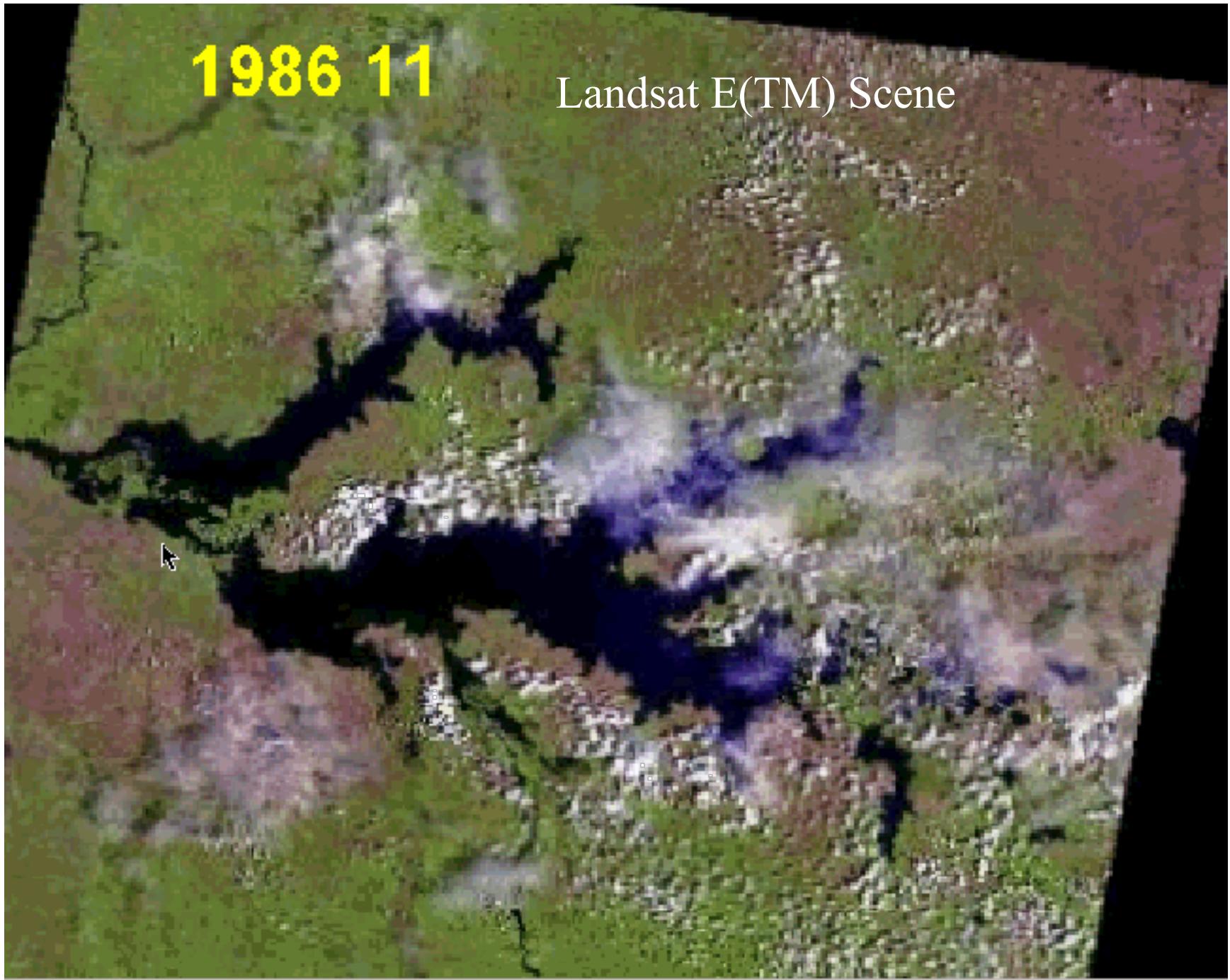
1986 01

Landsat E(TM) Scene



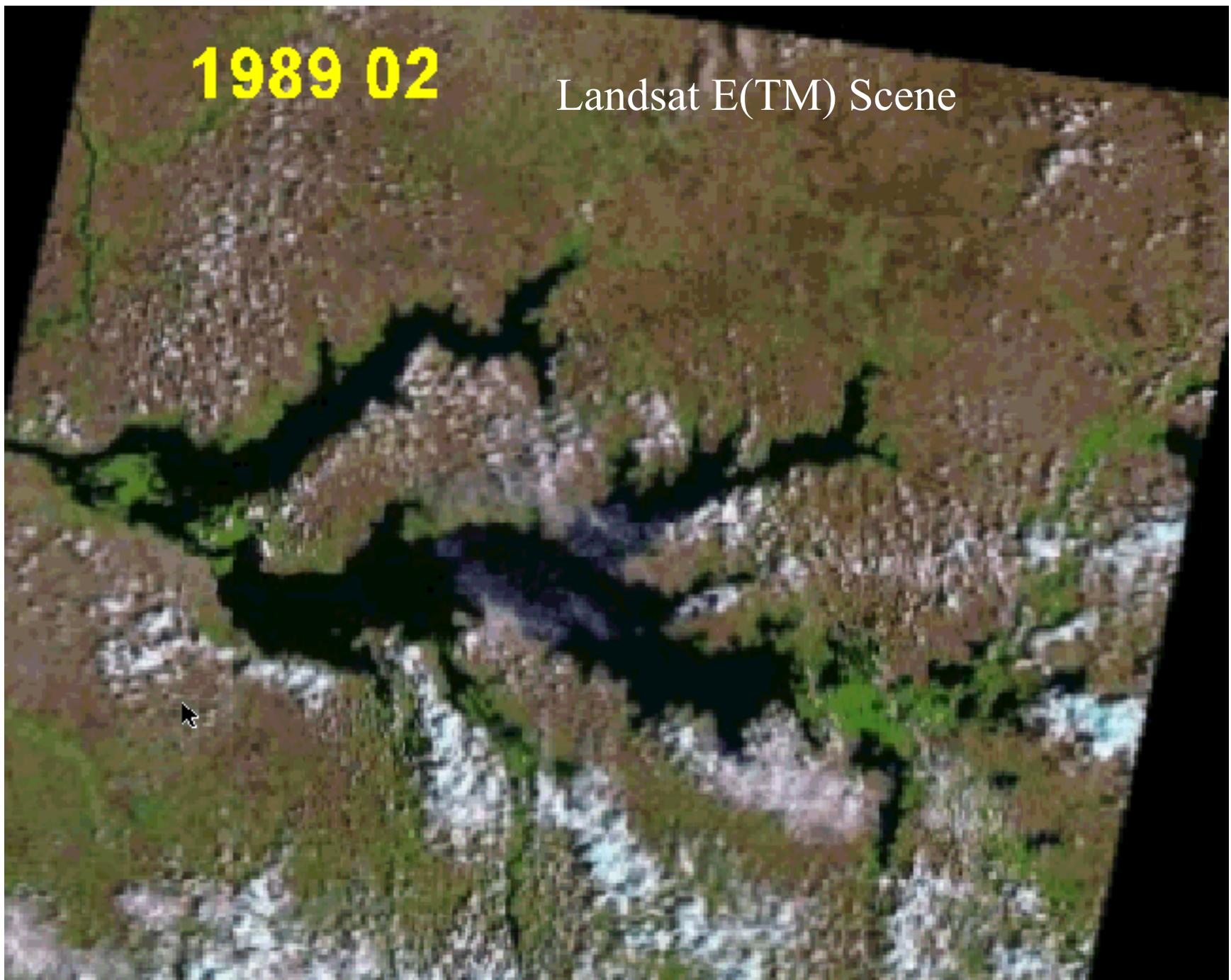
1986 11

Landsat E(TM) Scene



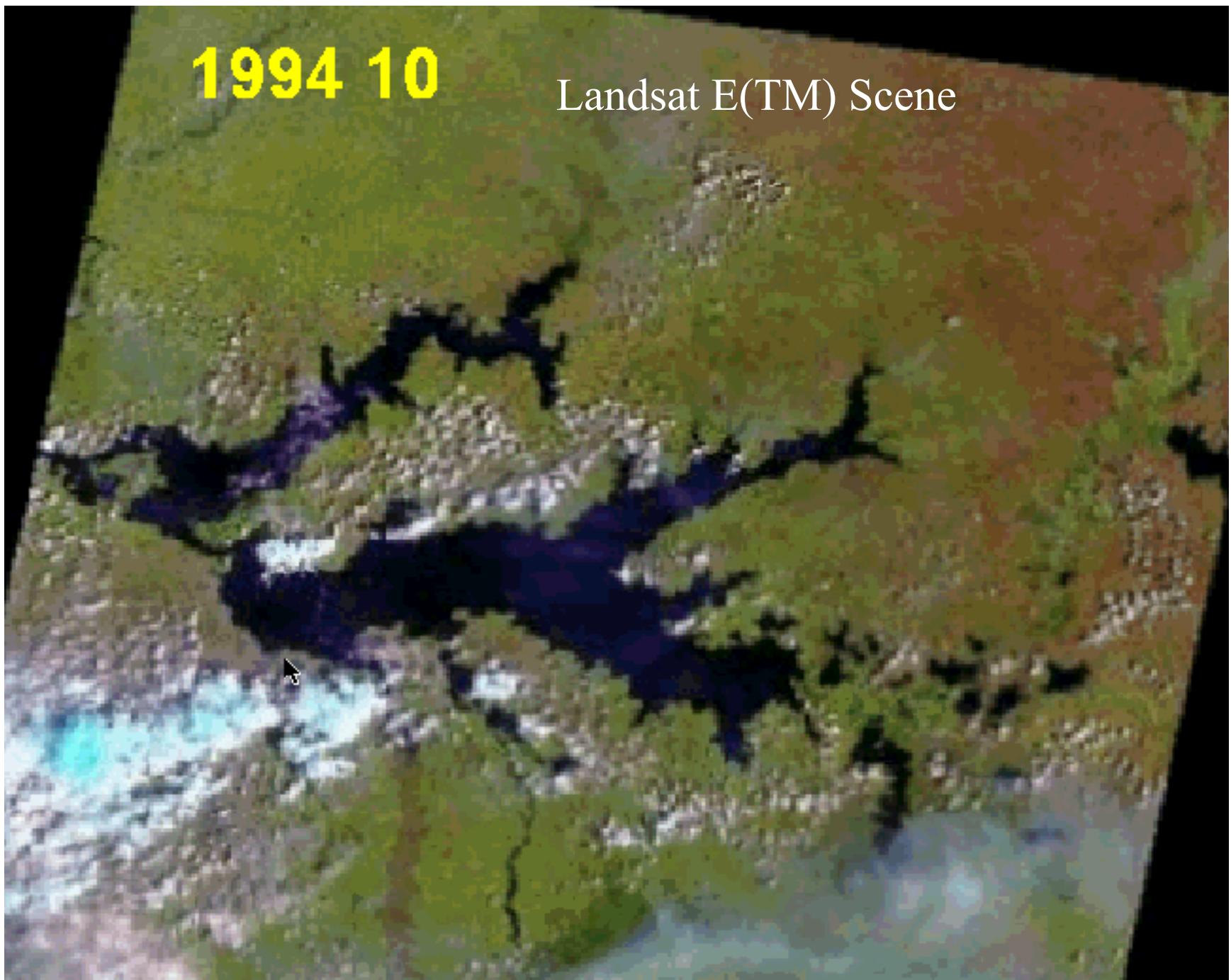
1989 02

Landsat E(TM) Scene



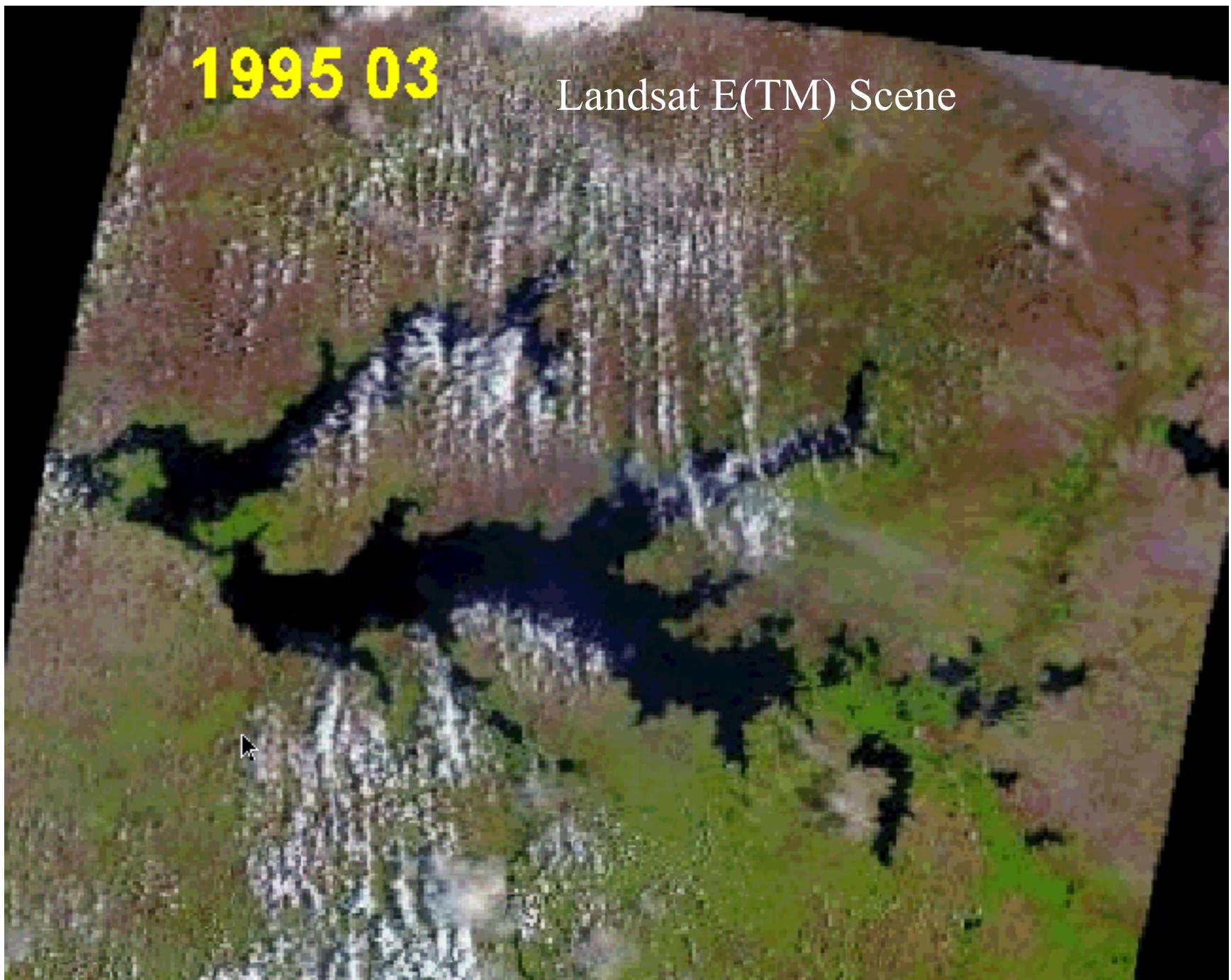
1994 10

Landsat E(TM) Scene



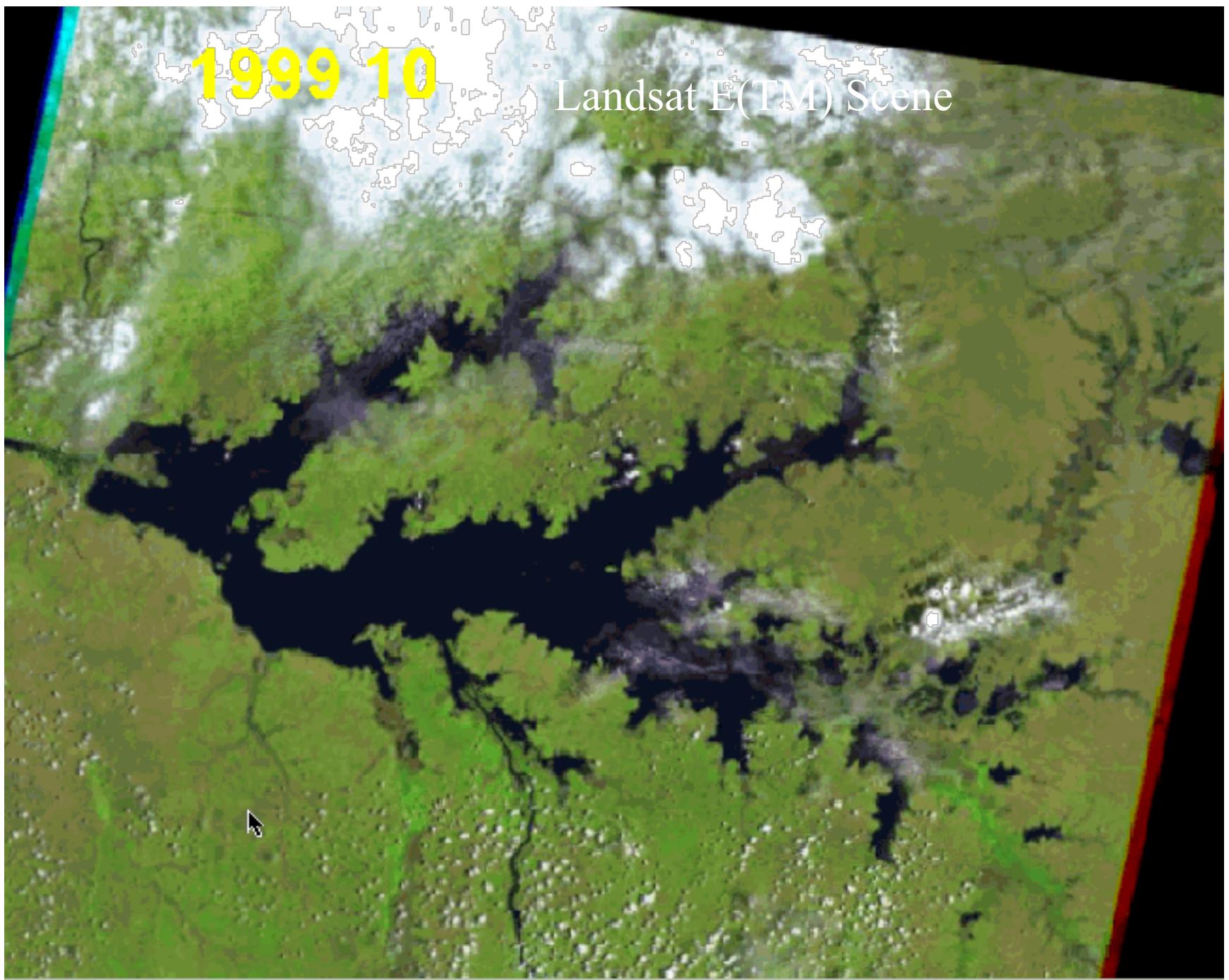
1995 03

Landsat E(TM) Scene



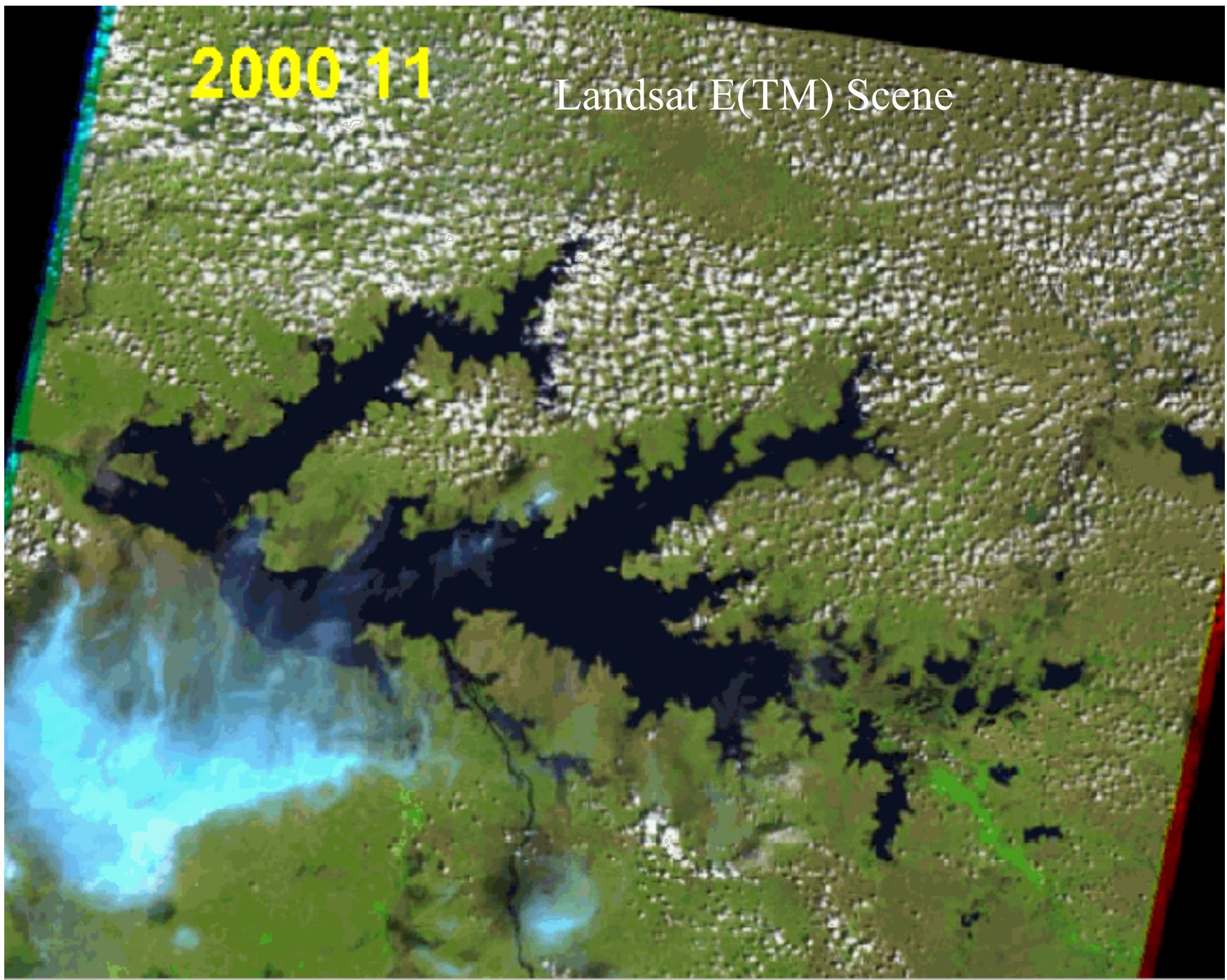
1999 10

Landsat E(TM) Scene



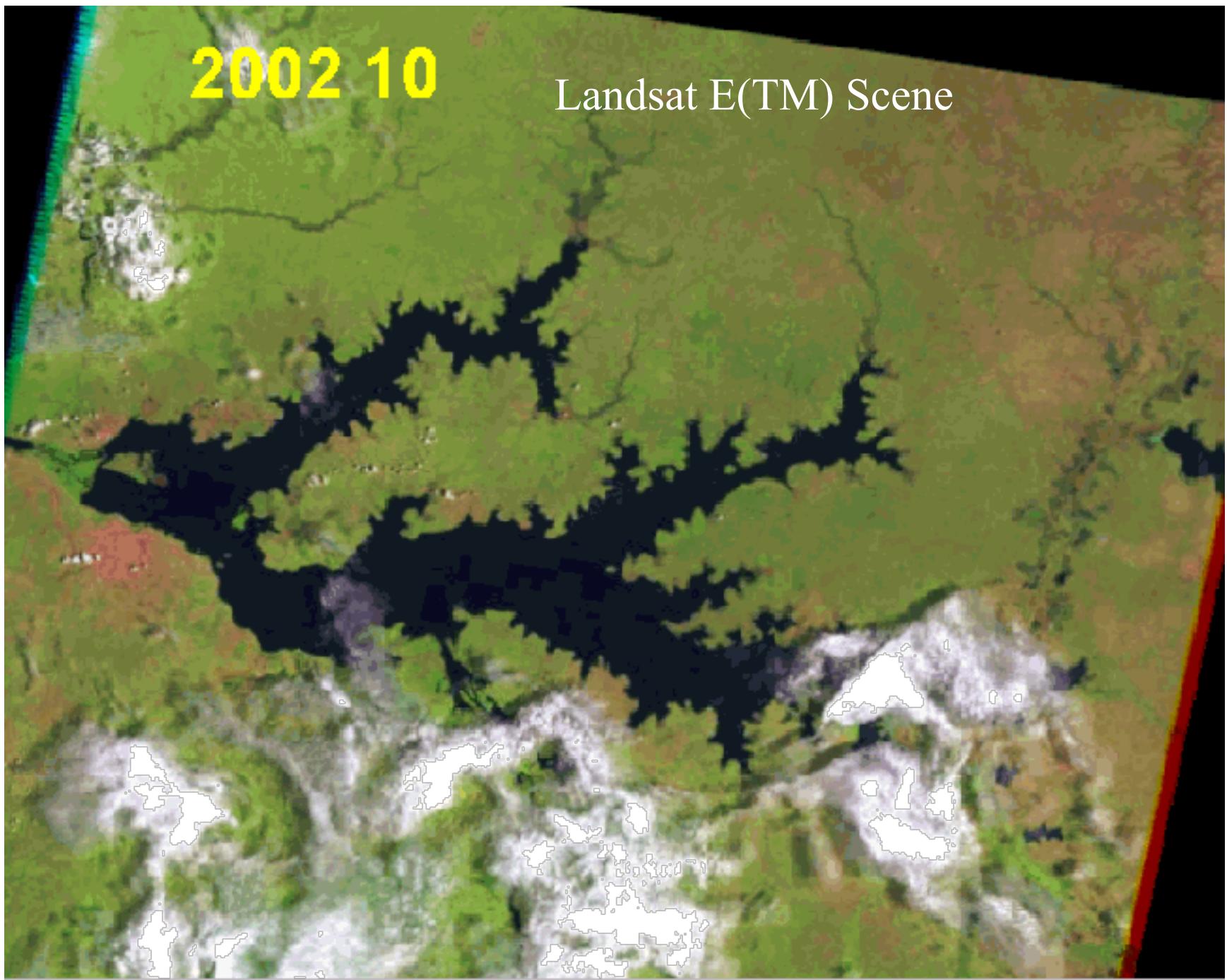
2000 11

Landsat E(TM) Scene



2002 10

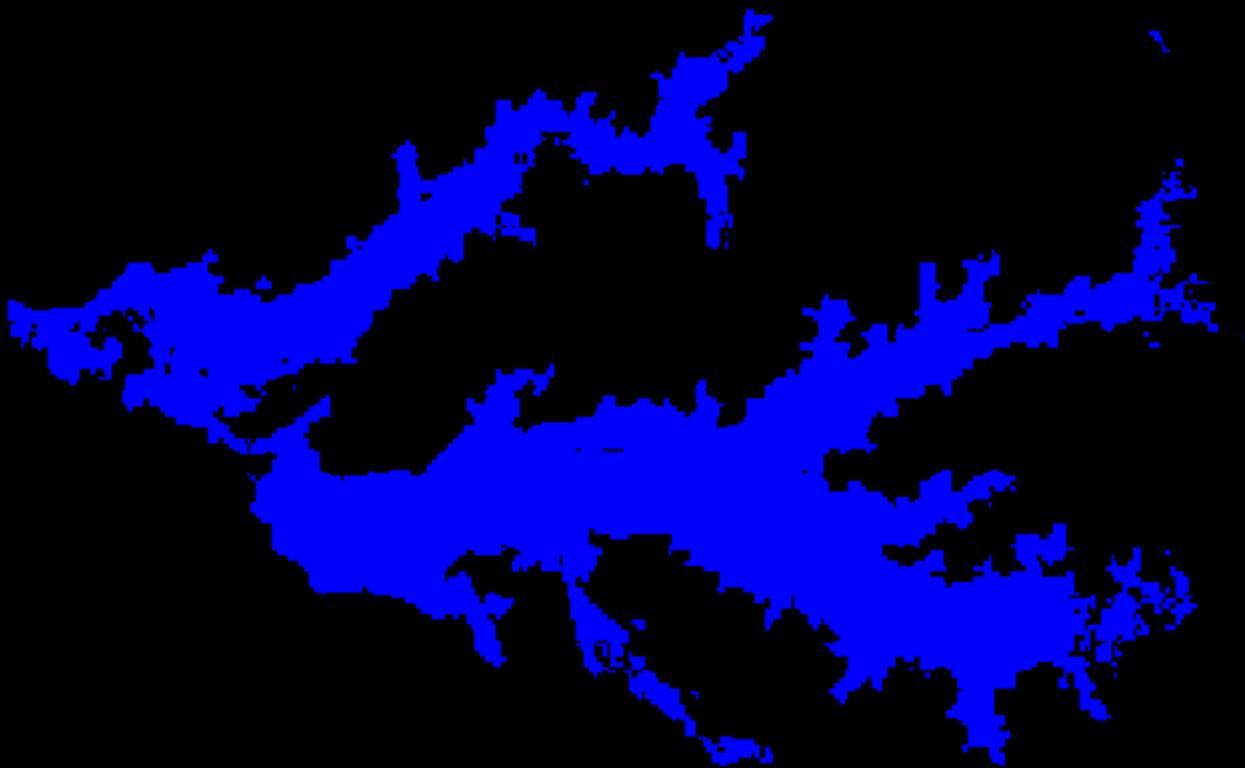
Landsat E(TM) Scene



1984

Lake Kyoga

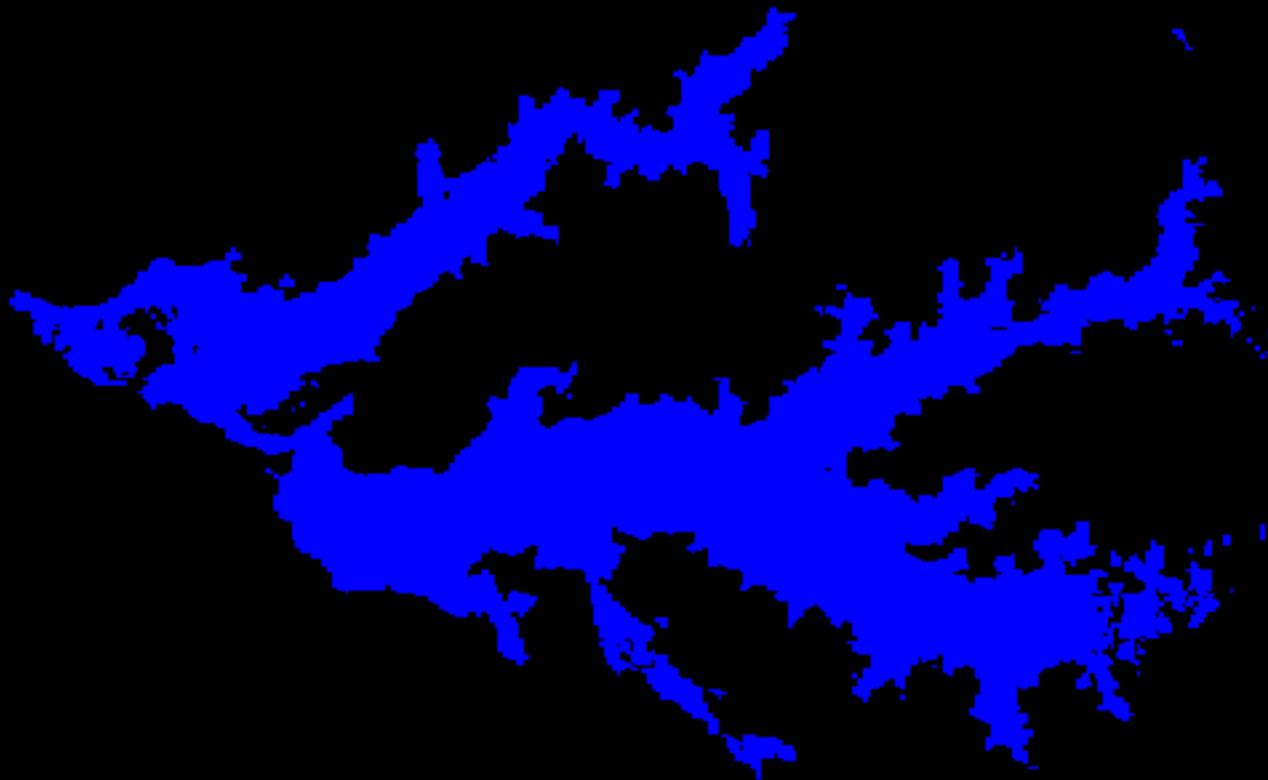
- Water area classified from
Landsat E(TM) Scene



1995

Lake Kyoga

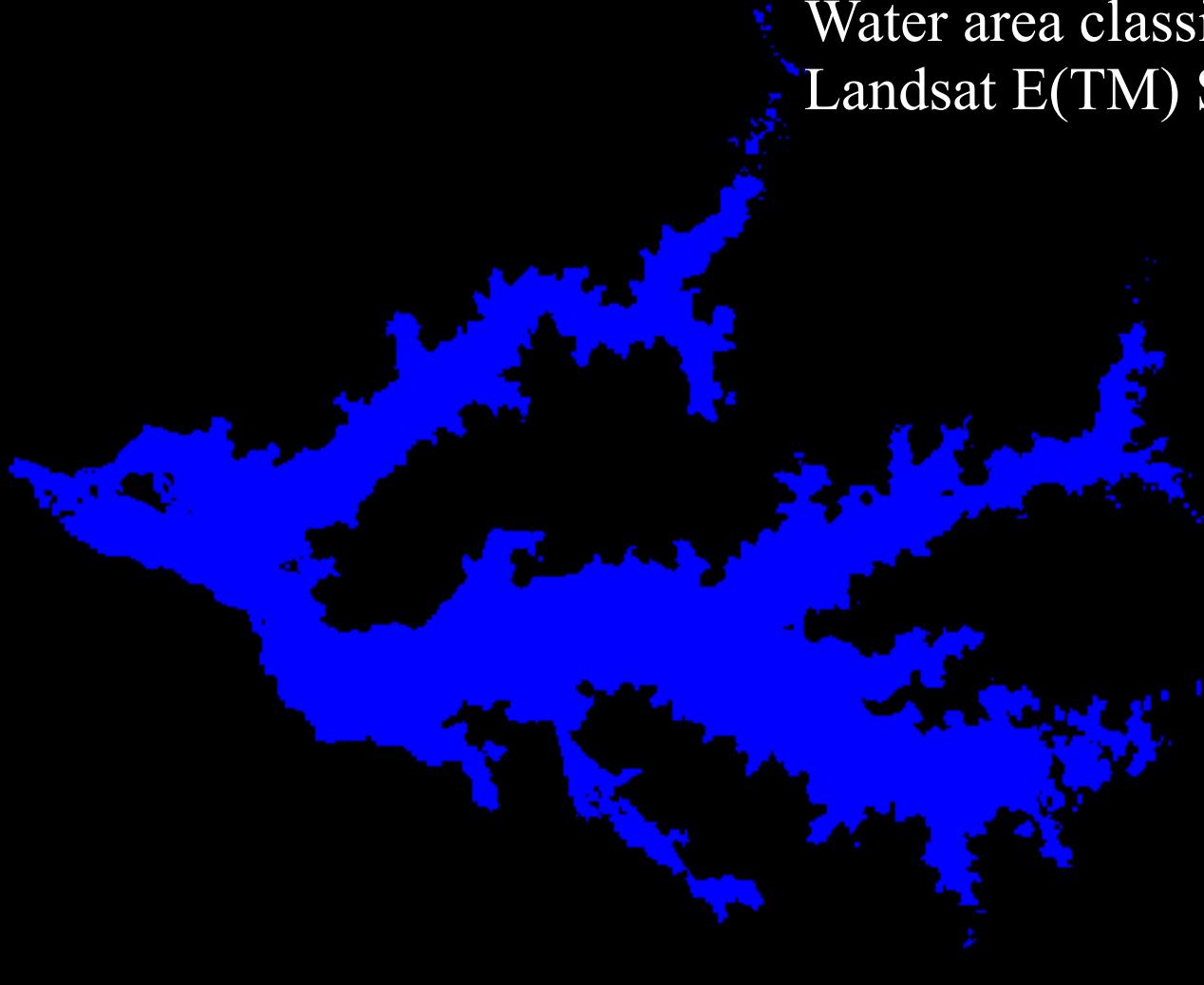
- Water area classified from Landsat E(TM) Scene



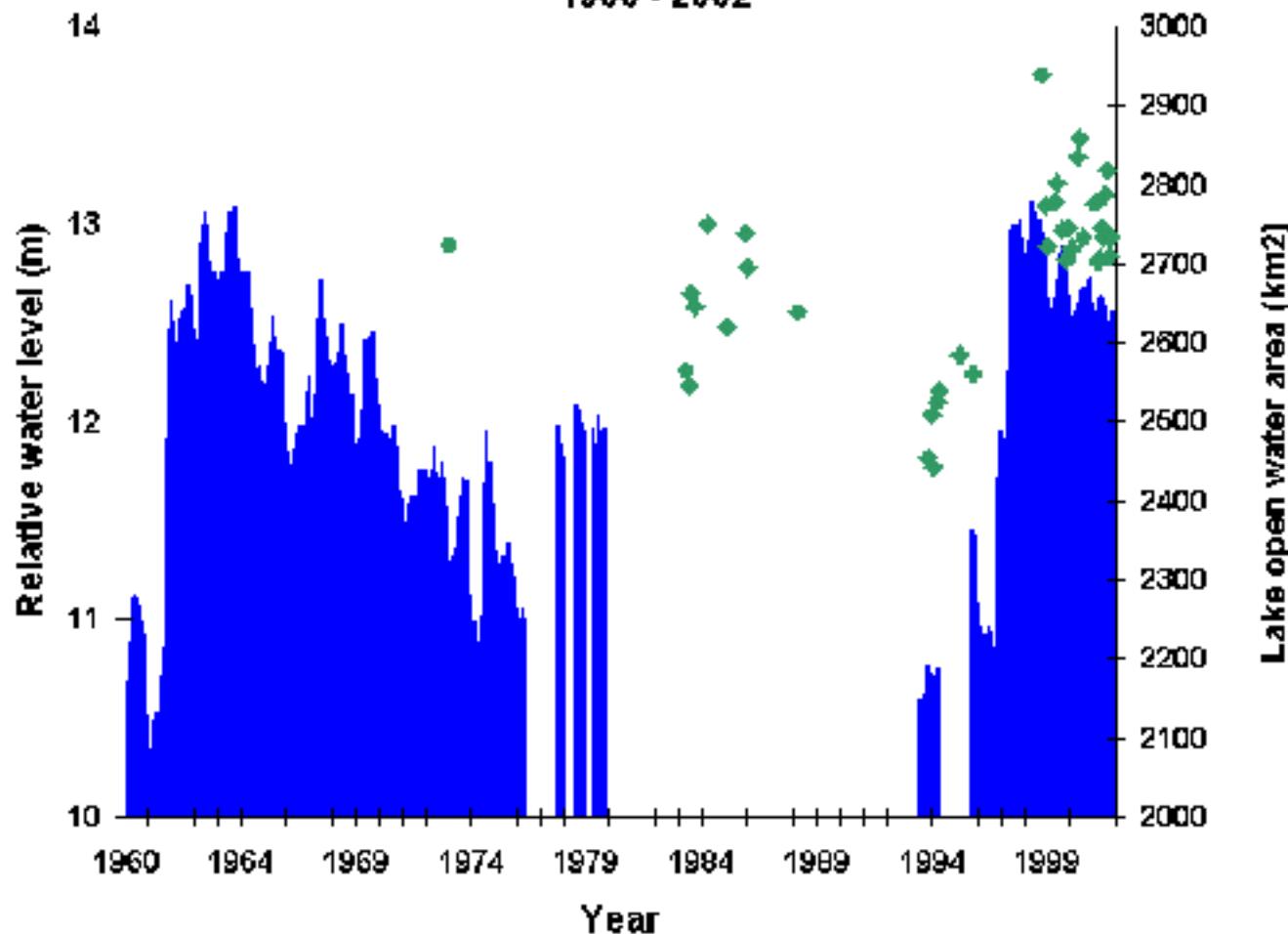
2001

Lake Kyoga

Water area classified from
Landsat E(TM) Scene



**Relative water levels and Lake area of Lake Kyoga, Uganda,
1960 - 2002**



Software and dissemination

All that you have seen is based on free data

Almost all data is covering the whole Lake Victoria basin

All that you have seen can be done using freeware

All can hence be disseminated as maps and CDs

The graphical possibilities can be used to create learning tools for everyone; from the local farmer to the university student.

Examples of what could be done (data driven models)

Mapping changes in land cover; forest and wetland conversion etc

Mapping and modeling the water cycle

Mapping and modeling erosion and water quality

Mapping and modeling soil fertility

Mapping and modeling vegetation growth and its changes

Disease and health modeling

Forecasting floods and affected population

Understanding the relation between land cover and erosion

Understanding the relation between land cover and runoff

Understanding the relation between wetlands and water quality



**THE INTER-UNIVERSITY COUNCIL
FOR EAST AFRICA**



Sida

VicRes are about to fund a project on

Wetlands as regulators of water flow and matter transport – development towards sustainable tropical landscapes

ICRAF – The World Agroforestry Centre

UDSM – Univ. of Dar Es Salaam

UCLAS – Univ. Coll. Land & Agric. Studies

JKUAT – J. Kenyatta Univ. Agric. & Techn.



THE INTER-UNIVERSITY COUNCIL
FOR EAST AFRICA



Sida

The project's *goal* is to understand the relation between wetlands, and hydrological and biogeochemical processes on a catchment scale representative for the Lake Victoria basin; its past, present and future. The *objective* is to quantitatively estimate the interaction between the water cycle, biogeochemical cycles and wetlands over the past century in the Mara basin; to construct robust GIS integrated models based on first principles for environmental impact assessment (e.g. prediction of risks of flooding, erosion and eutrophication) under scenarios of changes in wetlands, including the consequences of stabilising the hydrograph by wetland rehabilitation/restoration.

Examples of what could be done (goal driven evaluations)

- Suitability for land allocation of various agricultural production systems
- Value of environmental water services
- Allocation of protected areas for biodiversity

A proposal for the Challenge Program on Water and Food

Improving water and ecosystem services and food security through transborder negotiations, water service payments and discussion support in Mara-Serengeti

- ICRAF - World Agroforestry Centre
- IFPRI - International Food Policy Research Institute
- ILRI - International Livestock Research Institute

JKUAT - J. Kenyatta Univ. Agric. & Techn.

UCLAS - Univ. Coll. Land & Agric. Studies

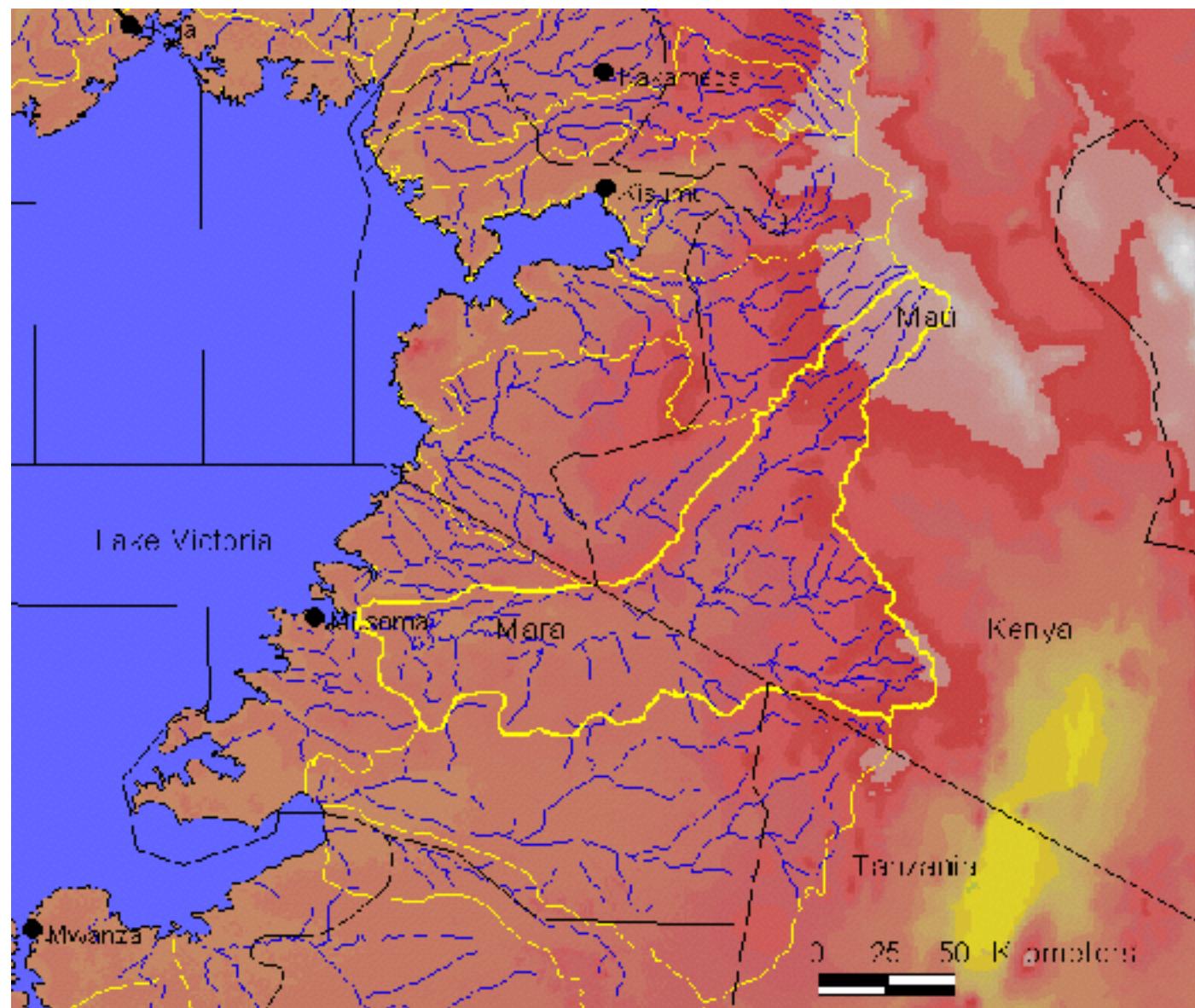
UDSM – Univ. Dar Es Salaam

FAN – Forest Action Network

Improving water and ecosystem services and food security through transborder negotiations, water service payments and discussion support in Mara-Serengeti

This project *goal* is to improve water and food security and reduce climate and water related vulnerability of poor pastoralists, farmers, and fishers by using reforestation and agroforestry for revitalising ecosystem services, stabilising water flow and improving the sustainability of water productivity for food and livelihoods in the trans-boundary Mara-Serengeti watershed.

Improving water and ecosystem services and food security through transborder negotiations, water service payments and discussion support in Mara-Serengeti



Improving water and ecosystem services and food security through transborder negotiations, water service payments and discussion support in Mara-Serengeti

		2	0	0	4	2	0	0	5	2	0	0	6	2	0	0	7	Comment	
No	Output/activity	Team	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
1.1	Local knowledge harnessing																		
1.2a	Historical point data retrieval																		
1.2b	Survey/logging at key points																		
1.3a	DEM																		
1.3b	Vegetation dynamics																		
1.3c	Land use/cover map																		
1.3d	Hydroclimatic maps																		
1.3e	Land cover change map																		
1.3f	Map accuracy assesment																		
1.4	Socio-economic maps																		
1.5	Indicator definition																		
1	Milestones				1		2		3		4		5,6,7			8		9	
2.1a	Hydrological modelling																		
2.1b	Matter transport modelling																		
2.1c	Water quality modelling																		
2.2	Water impact scenarios																		
2.3	Wildlife-water cycle relations																		
2	Milestones										1	2			3	4	5,6		
3.1	DSS development																		
3	Milestones							1			2	3		4		5			
4.1a	Conjoint analysis																		
4.1b	Open fora discussions																		
4.2	Water payment scheme																		
4.3	Advisory committee workshop																		
4.4	Audio-video dissemination																		
4	Milestones		1		2		3				4	5			6	7-9	10		
5.1	Management meetings																		
5.2	Internal review/external eval.																		
5.3	Project reporting																		
5	Milestones		1	2		3					4				5	6			

Integrated land-water management and fish yield sustainability – Lake Kyoga and its basin.

Another proposal for the Challenge Program

