United Nations Economic Commission for Africa

Role of GIS and Remote Sensing to Environment Statistics

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A Definition

- Environment statistics are statistics that describe the state and trends of the environment, covering the media of the natural environment (air/climate, water, land/soil), the biota within the media, and human settlements.
  - » UNSD. 1997. Glossary of Environment Statistics, Studies in Methods, Series F, No. 67

Scope of Environment Stats

- Depends on:
  - Perception of major users and producers
  - Socioeconomic and environmental policies
  - Specific to particular conditions

Integrative

- Environment Statistics bring together:
  - Human activities
  - Natural events
  - Impacts of activities and events on environment
  - Social responses to impacts
  - Quality and availability of natural assets

Interdisciplinary Modelling Problems

- Its interdisciplinary nature calls for synthetic presentation of data from various subject areas and sources
- Characteristics of databases from various disciplines differ, specific examples for bio-physical databases:
  - Environmental variables based on scientific readings from instruments
  - Map data from ground surveys and remote sensing imagery
  - Sampling frameworks based on spatial rather than population distributions

Framework vs System

- Environment statistics do not lend easily to "systems" modelled on entities and bookkeeping, such as SNA
- Instead, framework in the form of a logical structure for organizing information

  →Leading to the Framework for development of environment statistics

Modelling Approaches

- Media approach: organizes environmental issues from the perspective of the major environmental components of air, land, water, and the human-made environment
- Stress-response approach: focuses on impacts of human intervention with the environment (stress) and the environment's subsequent transformation

Approaches …

- Resource accounting approach: aims at tracing the flow of natural resources from their extraction from the environment, through successive stages of processing and final use, to their return to the environment as waste or to the economy for recycling
- Ecological approach: include a variety of models, monitoring techniques and ecological indices in a broad field that could be characterized as "statistical ecology" or "ecological statistics"

FDES

- A Framework for the Development of Environment Statistics
- Combines media and stress-response approaches
- Developed by UNSD in 1984
- Endorsed by StatCom in 1995
- Relates components of the environment to information categories

FDES

Components of the environment	Information categories			
	Social and economic activities, natural events	Environmental impacts of activities/events	Responses to environmental impacts	Inventories, stocks and background conditions
1. Flora 2. Fauna 3. Atmosphere 4. Water 5. Land/Soil 6. Human Settlement				

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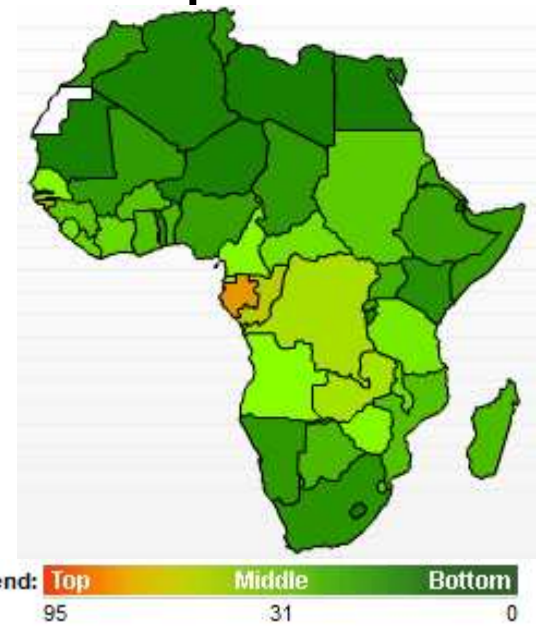
GIS for Visual Presentation

- Environmental phenomena are location-based and better presented as maps
- Compare:



Rank	Countries	Amount	Date
# 1	Suriname:	94.72 % of land area	2005
= 2	American Samoa:	90 % of land area	2005
= 2	Micronesia, Federated States of:	90 % of land area	2005
= 4	Palau:	86.96 % of land area	2005
= 4	Seychelles:	86.96 % of land area	2005
# 6	Gabon:	84.51 % of land area	2005
# 7	Solomon Islands:	77.6 % of land area	2005
# 8	Guyana:	76.73 % of land area	2005
# 9	Finland:	73.87 % of land area	2005
# 10	Guinea-Bissau:	73.68 % of land area	2005
# 11	Belize:	72.47 % of land area	2005
# 12	Laos:	69.94 % of land area	2005
# 13	Northern Mariana Islands:	69.18 % of land area	2005
# 14	Japan:	68.22 % of land area	2005
# 15	Bhutan:	67.98 % of land area	2005
# 16	Sweden:	67.09 % of land area	2005
# 17	Congo, Republic of the:	65.8 % of land area	2005
# 18	Papua New Guinea:	65 % of land area	2005
# 19	Malaysia:	63.58 % of land area	2005
# 20	Korea, South:	63.46 % of land area	2005
# 21	Slovenia:	62.76 % of land area	2005

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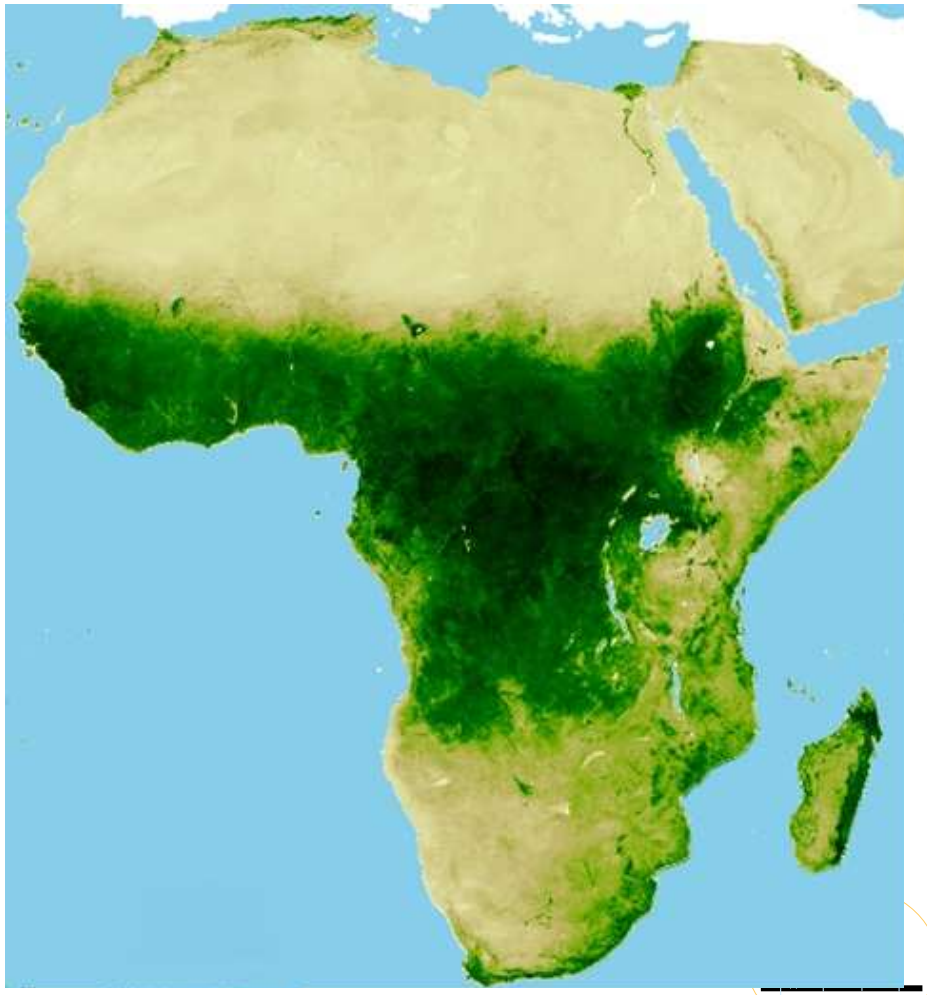
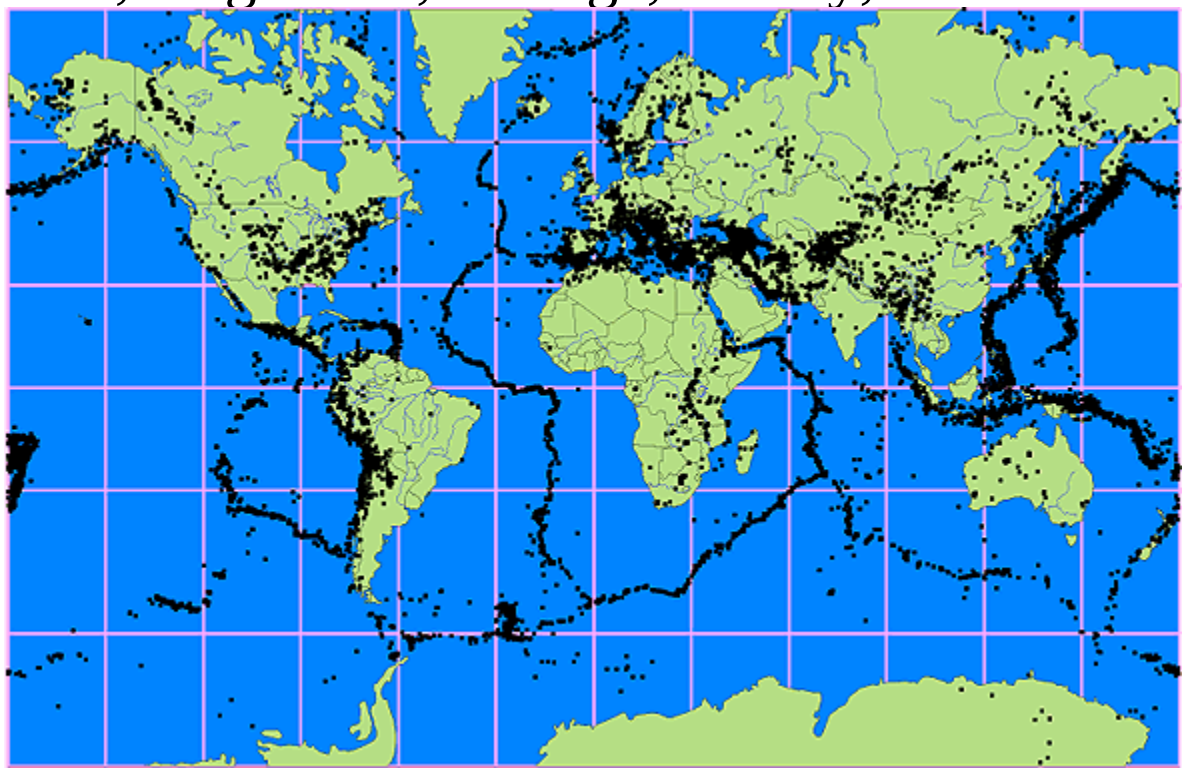
GIS for Richer Content

- Now compare last map of % of forest cover with actual vegetation cover
- Richer content for more detailed analyses
- GIS provides better data modelling for environmental phenomena



Points: Earthquake locations

- Location of each point stored in GIS
- Attributes of each point stored in relational database
  - E.g., date, magnitude, damage, fatality, etc.



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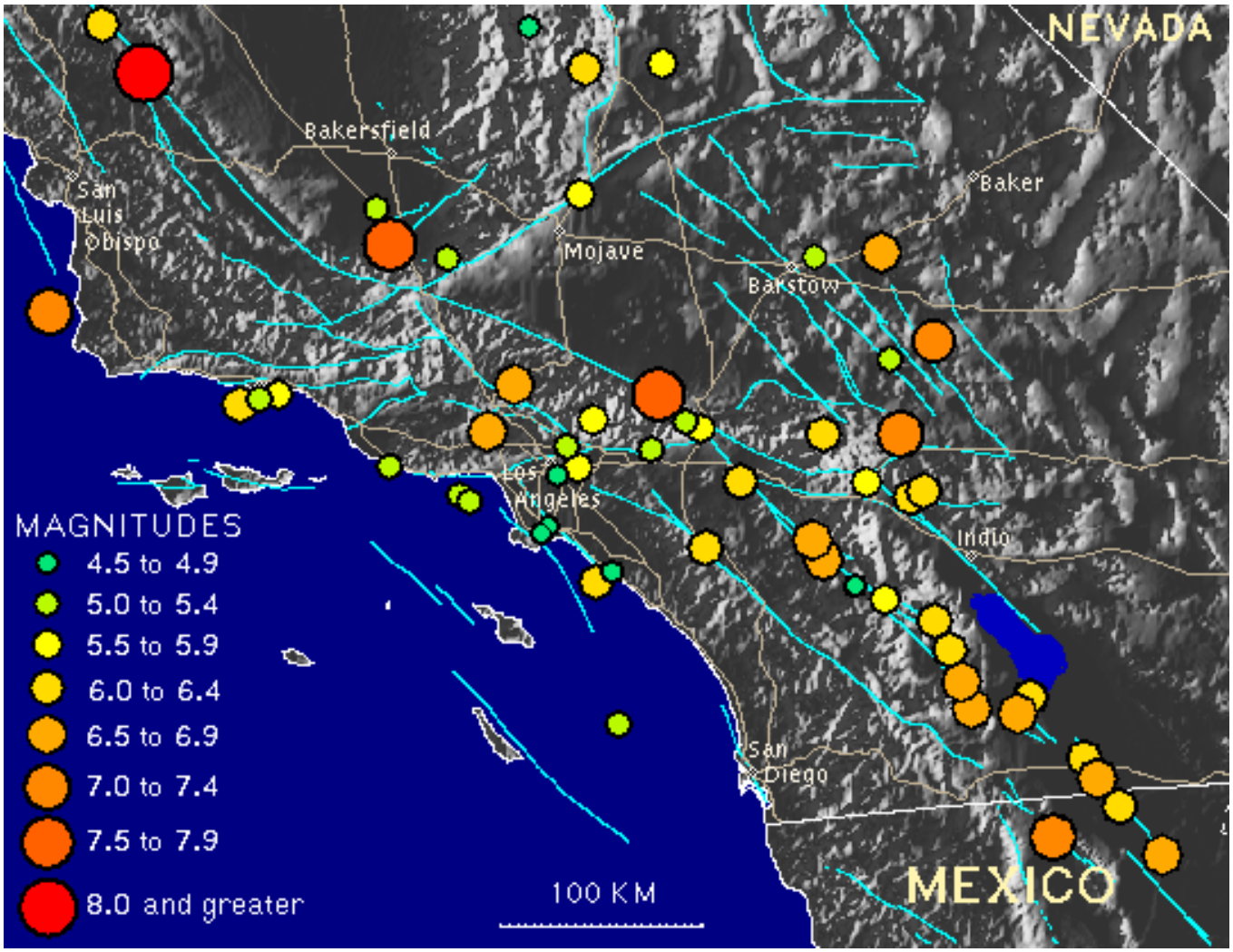
Symbolized by Magnitude



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Pin Maps

- “Pins” are placed at the point locations and attributes from the database are displayed on clicking the pin symbol
- Pins may be symbolized by attribute to present at-a-glance information

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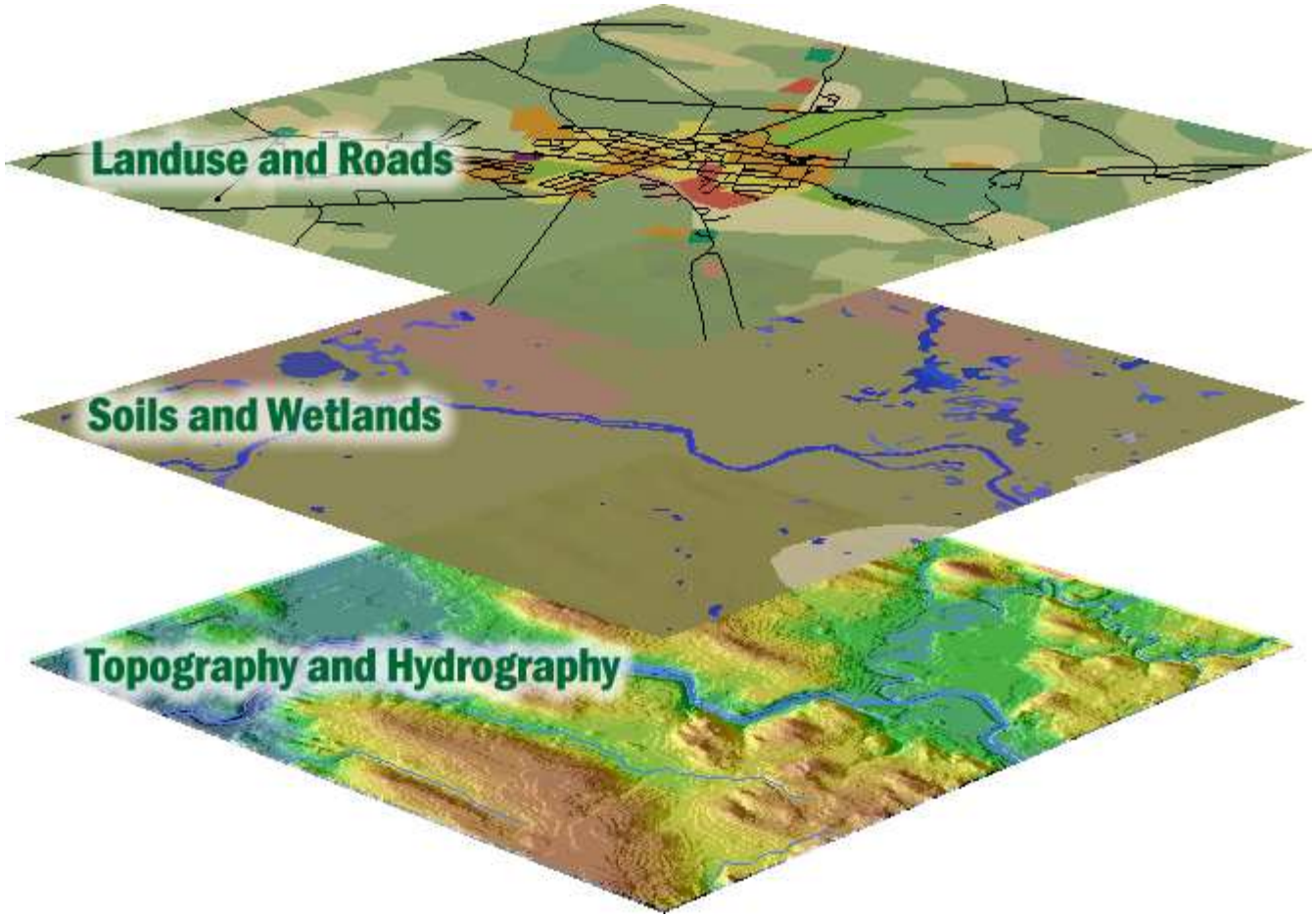
GIS for Data combination

- Even though FDES organizes data in categories, we still need to combine and integrate them for visualization and policy analysis
- Common criterion for selection of data for such combination is location
- Therefore we need a tool that can select and combine data on the basis of the location

  →Geographic Information System (GIS)

Overlay



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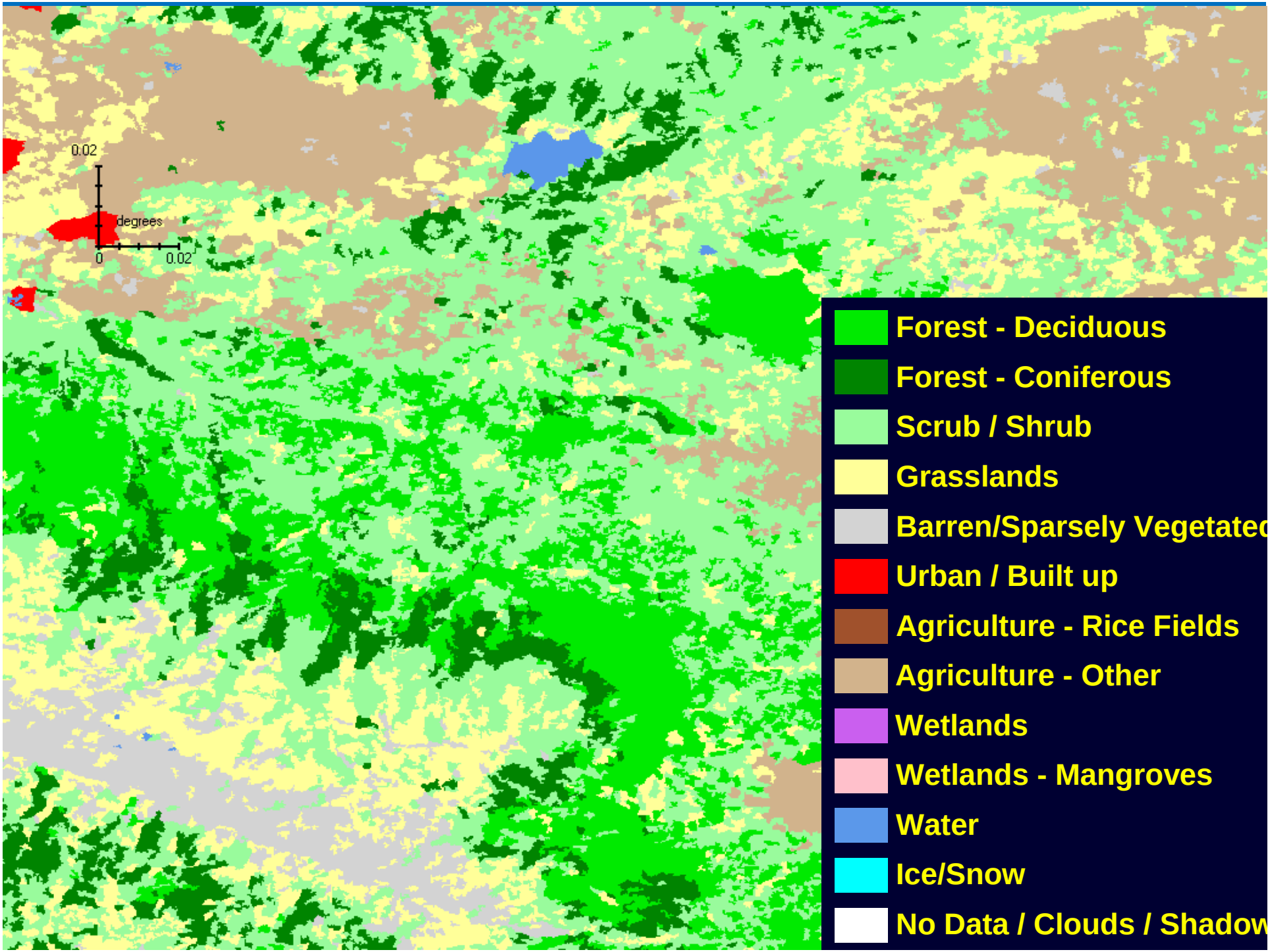
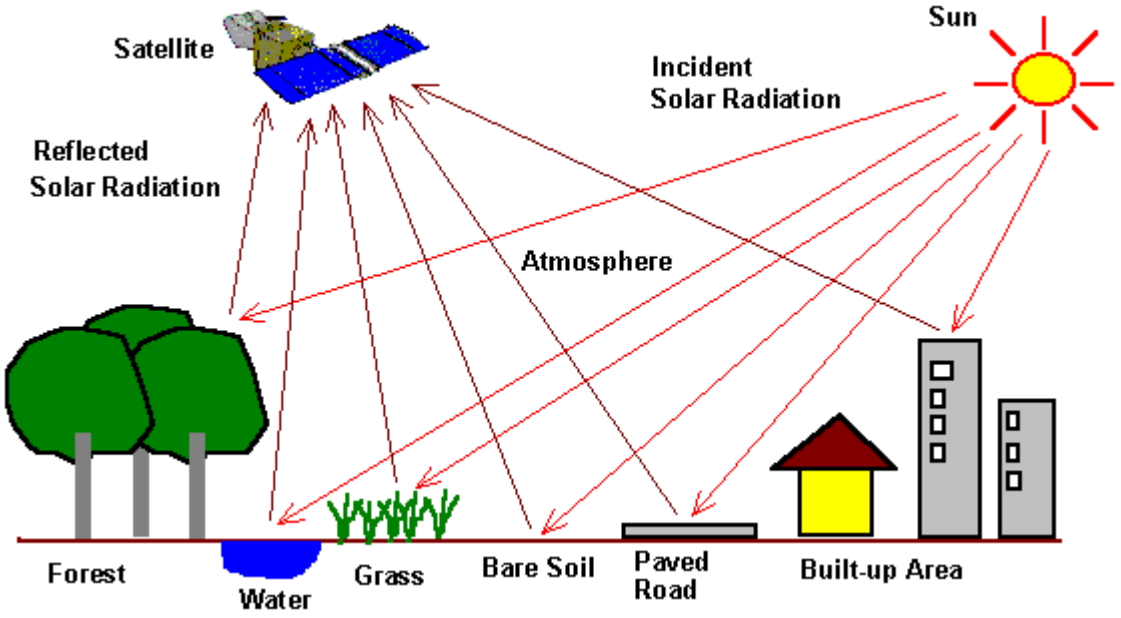

0.02
degrees
0
0.02
Forest - Deciduous
Forest - Coniferous
Scrub / Shrub
Grasslands
Barren/Sparsely Vegetated
Urban / Built up
Agriculture - Rice Fields
Agriculture - Other
Wetlands
Wetlands - Mangroves
Water
Ice/Snow
No Data / Clouds / Shadow

Remote Sensing

- But how do we collect the surface characteristics from every point for these detailed analyses?
- Spatial sampling and interpolation. We take observations at known sample points (e.g., rain gauges) and use mathematical models in GIS to estimate values at other points
- Then there is remote sensing …

Satellites can detect a wide range of reflected or emitted frequencies of electromagnetic radiation.



http://rst.gsfc.nasa.gov/Intro/Part2_1.html

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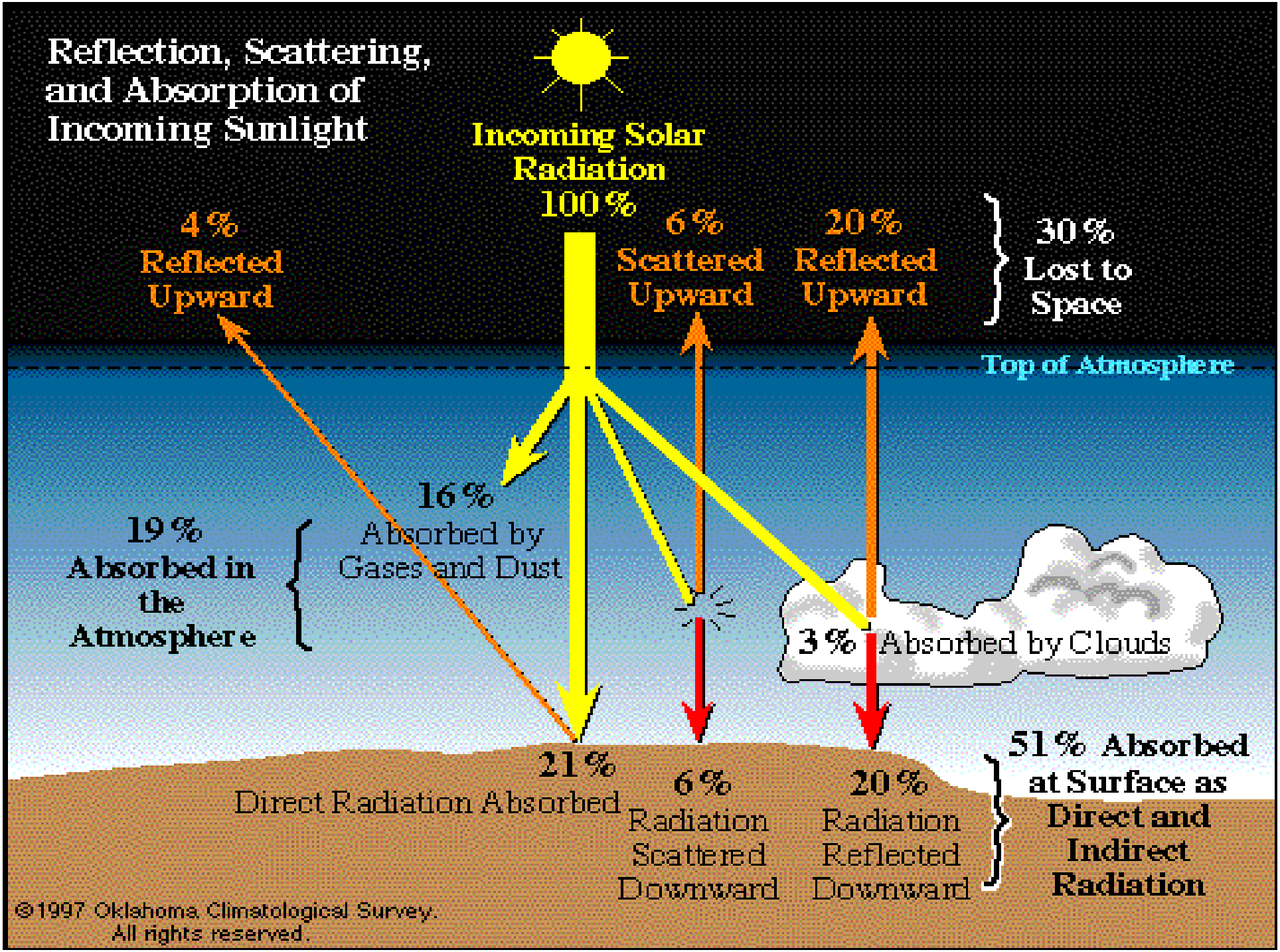
Reflection, Scattering, and Absorption of Incoming Sunlight
Incoming Solar Radiation 100%
4% Reflected Upward
6% Scattered Upward
20% Reflected Upward
30% Lost to Space
Top of Atmosphere
16% Absorbed by Gases and Dust
19% Absorbed in the Atmosphere
3% Absorbed by Clouds
21% Direct Radiation Absorbed
6% Radiation Scattered Downward
20% Radiation Reflected Downward
51% Absorbed at Surface as Direct and Indirect Radiation
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Data indicating different amounts of reflected radio waves can be used to generate a “false color image” of rates and types of precipitation.

http://www.google.com/webhp?hl=en

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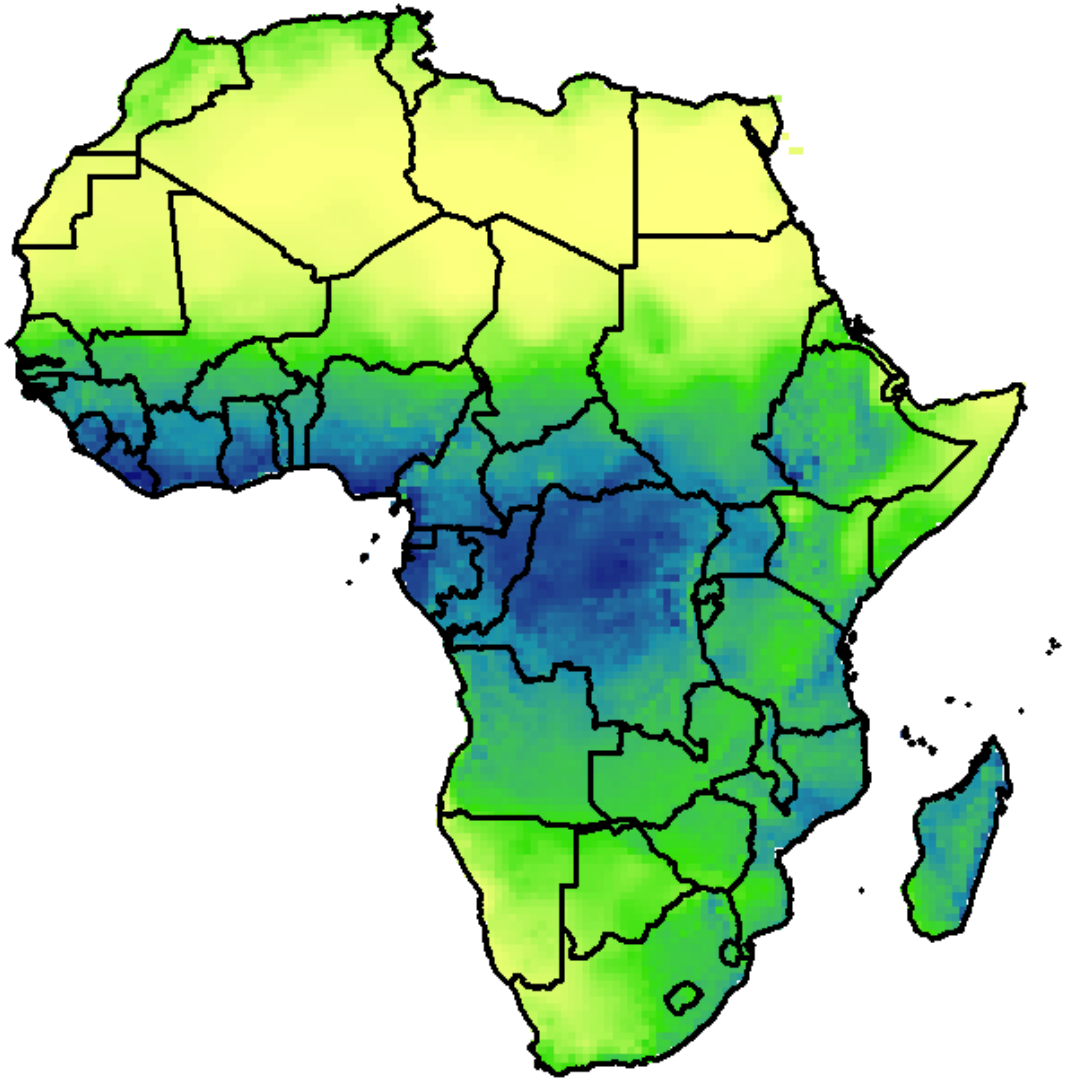
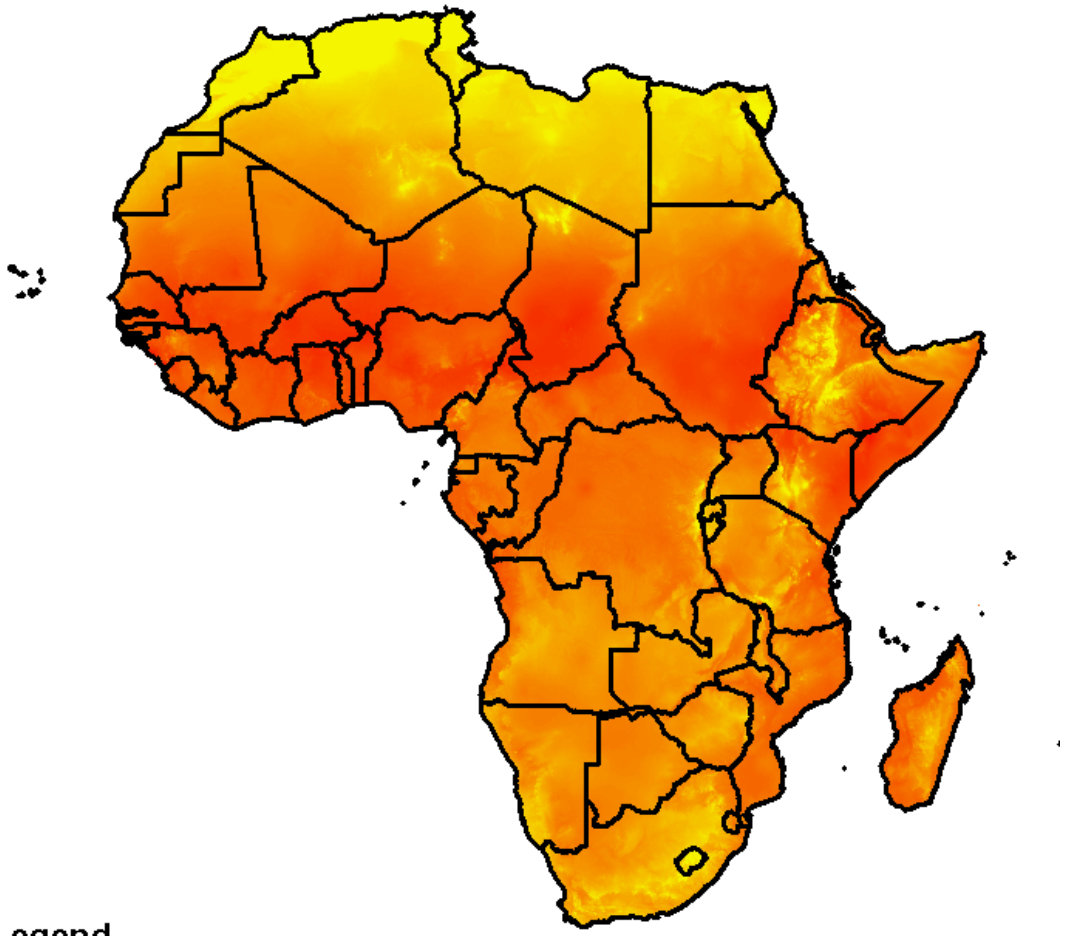
Remote sensing for more detailed data capture

- EvapoTransportation Map



Mean Temperature



Legend

Soil Moisture

d

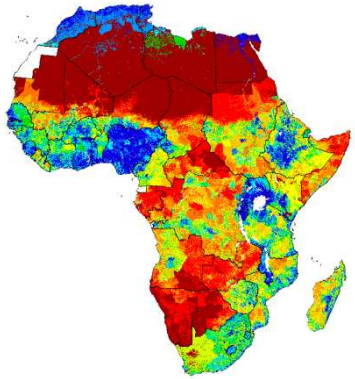
Analysis and Modelling

- With detailed location specific data, we can now use the power of GIS to answer complex spatial queries and what if …? Scenarios

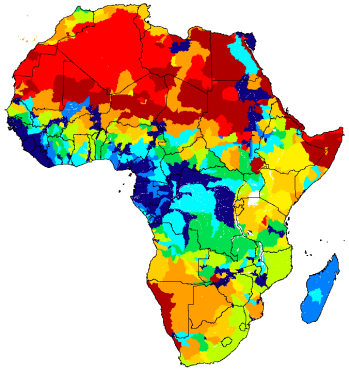
Food Security Modeling using Landcover

***GeoCover LC* Integrated into each model**

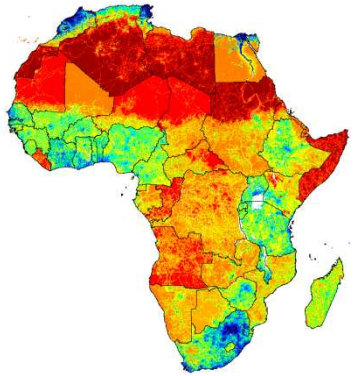
Total Potential Food Supply



Water Vulnerability

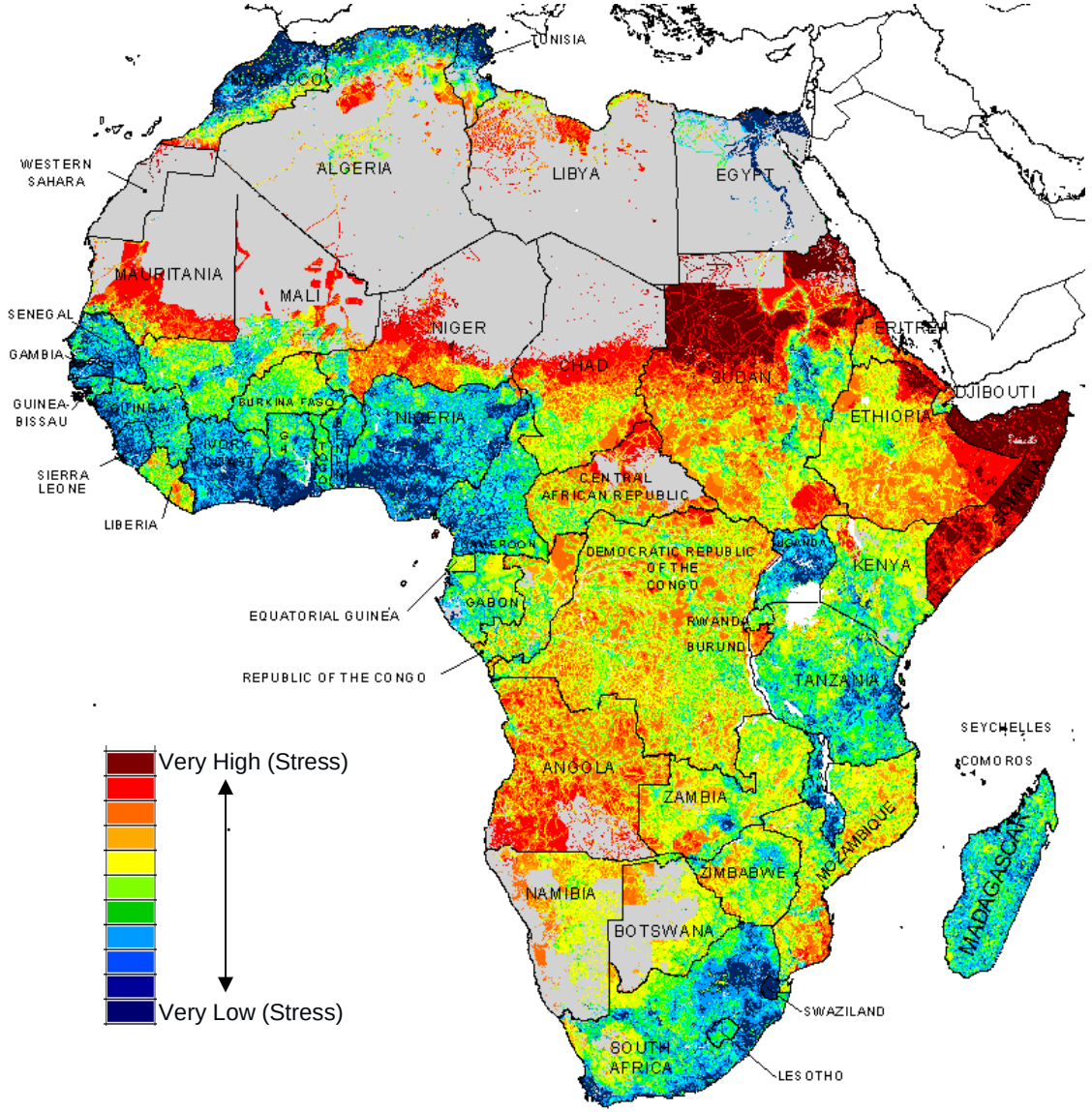


Capacity



(food + water vulnerability) x (capacity)

Africa Geospatial I&W: Regions at Risk
Population (Food-Water) Risk Surface



To Conclude

- Remote sensing allows the collection of detailed data about bio-physical characteristics that cannot be collected by questionnaires
- GIS allows the data, even questionnaire data to be visualized graphically
- GIS also provides for interpolation of values from spatial samples
- And complex combination of data based on their location for analyses


The End