

# Remote Sensing and Biodiversity Indicators

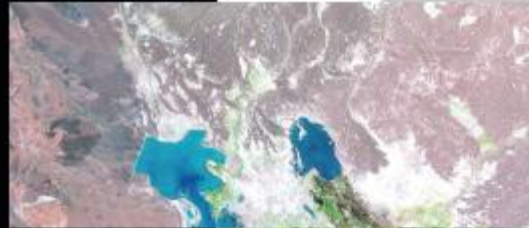
and

The Group on Earth Observations  
(GEO) Support of the CBD 2010  
Targets



32

SOURCEBOOK ON REMOTE SENSING AND  
BIODIVERSITY INDICATORS



Prepared by the NASA-NGO Biodiversity  
Working Group and UNEP-WCMC to  
support implementation of the  
Convention on Biological Diversity



*Edited by Holly Strand, Robert Höft,  
James Strithoit, Lera Miles,  
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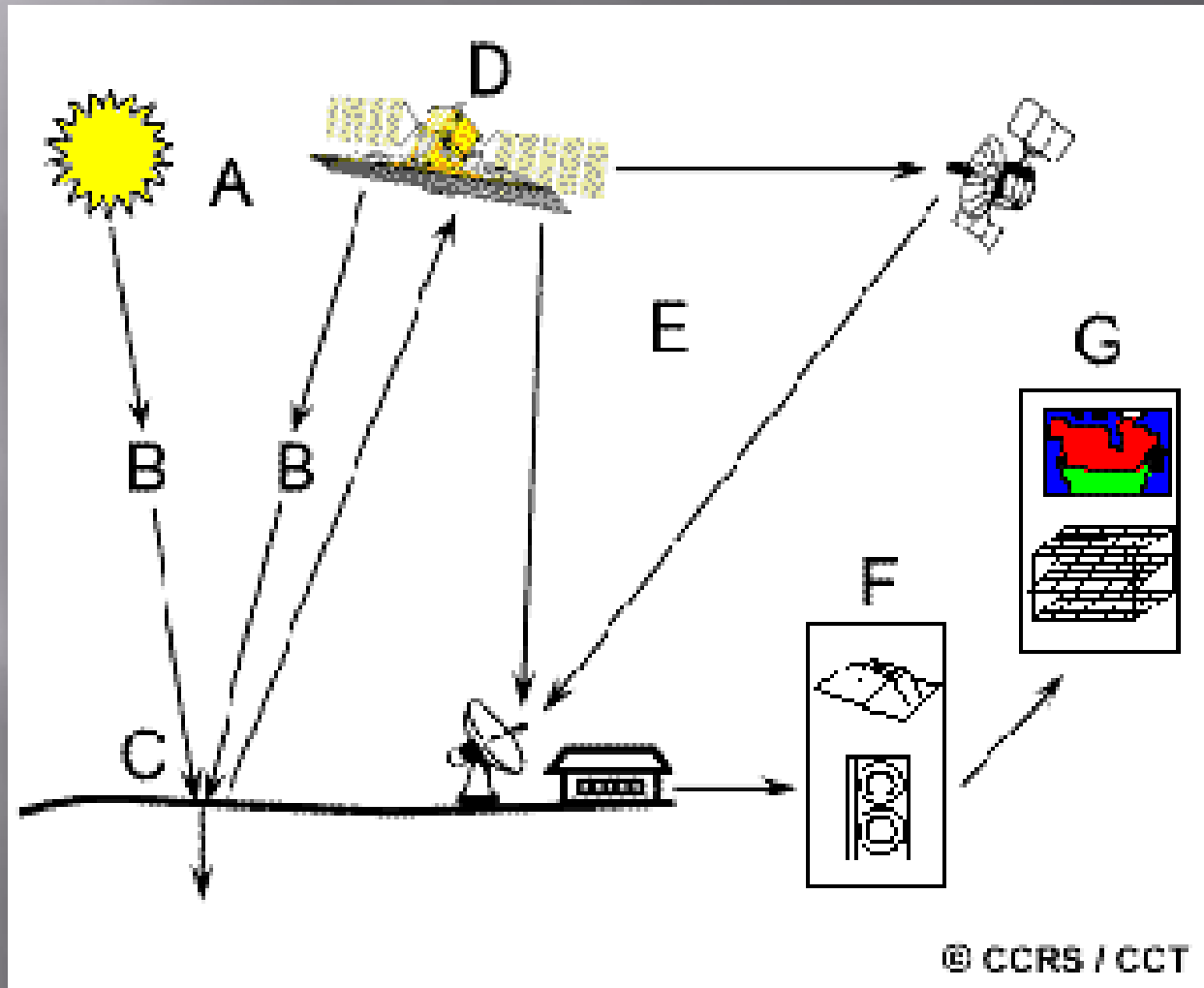
# NASA-NGO Biodiversity Working Group

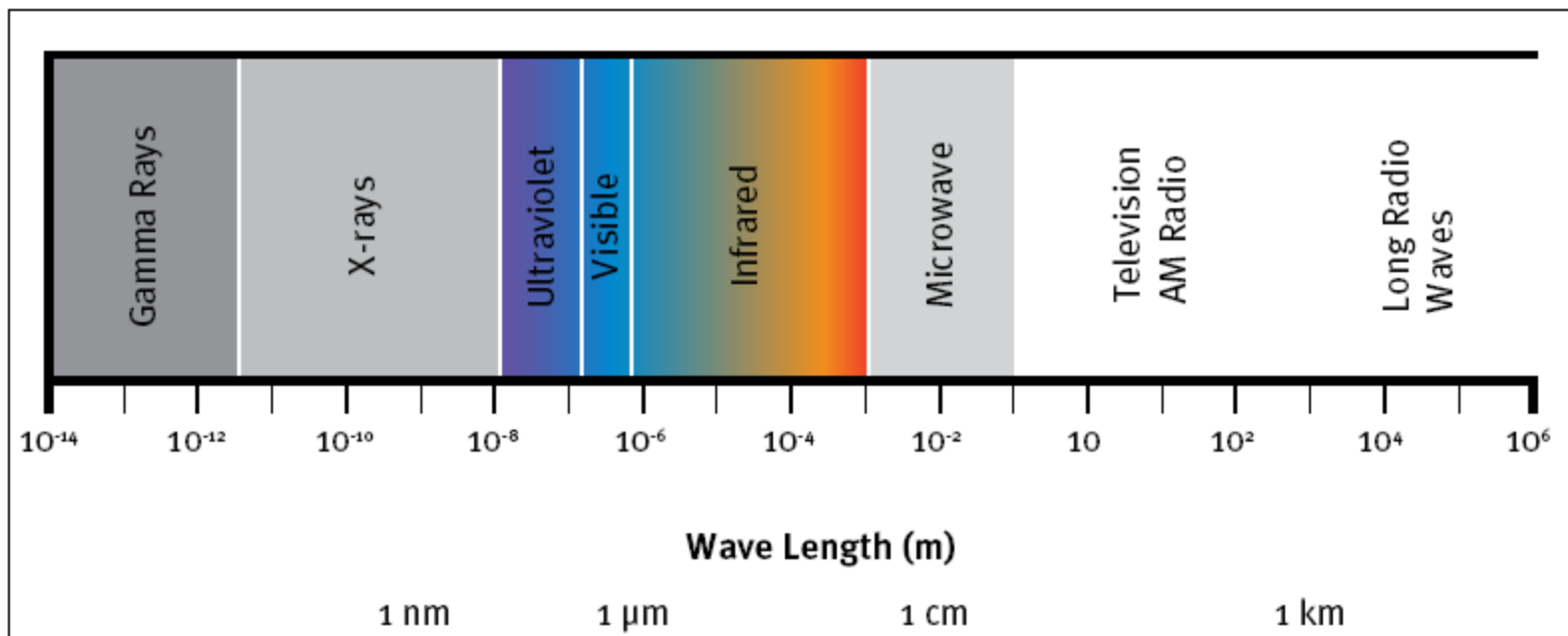
- American Museum of Natural History
- Conservation Biology Institute
- Conservation International
- Conservation and Research Center of the Smithsonian National Zoological Park.
- The Nature Conservancy
- The Wilderness Society
- Wildlife Conservation Society
- World Wildlife Fund
- University of Maryland
- UNEP GRID Sioux Falls

# Remote sensing basics

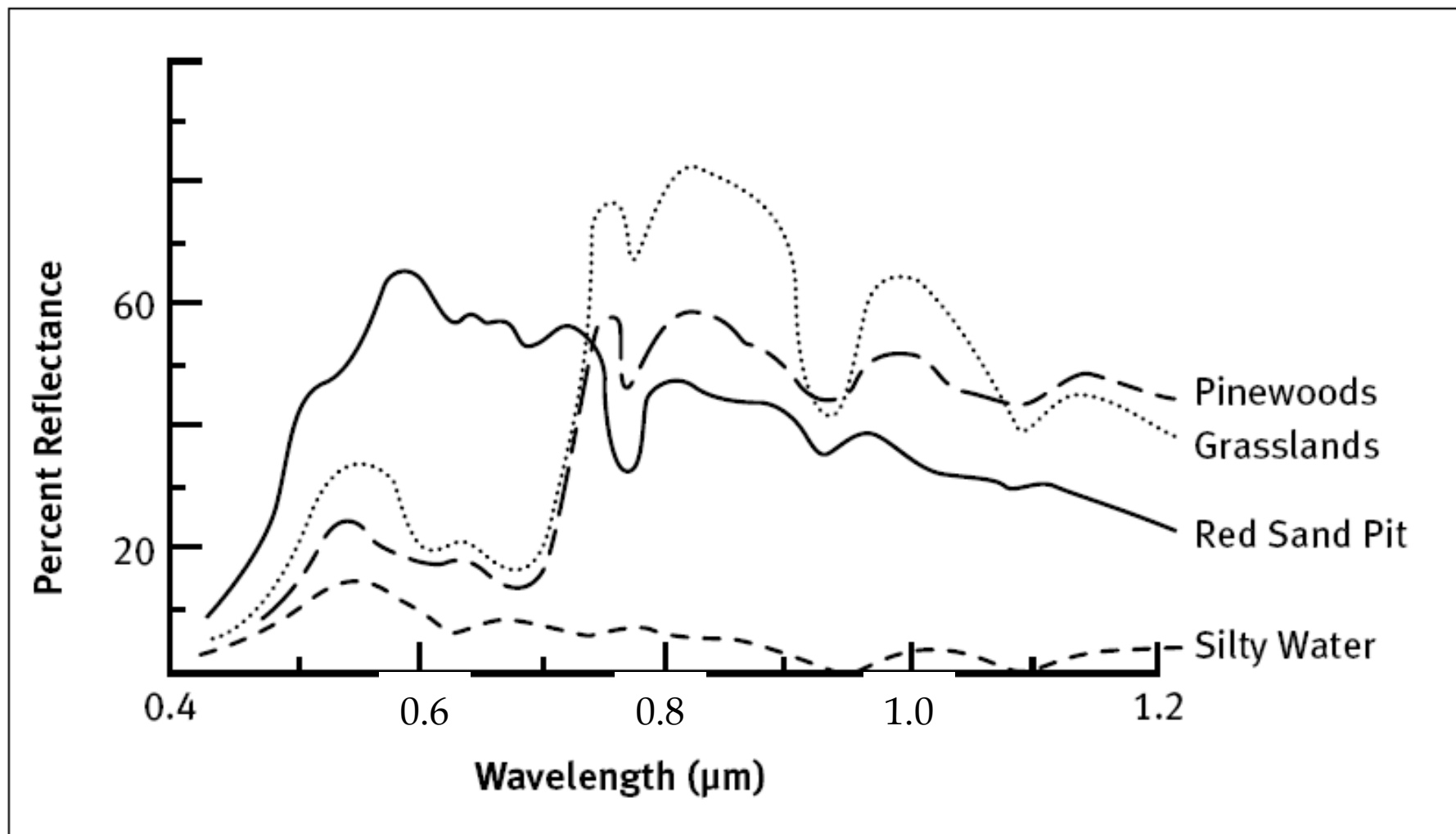
“Remote sensing is the science (and to some extent, art) of acquiring information about the Earth’s surface without actually being in contact with it. This is done by sensing and recording reflected or emitted energy and processing, analyzing and applying that information.”

# Remote sensing basics





**FIGURE 3.1** Spectral chart. Source: Short, N.M. NASA remote sensing tutorial <http://rst.gsfc.nasa.gov> (accessed April 12, 2007).



**FIGURE 3.3** Spectral curves for various natural features Source: NASA remote sensing tutorial available at <http://rst.gsfc.nasa.gov> (accessed December 2006)

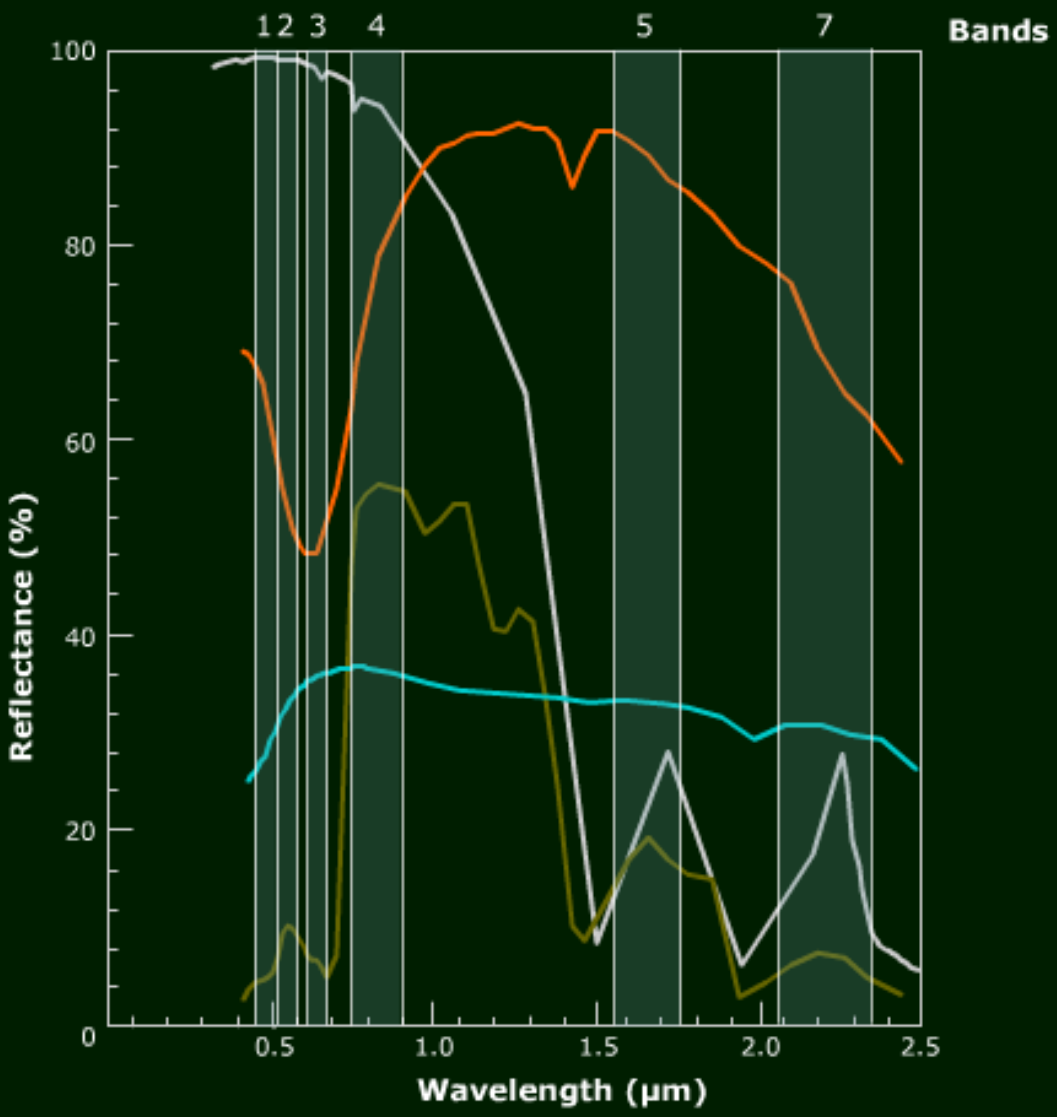
# Overlaying spectral curves on sensor bands

**Satellite mode.** Click on a satellite's band width or band center button to display it's bands on the graph.

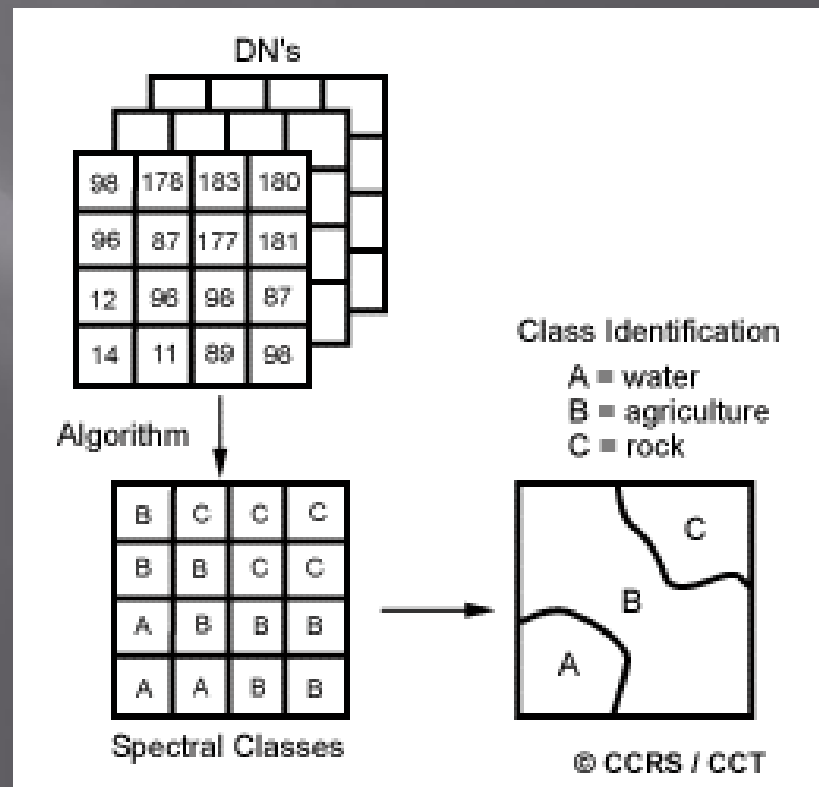
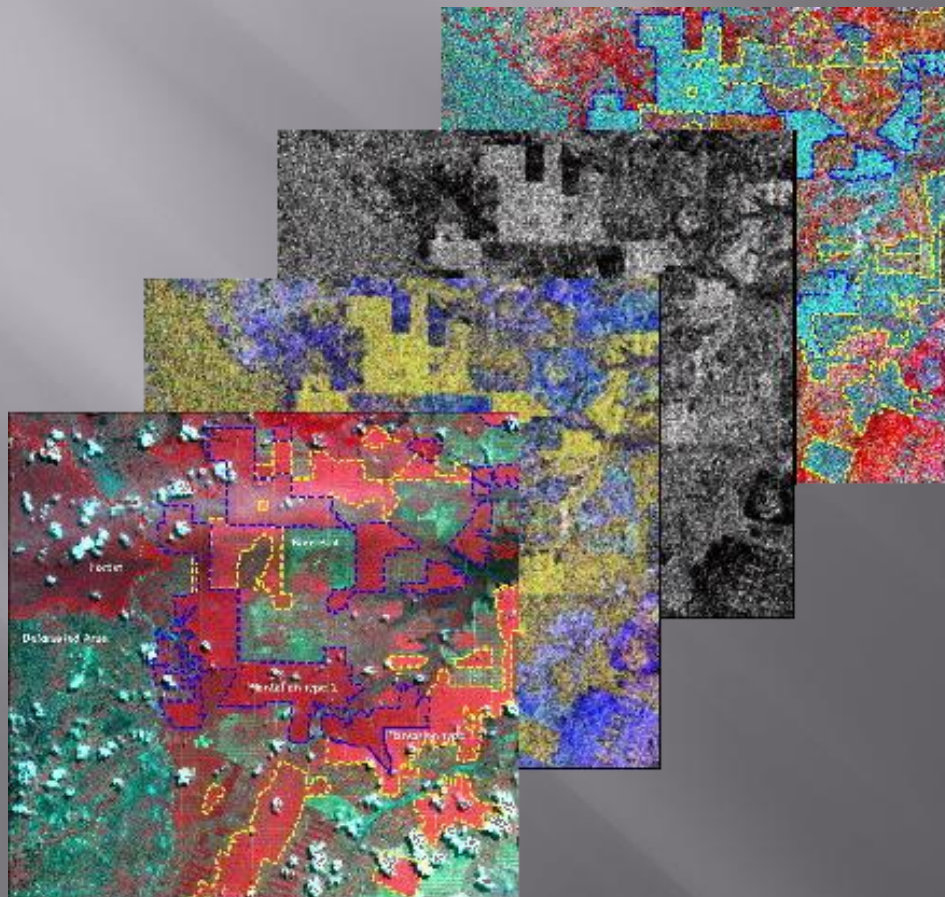
- LANDSAT ETM+ widths     LANDSAT ETM+ centers
- LANDSAT ETM+ Panchromatic band widths
- ASTER band widths         ASTER band centers
- MODIS band widths         MODIS band centers
- IKONOS band widths        IKONOS band centers
- IKONOS Panchromatic band widths
- HYPERION band widths     HYPERION band centers

**Feature key.** Click on a feature to toggle it's spectral curve on and off of the graph.

- arroyo willow
- asphalt
- cheat grass
- concrete
- dry long grass
- fine snow
- kaolinite
- live oak
- pinlon pine
- quartz
- tap water

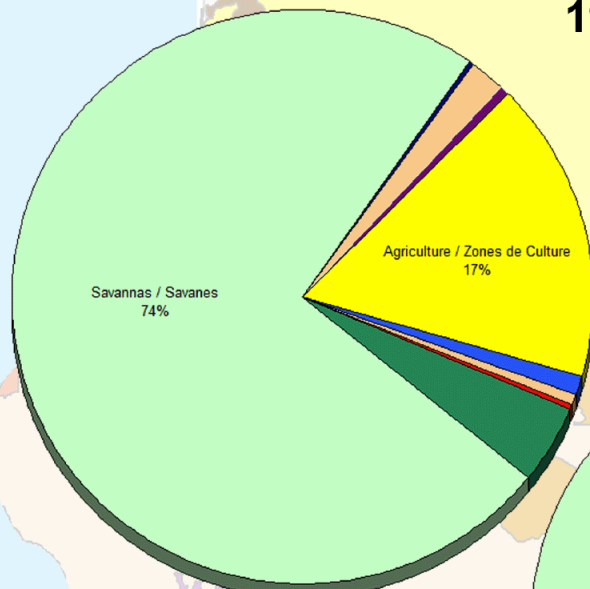




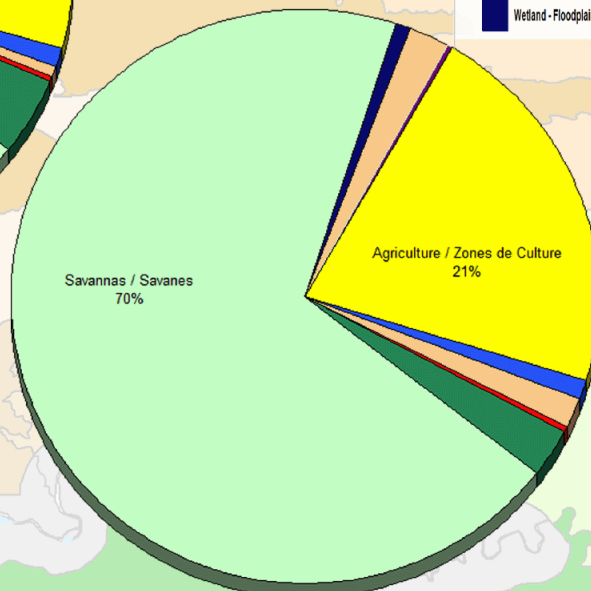


# Creating Indicators from RS Data National Level Inventory

## Senegal Land Use / Land Cover Change. 1965 to 2000



1965



2000

	1965	2000
Agriculture / Zones de Culture	17.0%	21.4%
Bare Soils / Sols Dénudés	0.7%	1.7%
Forests / Forêt	4.4%	2.6%
Mangroves / Mangroves	0.6%	0.4%
Savannas / Savanes	73.7%	69.6%
Settlements / Habitations	0.2%	0.3%
Steppes / Steppes	1.8%	2.2%
Water Bodies / Plans d'eau	1.0%	1.1%
Wetland - Floodplain / Prairie marécageuse - Vallée inondable	0.5%	0.6%

# 2010 goal

to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and to the benefit of all life on earth



Remote sensing analyst

Environmental policy maker

# Intended audience

1. Biodiversity managers, environmental managers, and policy makers
2. Technical specialists not familiar with biodiversity applications
3. Anyone else involved in environmental monitoring including site-based monitoring and for those involved in governmental and intergovernmental processes.

FOCAL AREA	HEADLINE INDICATORS
Status and trends of the components of biological diversity	<ul style="list-style-type: none"> <li>★ Trends in extent of selected biomes, ecosystems, and habitats</li> <li>★ Trends in abundance and distribution of selected species</li> <li>■ Coverage of protected areas</li> <li>★ Change in status of threatened species</li> <li>■ Trends in genetic diversity of domesticated animals, cultivated plants, and fish species of major socioeconomic importance</li> </ul>
Sustainable use	<ul style="list-style-type: none"> <li>■ Area of forest, agricultural and aquaculture ecosystems under sustainable management</li> <li>■ Proportion of products derived from sustainable sources</li> <li>★ Ecological footprint and related concepts</li> </ul>
Threats to biodiversity	<ul style="list-style-type: none"> <li>■ Nitrogen deposition</li> <li>★ Trends in invasive alien species</li> </ul>
Ecosystem integrity and ecosystem goods and services	<ul style="list-style-type: none"> <li>■ Marine Trophic Index</li> <li>★ Water quality of freshwater ecosystems</li> <li>■ Trophic integrity of other ecosystems</li> <li>★ Connectivity / fragmentation of ecosystems</li> <li>■ Incidence of human-induced ecosystem failure</li> <li>■ Health and well-being of communities who depend directly on local ecosystem goods and services</li> <li>■ Biodiversity for food and medicine</li> </ul>
Status of traditional knowledge, innovations and Practices	<ul style="list-style-type: none"> <li>■ Status and trends of linguistic diversity and numbers of speakers of indigenous languages</li> <li>■ Other indicator of the status of indigenous and traditional knowledge</li> </ul>
Status of access and benefit-sharing	<ul style="list-style-type: none"> <li>■ Indicator of access and benefit-sharing</li> </ul>
Status of resource transfers	<ul style="list-style-type: none"> <li>■ Official development assistance provided in support of the Convention</li> <li>■ Indicator of technology transfer</li> </ul>

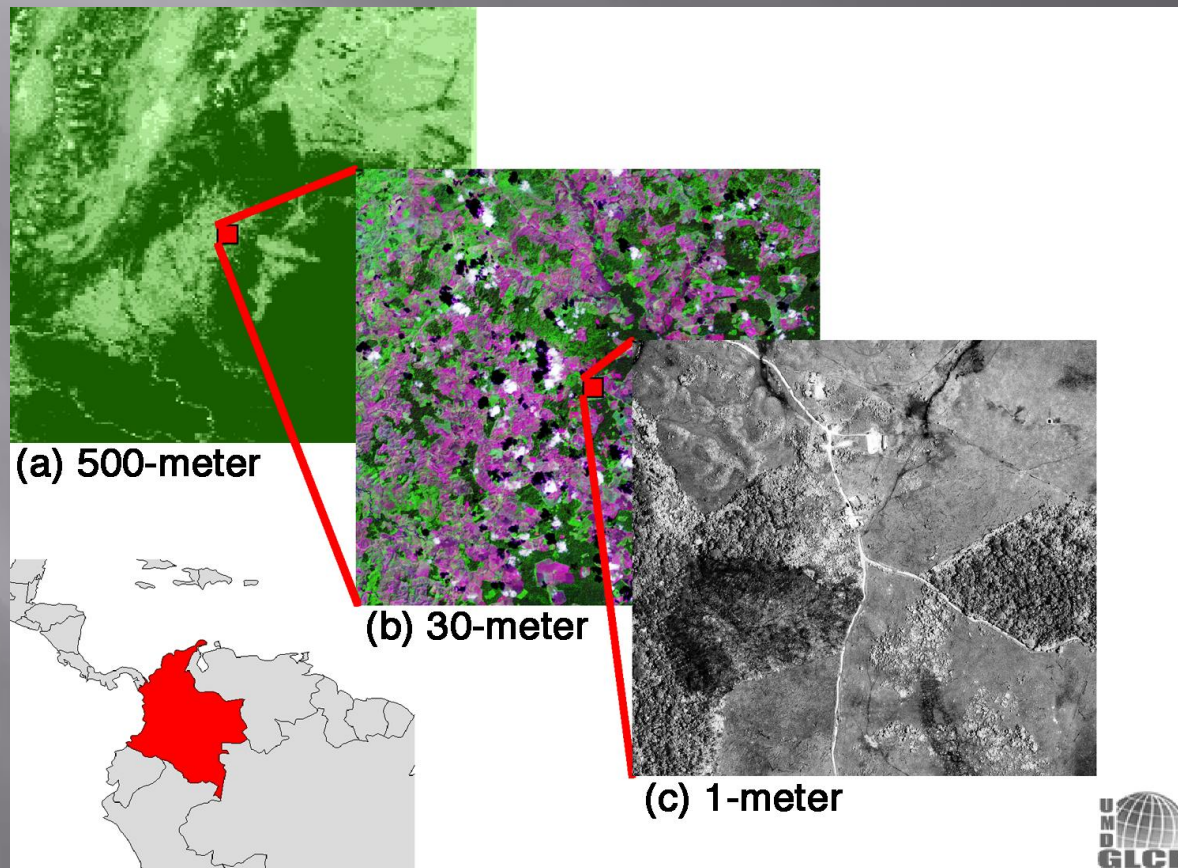
# Structure

Focal Area	Headline Indicators
Status and Trends of the Components of Biological Diversity	<ul style="list-style-type: none"><li>• Trends in extent of selected biomes, ecosystems, and habitats</li><li>• Trends in abundance and distribution of selected species</li><li>• Coverage of protected areas</li><li>• Change in status of threatened species</li></ul>
Sustainable Use	<ul style="list-style-type: none"><li>• Ecological footprint and related concepts</li></ul>
Threats to Biodiversity	<ul style="list-style-type: none"><li>• Trends in invasive alien species</li></ul>
Ecosystem Integrity and Ecosystem Goods and Services	<ul style="list-style-type: none"><li>• Water quality of freshwater ecosystems</li><li>• Connectivity/fragmentation of ecosystems</li></ul>

- ▣ What types of information can be provided using sensor technology?
- ▣ How can this information be translated into a useful indicator?
- ▣ What are the limitations inherent in the current level of technology?



# Importance of Scale



# Importance of Ground Truth Data



- Ground sample data - link to biodiversity
  - Calibration
  - Validation
- Local knowledge
  - Interpretation of remotely sensed data
  - Species knowledge
  - Ecosystem knowledge
  - Phenologic knowledge
  - Historical or community environmental record

# Limits of Accuracy

- ▣ increases with finer spectral and spatial resolution data
- ▣ increases with better field data,
- ▣ increases with coarser classification levels.

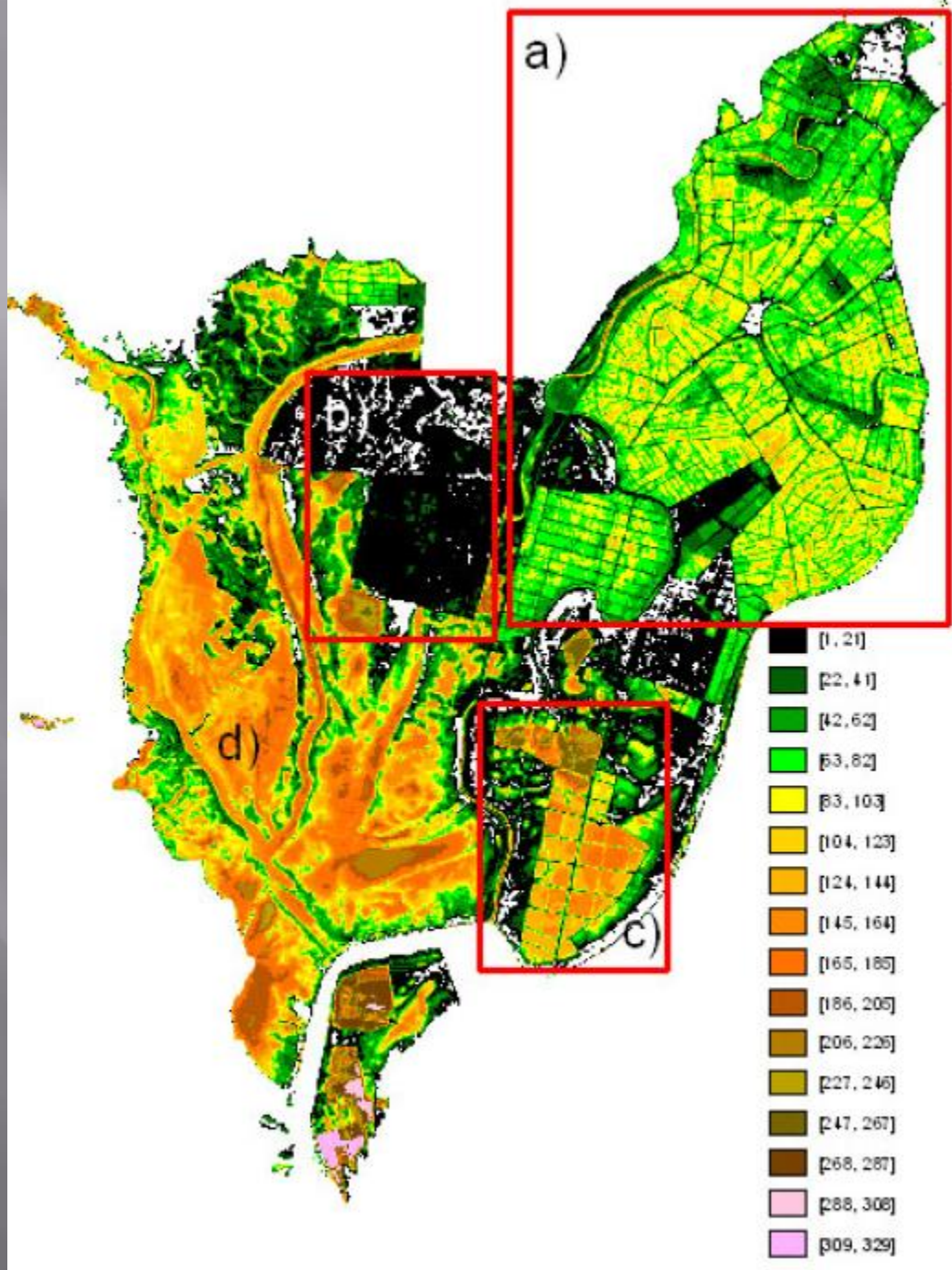
# Accuracy

- ▣ Forest/nonforest, water/no water, soil/vegetated: accuracies in the high 90%
- ▣ Conifer/hardwood: 80-90%
- ▣ Genus: 60-70%
- ▣ Species: 40-60%
- ▣ Bottom line: The greater the detail (precision) the lower the per class accuracy
- ▣ Note: If including a Digital Elevation Model (DEM) in the classification, add 10%

# Inland Waters

## **Remote sensing based indicators for inland waters:**

- **Extent of large inland waters and wetlands**
- **Variability of water levels and extent**
- **Coupling biological and physical assessments**
- **Changes in habitat and ecosystem quality**



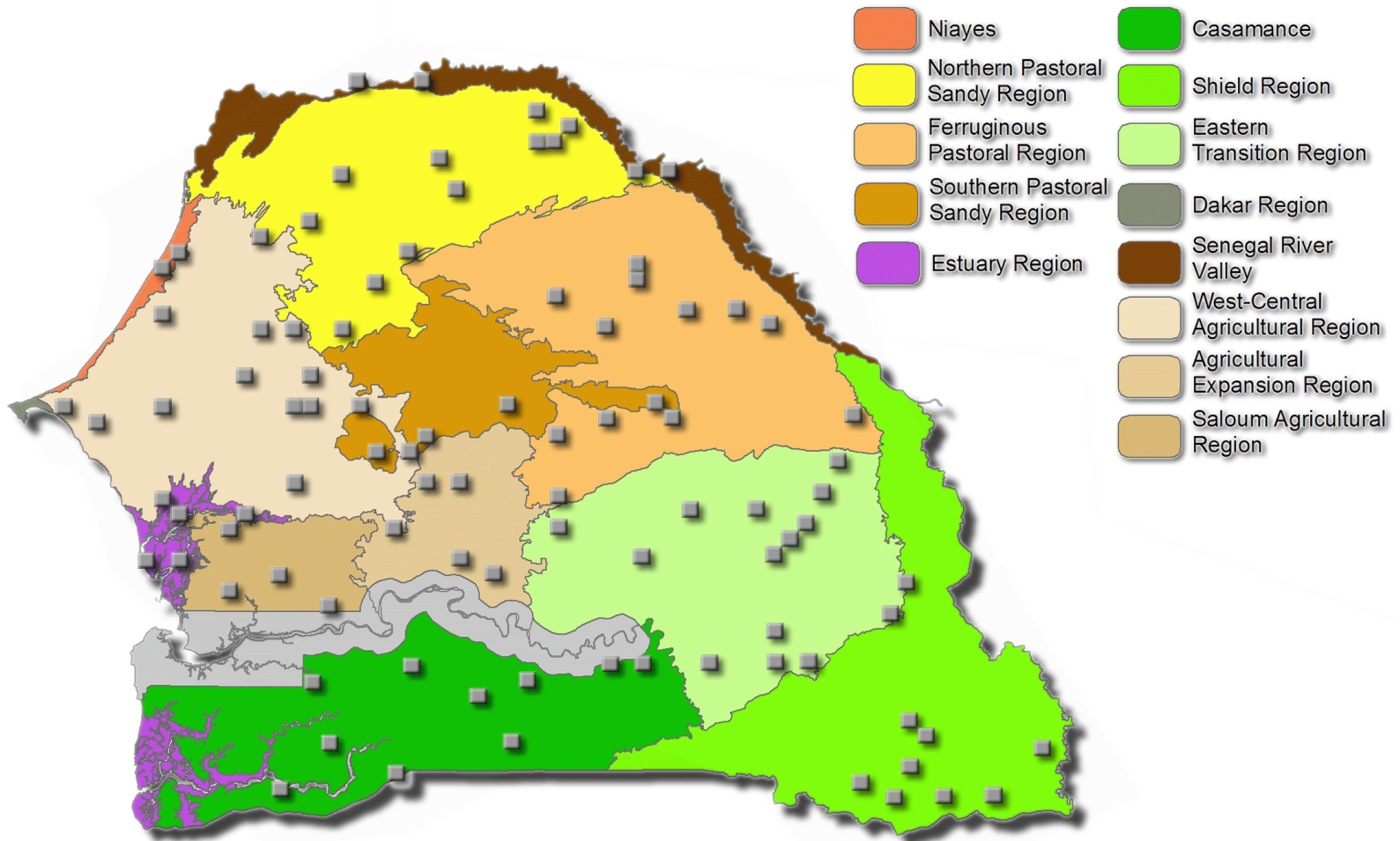
# Dry and Subhumid Lands

- **Extent of grassland, desert and Mediterranean ecosystems**
- **Intact biodiversity**
- **Land degradation**
- **Grazing pressure**
- **Climate change**
- **Extent of alien species invasion**
- **Fire location and frequency**

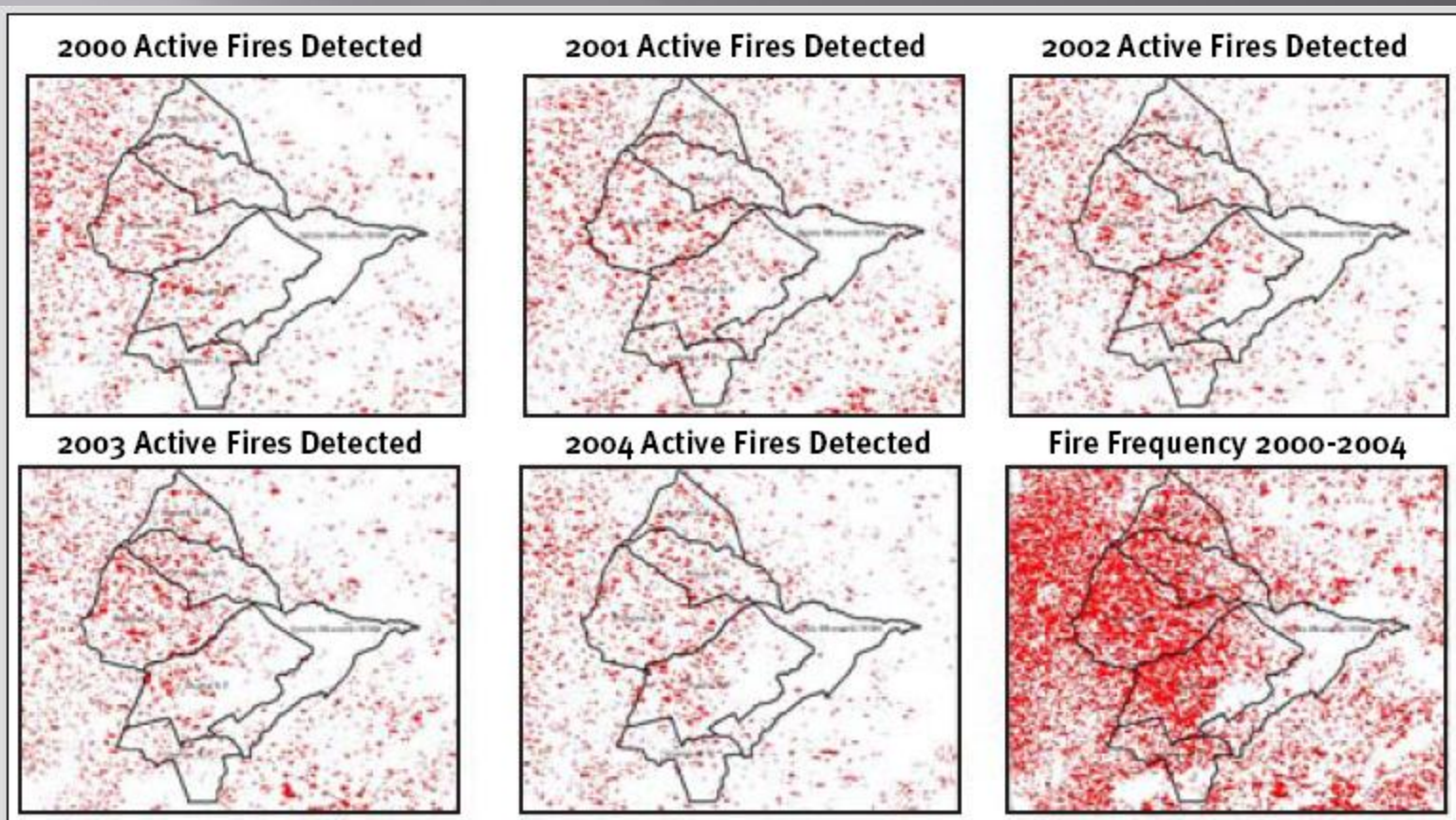
# Sampling

## The Ecoregions of Senegal

showing the 10x10 km Sampling Frames





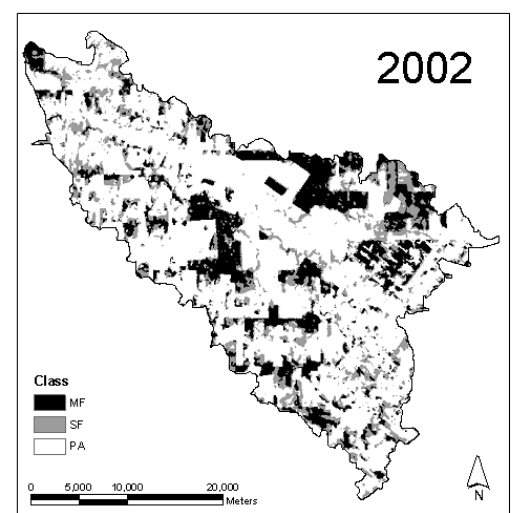
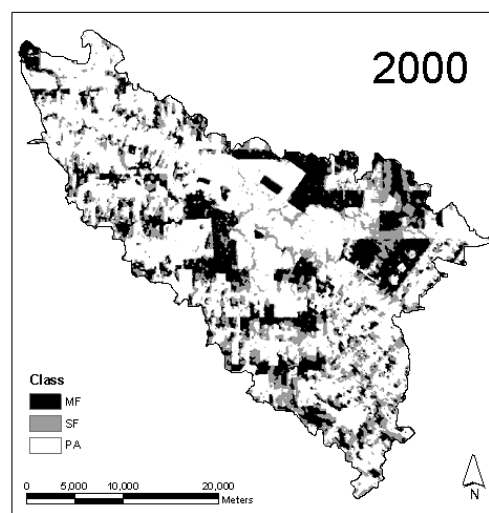
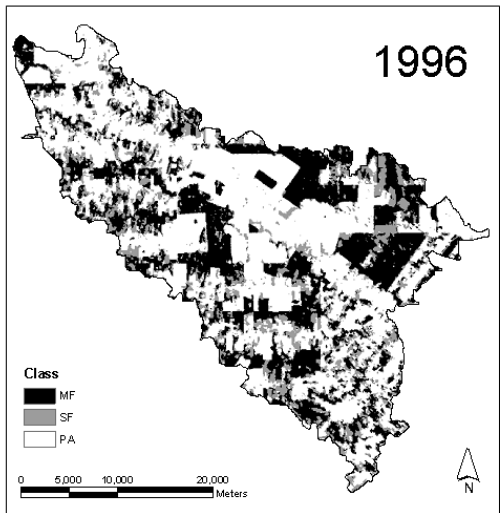
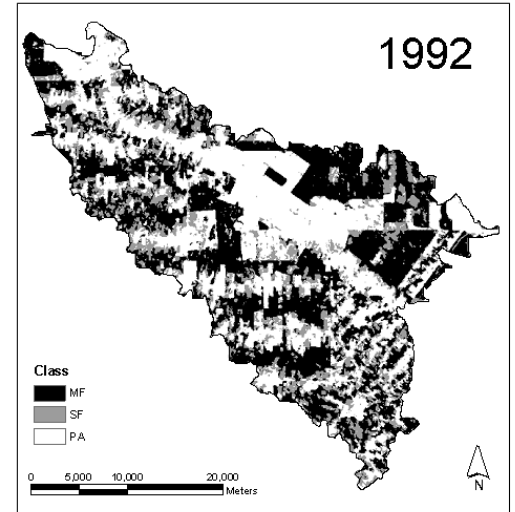
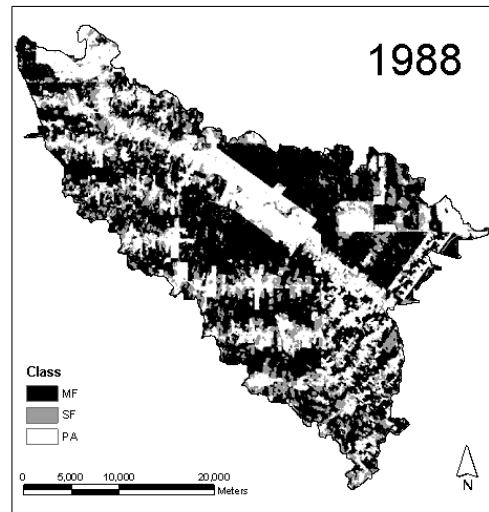
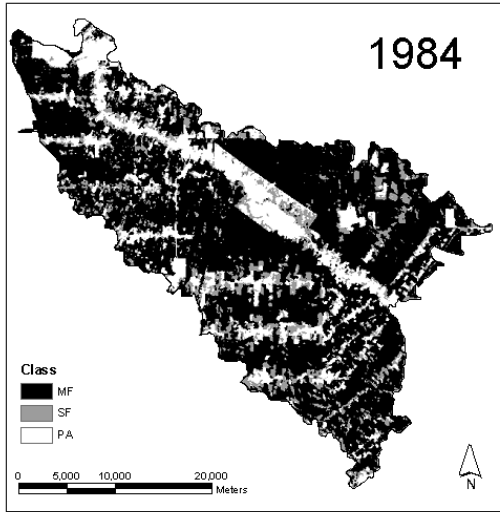


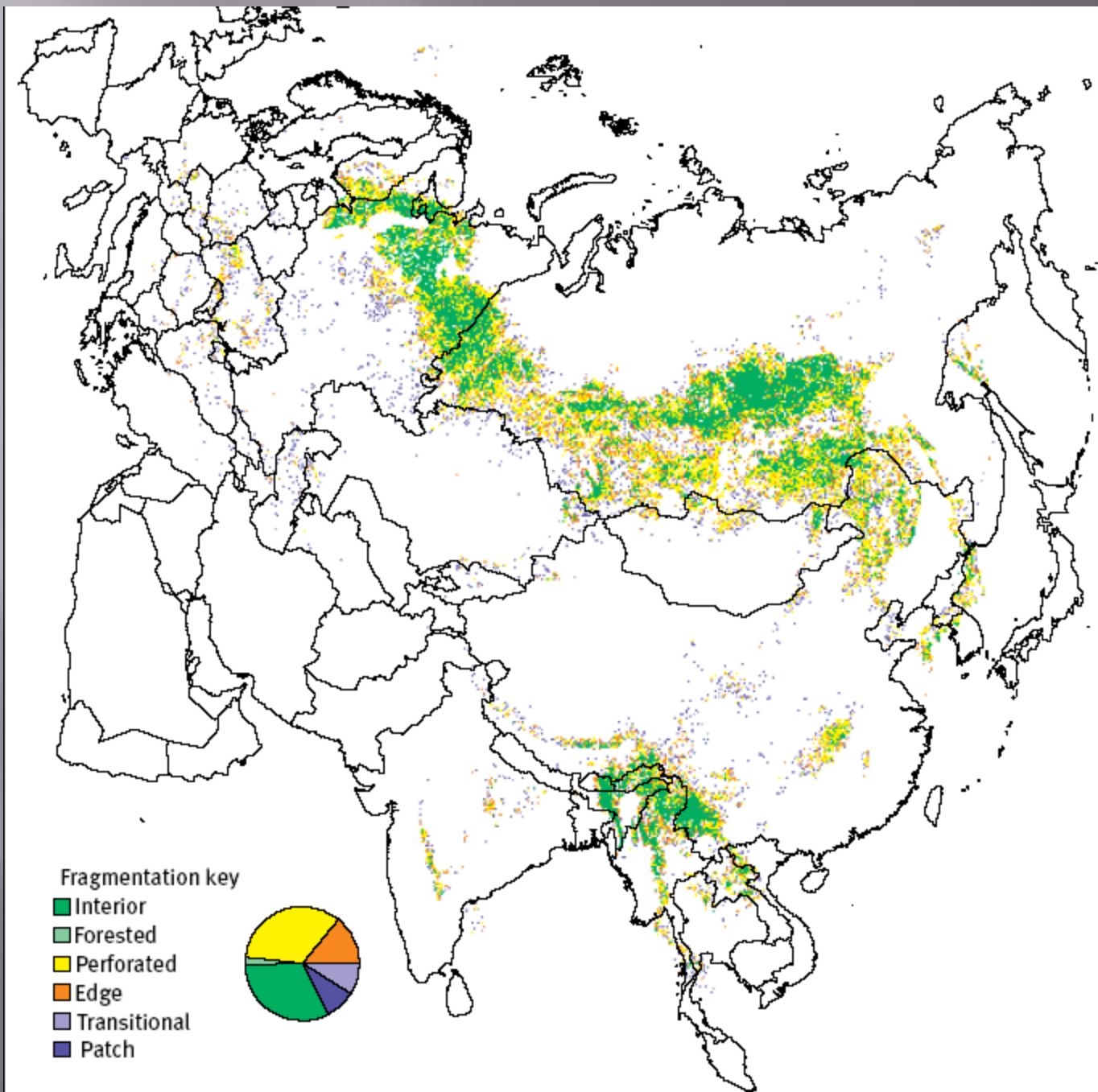
**FIGURE 5.6.** Dry season active fires detected with MODIS Active Fire product in the Rungwa Ruaha landscape, 2000-2004 (Map by: G. Picton Phillipps, WCS)

# Connectivity/Fragmentation of ecosystems

Remote sensing based indicators for fragmentation and connectivity:

- **Total number of land cover types**
- **Patch size (largest, average)**
- **Patch density**
- **Perimeter-to-area ratio (average)**
- **Core area index**
- **Fractal dimension**
- **Distance to nearest neighbor (average)**
- **Contagion**
- **Juxtaposition index**
- **Road length**
- **Road density**





Fragmentation key

Interior

Forested

Perforated

Edge

Transitional

Patch



# Appendices

- ▣ Glossary
- ▣ Sensor/satellite information
- ▣ Tutorials, learning tools
- ▣ Online data sources
- ▣ Software, including image viewers and open source
- ▣ Opportunities for support, both online and through institutions

# Biodiversity Community Needs

1. National-global monitoring linkages
2. Improved classification/measurement accuracy
3. Coordination of scientific and conservation monitoring communities
4. Continuity of Data Sources
5. Periodic data buys to increase availability to all
6. Technology transfer
7. Datasets designed to support the reporting requirements of various environmental treaties and agreements

**Thank you!**