The Abdus Salam
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United Nations
Educational, Scientific and
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Capacity building in satellite data analysis and visualization for ecosystem monitoring

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Capacity building in satellite data analysis and visualization for ecosystem monitoring

By

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Global Environmental Challenges

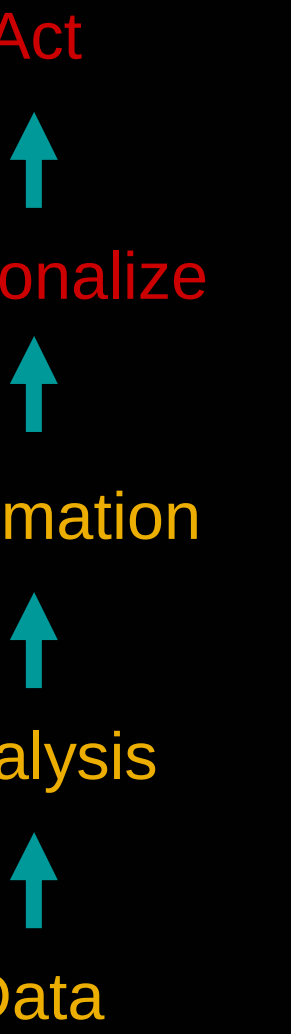
- Climate change: impact, mitigation, adaptation
- Water quantity and quality
- Land use change, deforestation
- Loss of biodiversity
- Land degradation, desertification
- Air pollution in megacities
- Urban waste , toxic waste, e waste, nuclear waste

Environmental monitoring is one of the most important uses of earth observation

What Is Needed

- Scientifically credible information on:
  - What is happening?
  - Where?
  - Why?
  - How is the problem being addressed?
  - What is likely to happen in the future?
- Early warning information
- Communication to policy makers

Information for Decision-Making



Capacity building in developing countries

Mainstreaming S&T to provide scientific basis for decision making by:

- Adding new categories of data/information not available in the country;

- Enhancing existing data collection systems by improving their accuracy, efficiency, and cost effectiveness;

- Altering a part or all of the existing data collection system, wherever appropriate to address "real life" mission critical needs.

Elements of capacity building

Assist in the development of national research, monitoring and assessment Capacity, including training in assessment and early warning, data and scientific resources access, networking among universities with programmes of excellence in the field of the environment.

- Access data and information from global sources;
- Collection, analysis and packaging of scientific data for decision making
- Remote sensing, GIS, and data integration and visualization tools
- Internet based application tools, sensor webs etc.
- Information about scientific literature available through open access sources
- Leveraging upon evolving technologies
- Long term ecosystem monitoring, climate change,
- Early warning of disasters and conflicts

United Nations Environment Programme

UNEP was established in 1972 with the mandate:

"To keep under review the world environmental situation in order to ensure that emerging ***environmental problems*** *of wide international significance* ***receive appropriate and adequate consideration*** *by governments."*

- UN General Assembly 1972

However -

UNEP is not alone in seeking the attention of policy makers and the public.

UNEP must compete in a crowded marketplace of ideas.

How can UNEP and others in the environmental community get our message across?

How can we connect local to global?

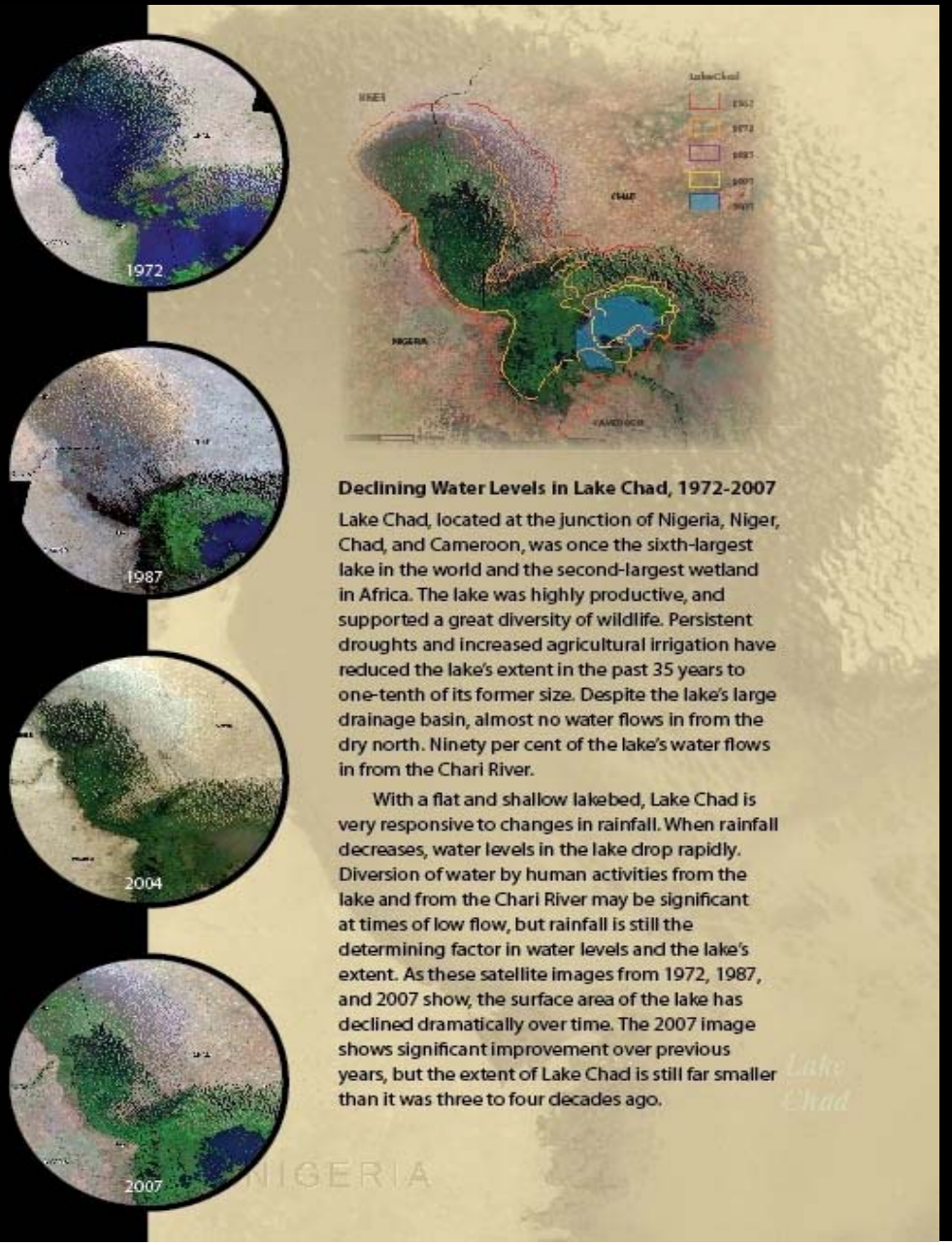
How do we at UNEP and others in the environmental community <u>get our message across?</u>

Text is important, but it requires an active interest on the part of the reader.

Those who already have an active interest in any given issue will read journal articles and reports.

How do we at UNEP and others in the environmental community <u>get our message across?</u>

Data visualization to provide information in a compelling fashion



Declining Water Levels in Lake Chad, 1972-2007

Lake Chad, located at the junction of Nigeria, Niger, Chad, and Cameroon, was once the sixth-largest lake in the world and the second-largest wetland in Africa. The lake was highly productive, and supported a great diversity of wildlife. Persistent droughts and increased agricultural irrigation have reduced the lake's extent in the past 35 years to one-tenth of its former size. Despite the lake's large drainage basin, almost no water flows in from the dry north. Ninety per cent of the lake's water flows in from the Chari River.

With a flat and shallow lakebed, Lake Chad is very responsive to changes in rainfall. When rainfall decreases, water levels in the lake drop rapidly. Diversion of water by human activities from the lake and from the Chari River may be significant at times of low flow, but rainfall is still the determining factor in water levels and the lake's extent. As these satellite images from 1972, 1987, and 2007 show, the surface area of the lake has declined dramatically over time. The 2007 image shows significant improvement over previous years, but the extent of Lake Chad is still far smaller than it was three to four decades ago.

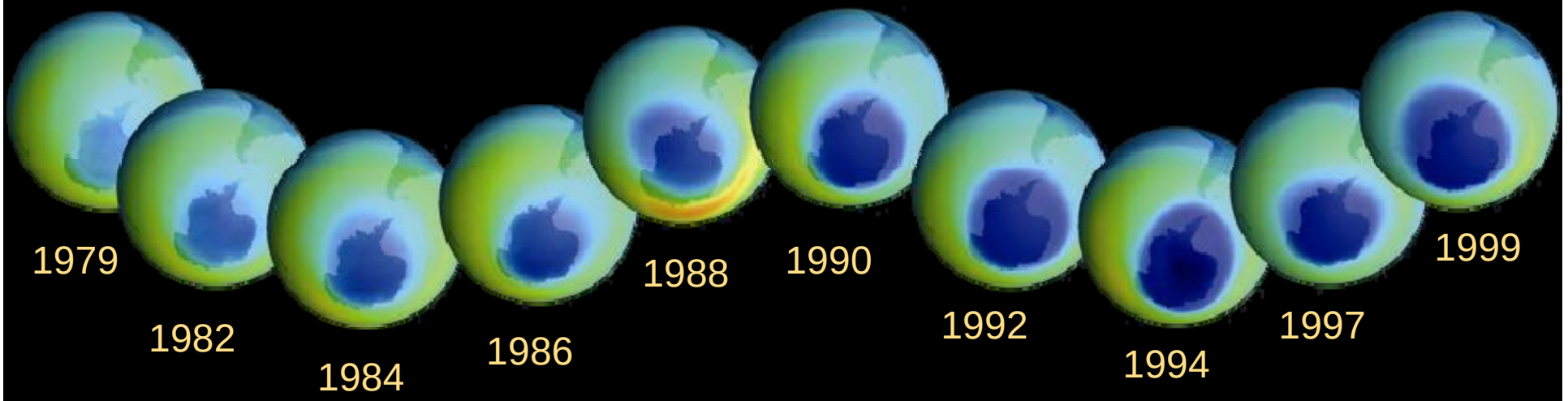
Apollo Image of the Planet

This view of the Earth from space drove home how finite, interconnected and fragile our planet is.

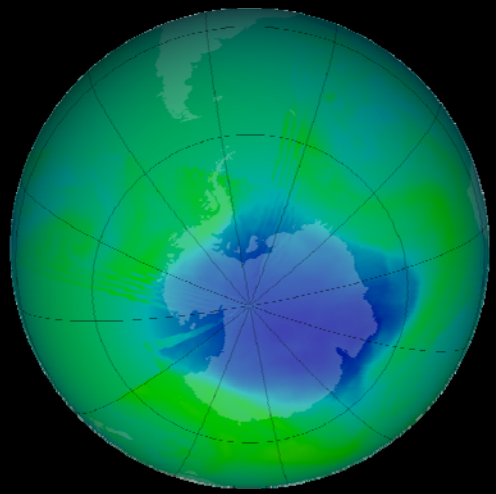
Most used image in the human history;

Led to Earth day celebration in US

Growth of the Antarctic ozone hole



Darkest blue areas represent regions of maximum ozone depletion.



2007

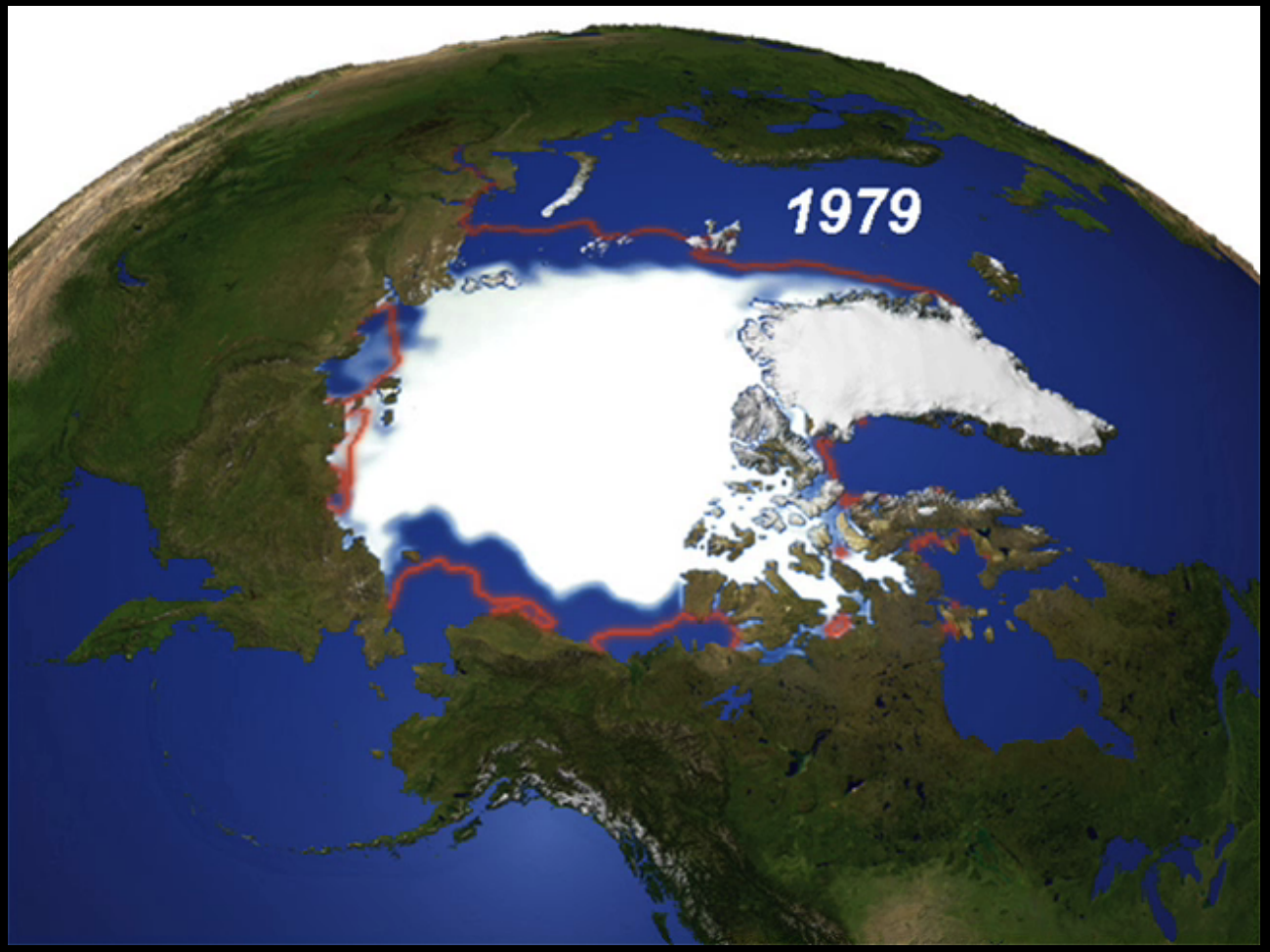
Raising awareness about Tropical Deforestation

movie

Rondonia, Brazil

- 1975 -Healthy natural vegetation
- 1989 -“Fishbone” pattern on the landscape indicate agriculture fields
- 2001 -Agriculture continues to replace forest cover

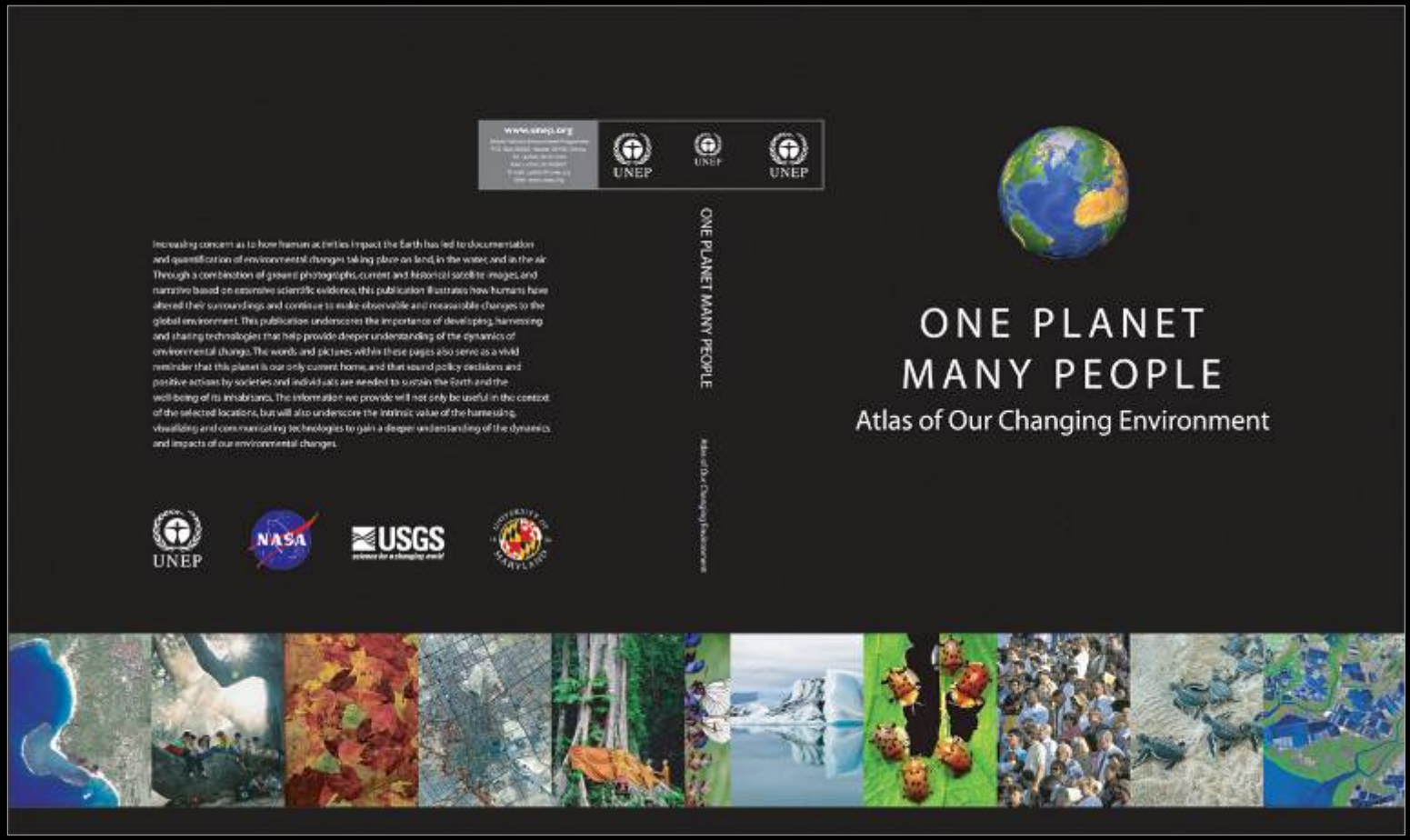
Dramatic Changes in Arctic: Imagine an Ice-free Arctic



1979-2003: Progressive Loss of Arctic Ice

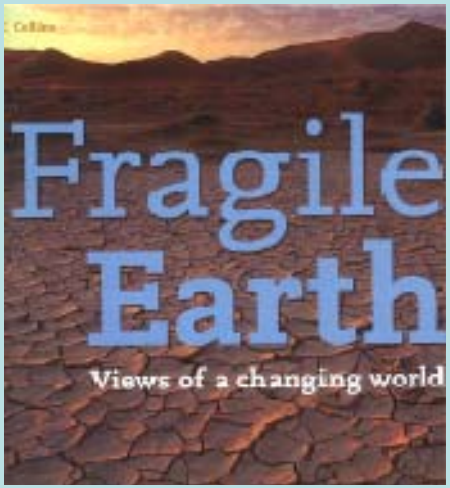
movie

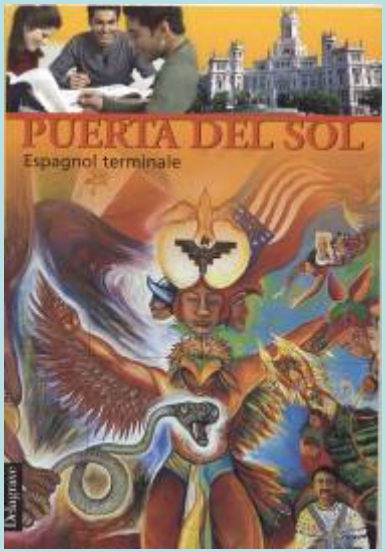
United Nations Environment Programme

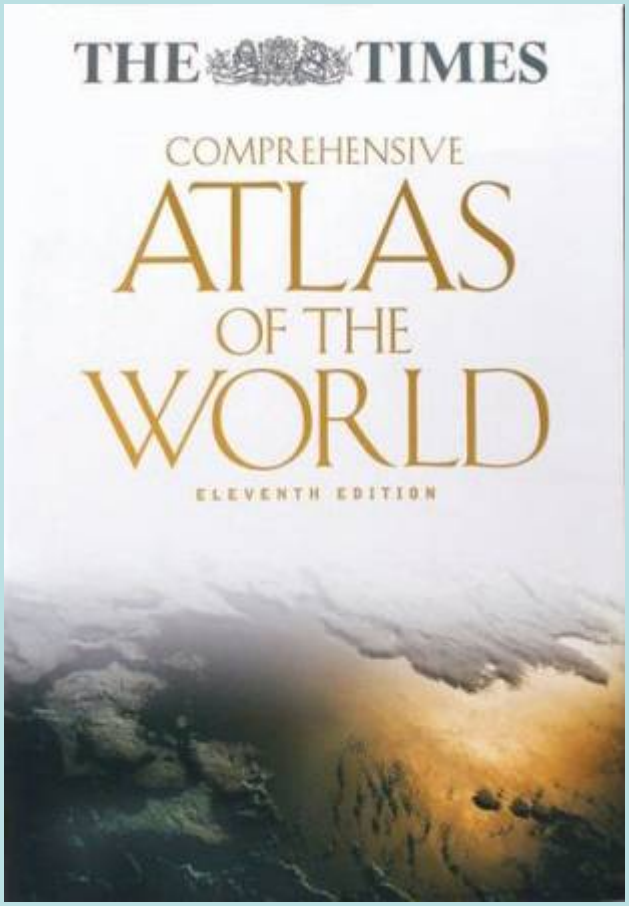


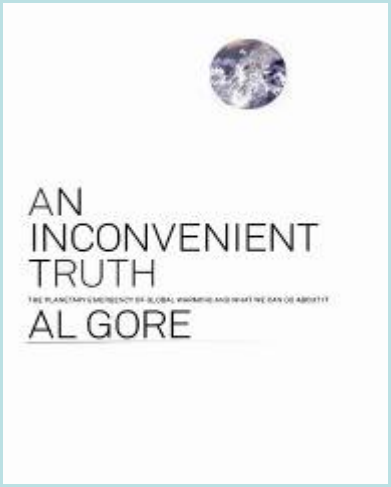
One Planet Many People: Atlas of our Changing Environment

We are featured in……









Awards

- ***2005 UN 21 Awards***

- ***Notable Government Documents Award 2005***

- ***IWA PR Awards 2006***

- **Winner of *the 1st International Digital Earth Grand Challenge 3D Visualization Contest 2006***

- ***MARS Best of Free Reference Web Sites of 2007***

WHAT

What is happening where?

WHY

- Trend over time is the most compelling information

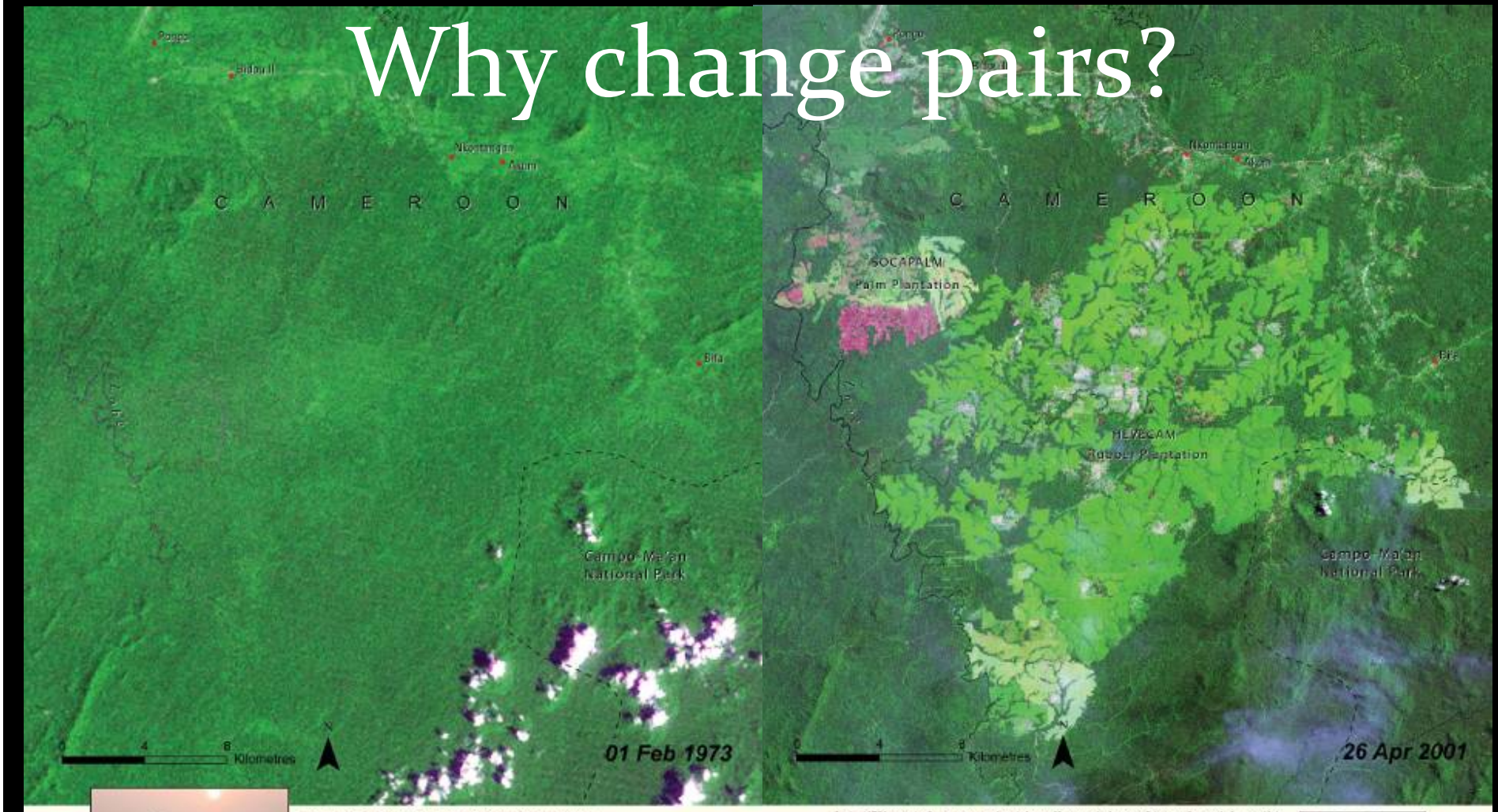
“A Picture is worth thousands words” and “Seeing is believing”

-Promote ‘evidence based” policies

HOW

Story of environmental changes told using current and historical satellite data, ground photographs and a short narratives

Why change pairs?

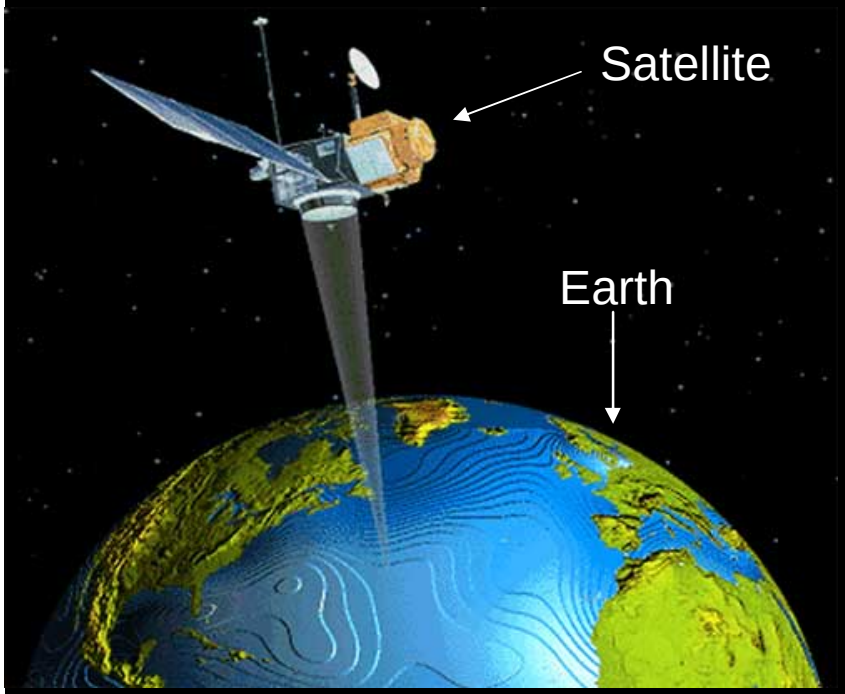


Plantations in Campo-Ma'an: Cameroon

The Campo-Ma'an rain forest in southern Cameroon covers approximately 770 000 hectares of the Guineo-Congolian Regional Centre of Endemism—a species-rich area of rain forest with many species found nowhere else in the world. While the human population density is quite low, the area supports a host of economic activities, many of which threaten the area's ecosystems, including logging, shifting agriculture, and commercial agro-forestry. These forces contribute to deforestation in southern Cameroon, which is among the highest in central Africa.

In the 1973 image the forest appears as largely intact. However, the impact of the agro-forestry industry, which is dominated by rubber and palm plantations, can be seen clearly in the centre of the 2001 image. Plantations, roads and cultivated areas dominate the landscape. These large-scale agro-industrial operations have replaced approximately 7.5 per cent of the area's forest cover.

Campo-Ma'an is an important focus of conservation efforts in Cameroon, and in 2000 the Campo-Ma'an National Park was created to protect its diverse flora and fauna. The park covers 26 400 hectares of diverse forests stretching from the coast to roughly 100 km inland.



1st Earth Observation satellite launched in 1972

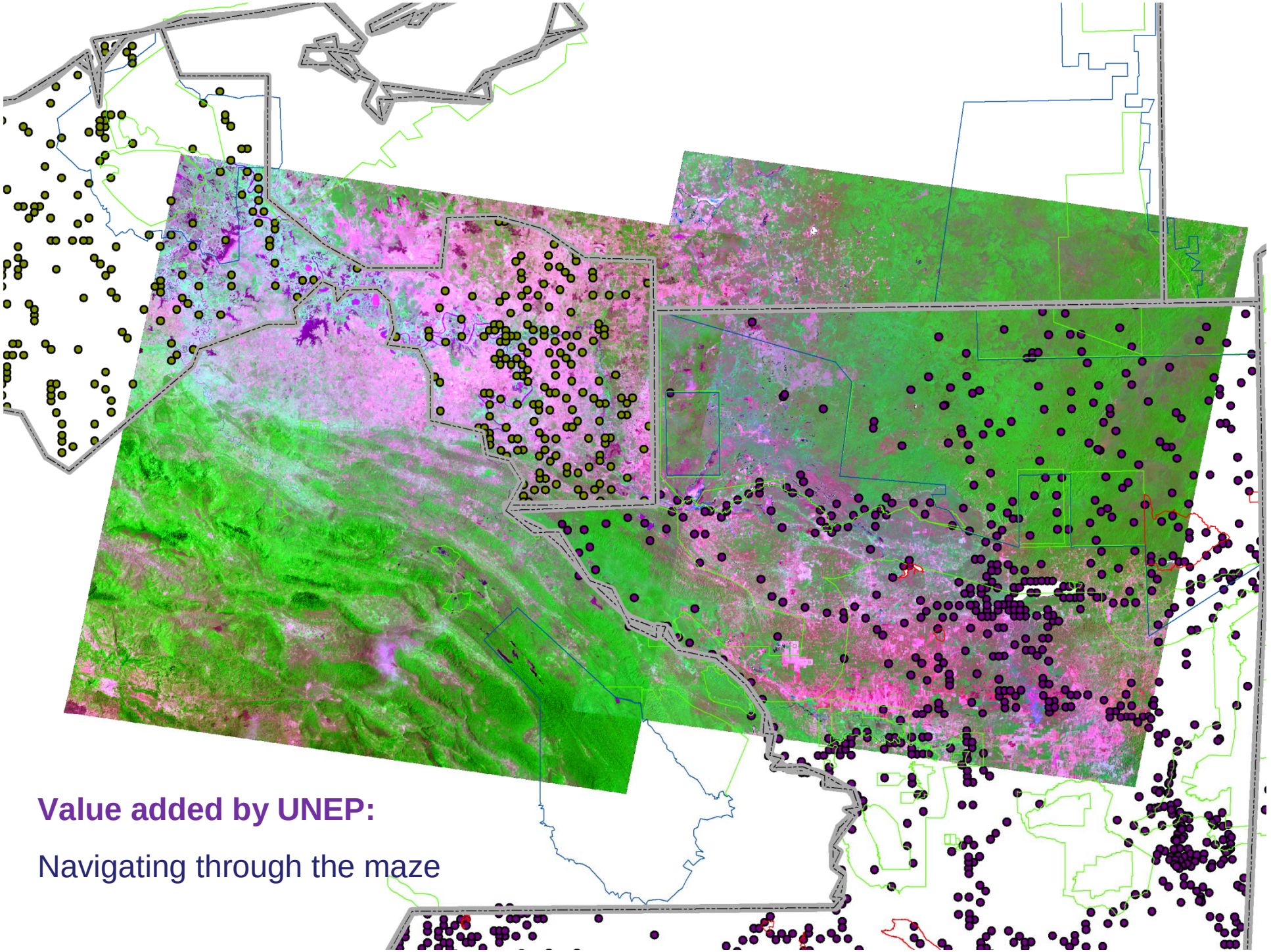
Distance from Earth – approx. 720 km (447 miles)

Spatial Resolution

Global (>1km)

Local (1m)

Annual investment estimated about 5 billion US$



Value added by UNEP:

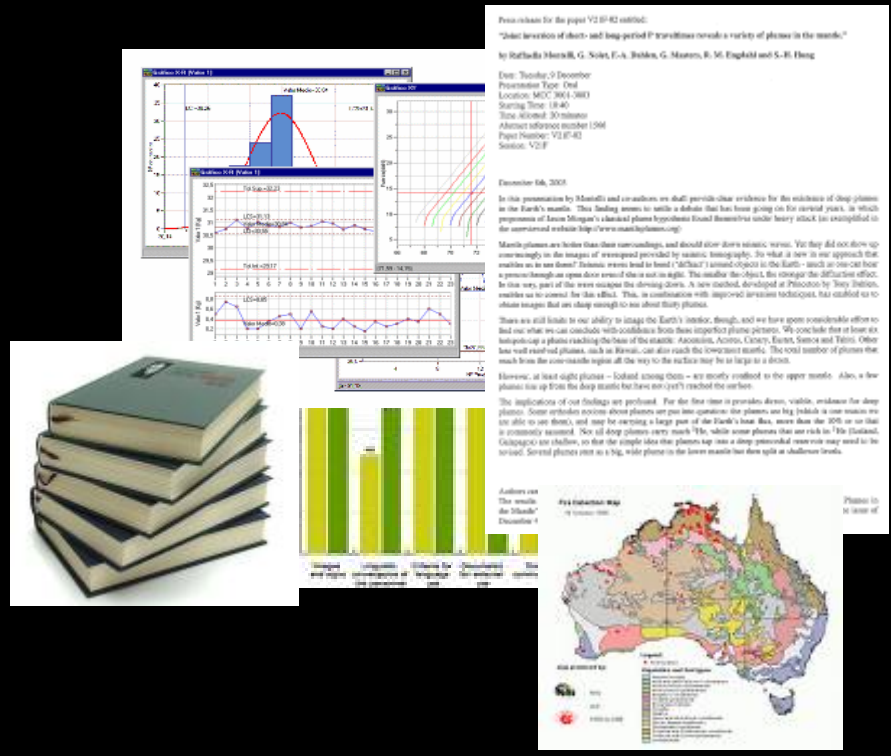
Navigating through the maze

1. Issue

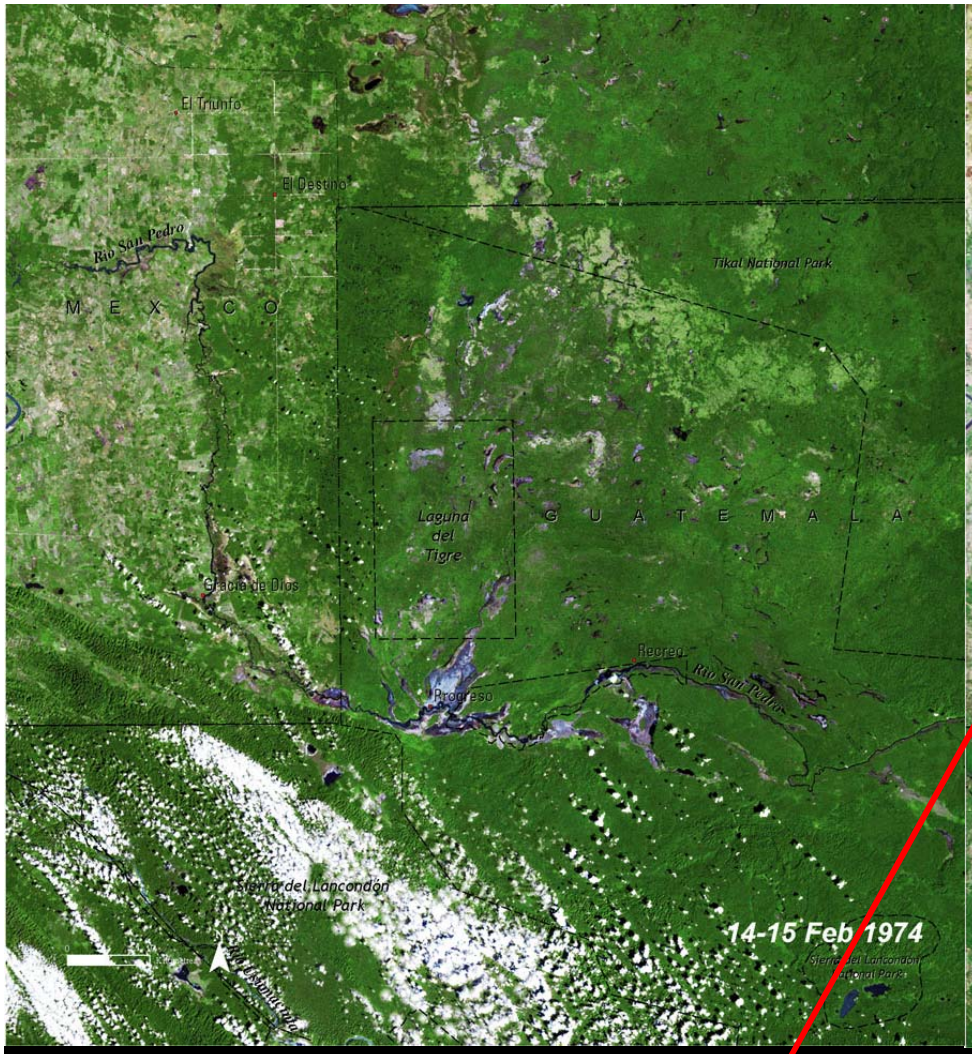
1. Deforestation
2. Coastal erosion
3. Biodiversity loss
4. Unsustainable agriculture

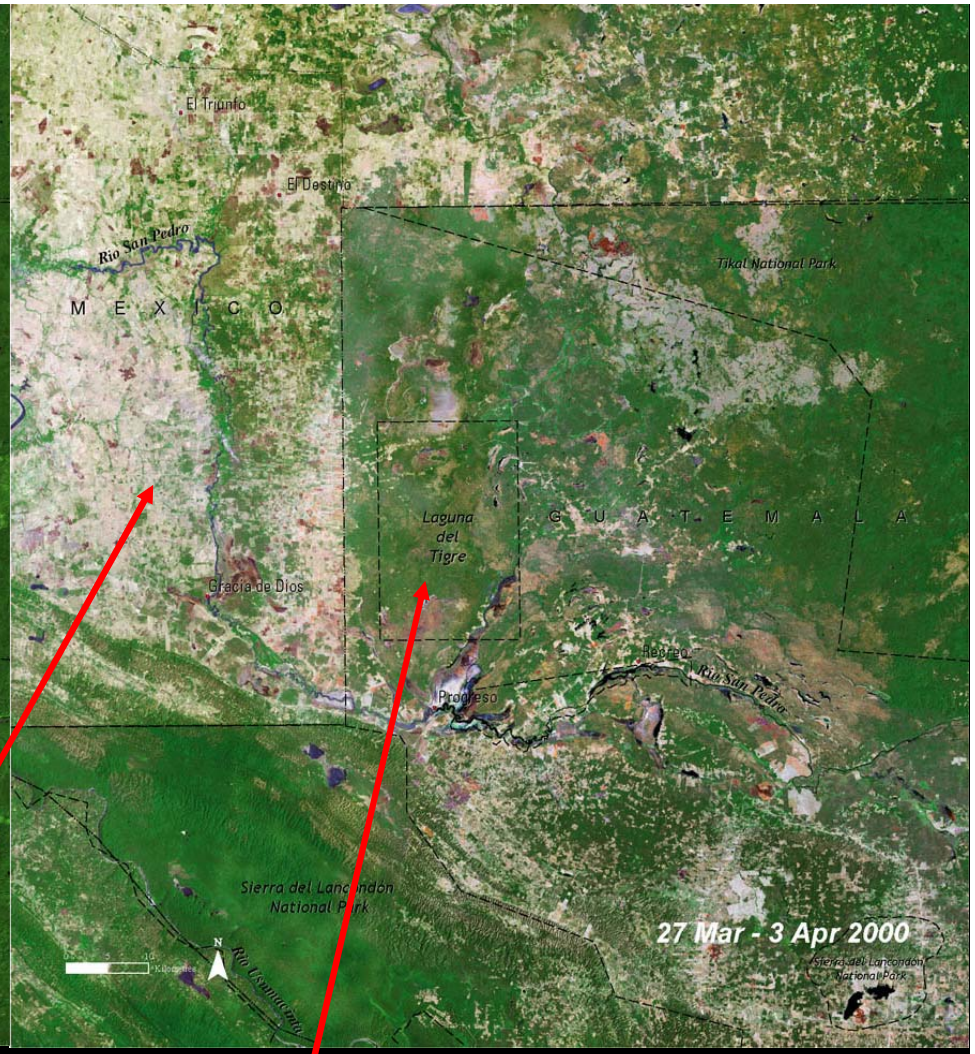
2. Images

3. Documentation



UNEP





The border between Guatemala and Mexico runs through Mexico's Chiapas Forest and Guatemala's El Peten. In this pair of images, the border is easy to see, even without the black lines that have been overlaid on the images to show the outlines of the two countries.

The region crossed by this border was once biologically very diverse. On the Guatemalan side, it still is, as most of the El Peten remains as closed canopy forest because of lower population densities and the protected status of the Sierra de Lacondon and Laguna del Tigre National Parks. Across the border in Chiapas, however, a larger and increasing population has an obvious effect on the landscape. Between 1974 and 2000, much of the forest on the Mexican side of the border has been converted to cropland or pasture.

Adding Map Layers & Putting It All Together.

National Borders

Protected Areas

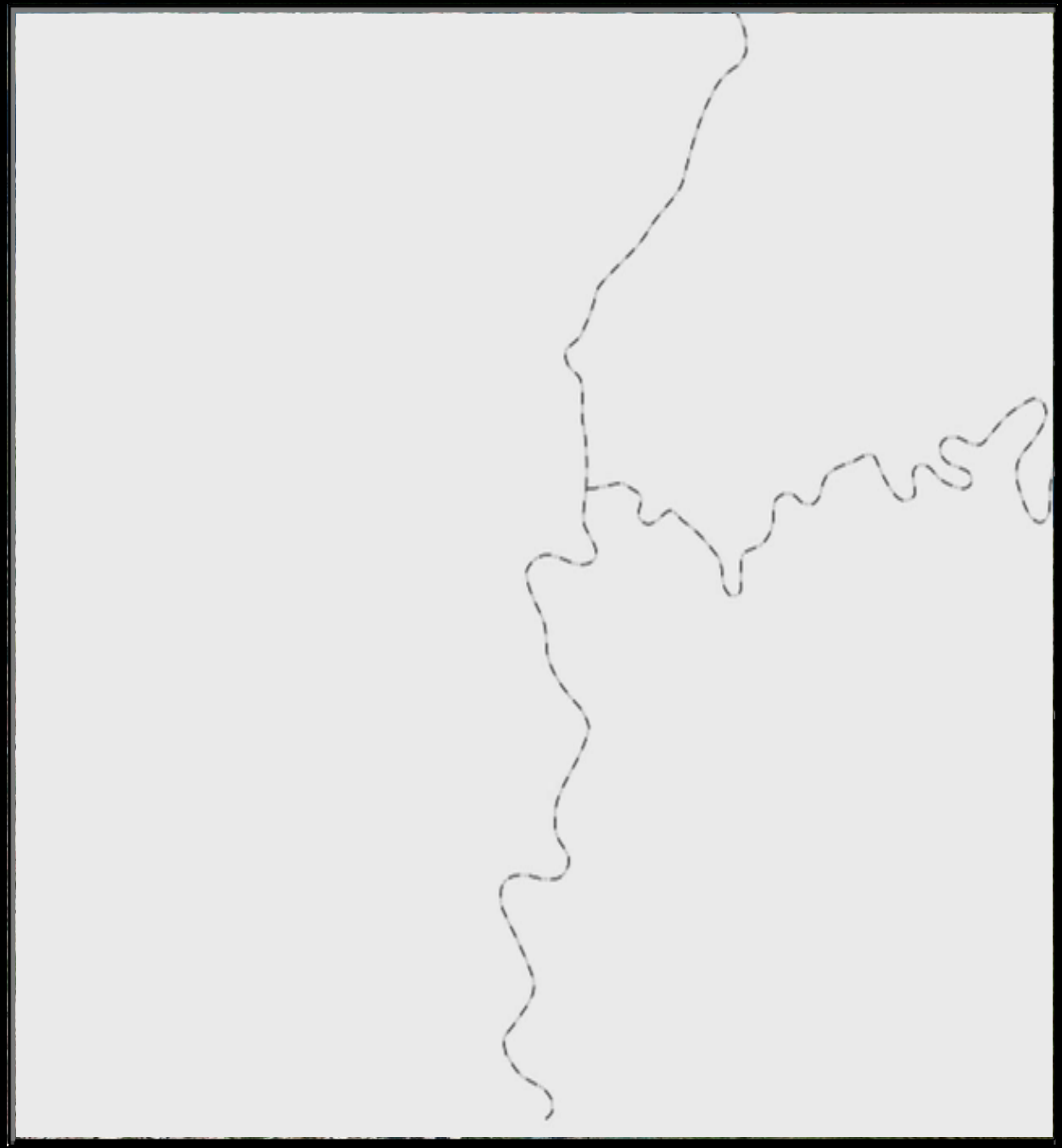
Cities

Annotation for countries, cities, water features, protected areas

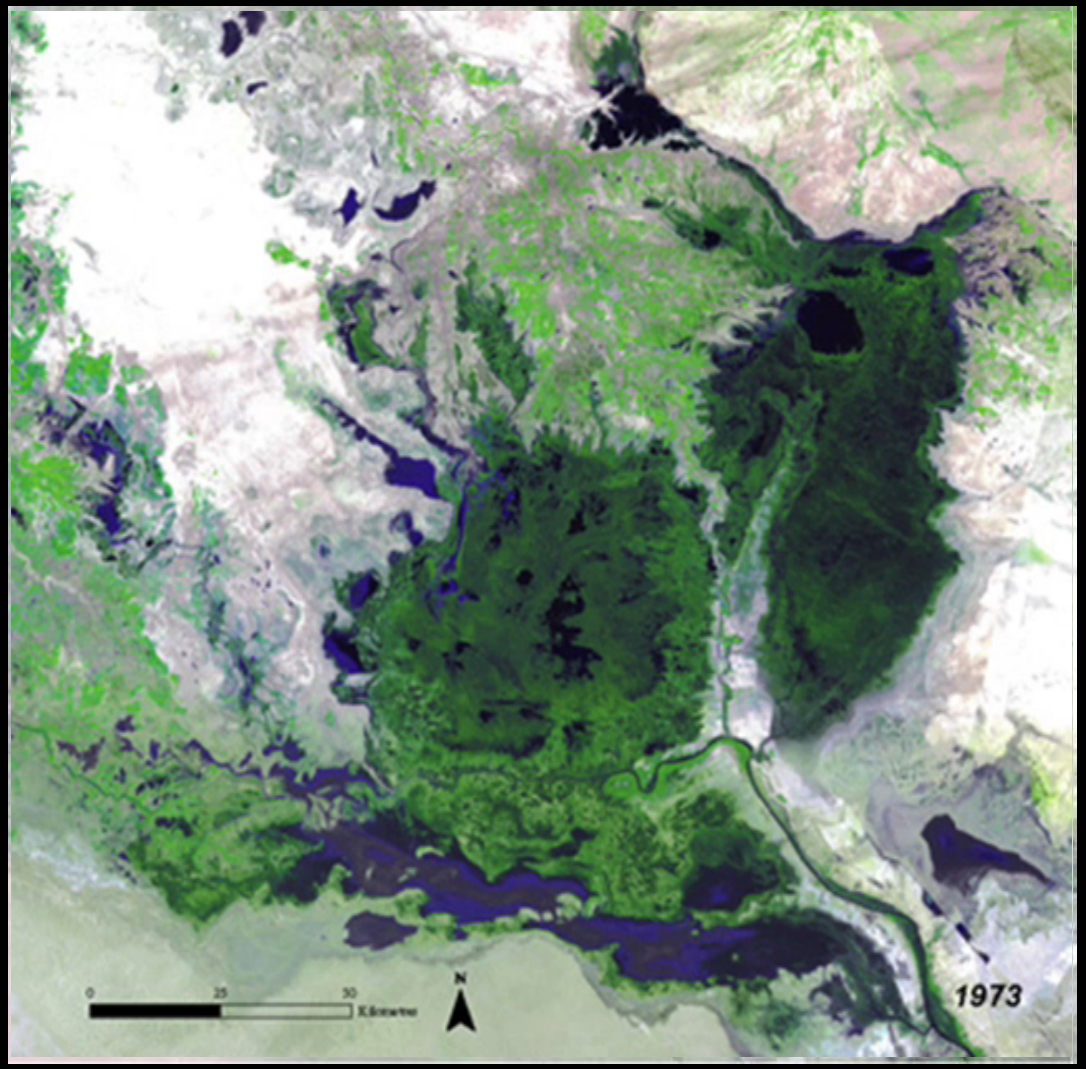
A “before image”
23 February 1973

An “after image”
12 May 2003

movie



Mesopotamian Marshland, Iraq and Iran: Demise of an Ecosystem



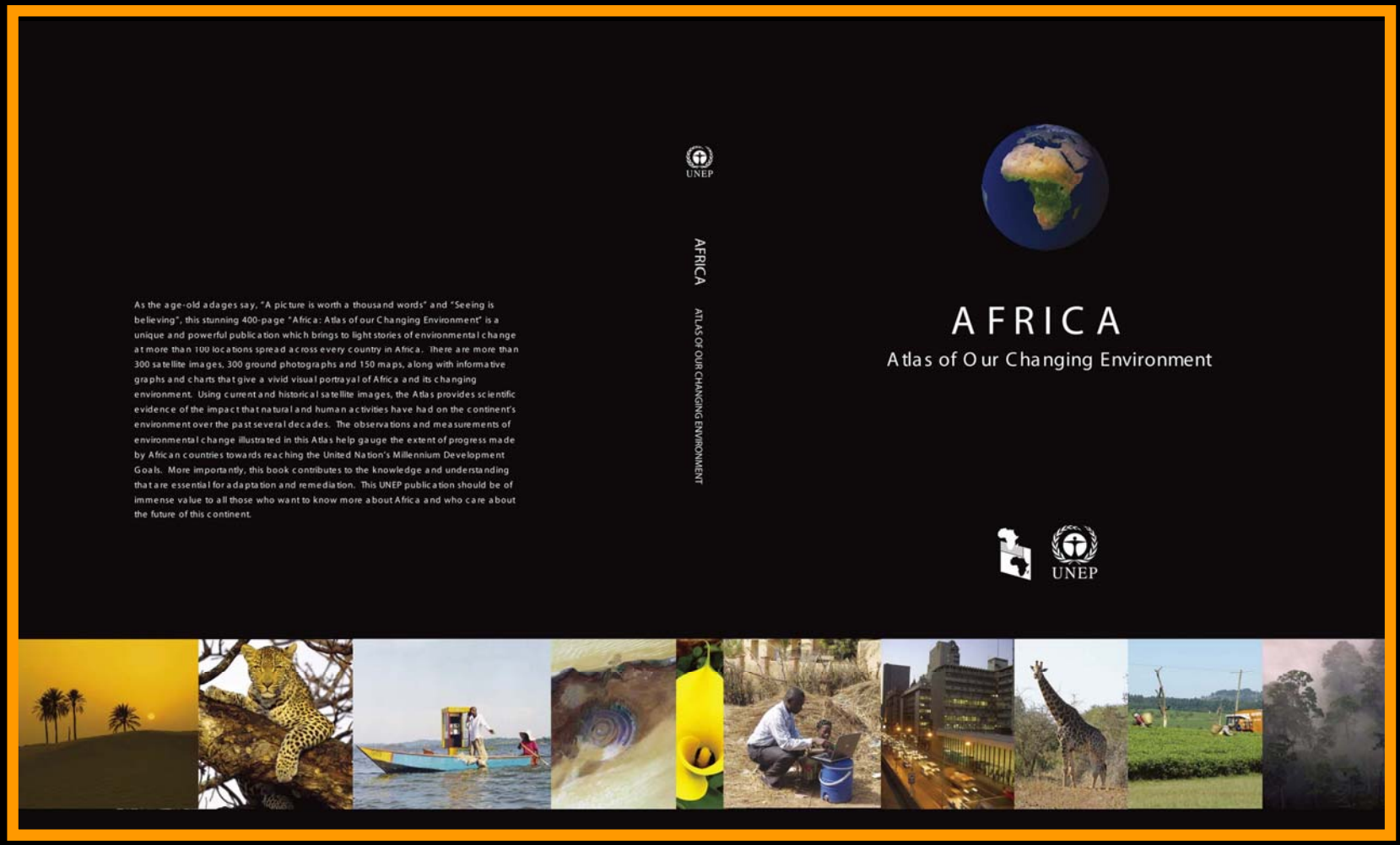
1973-2000: Most of the wetlands disappeared

movie

Water Returns to the Mesopotamian Marshlands

Greening of some of the Marshlands in recent years.

AFRICA: Atlas of our Changing Environment



Emmanuel Tachie-Obeng – Ghana

Erick Khamala – Kenya

Blessing Siwela – Zimbabwe / Botswana

Bernard Adusei - Ghana

Eugene Apindi Ochieng – Kenya

Henok Alemu – Ethiopia

Mahamadou Keita – Mali

Sami Eria – Uganda

Meron Abrham – Ethiopia

20 Visiting scientists from African countries have worked on the “Africa Atlas”

René Siwe – Cameroon

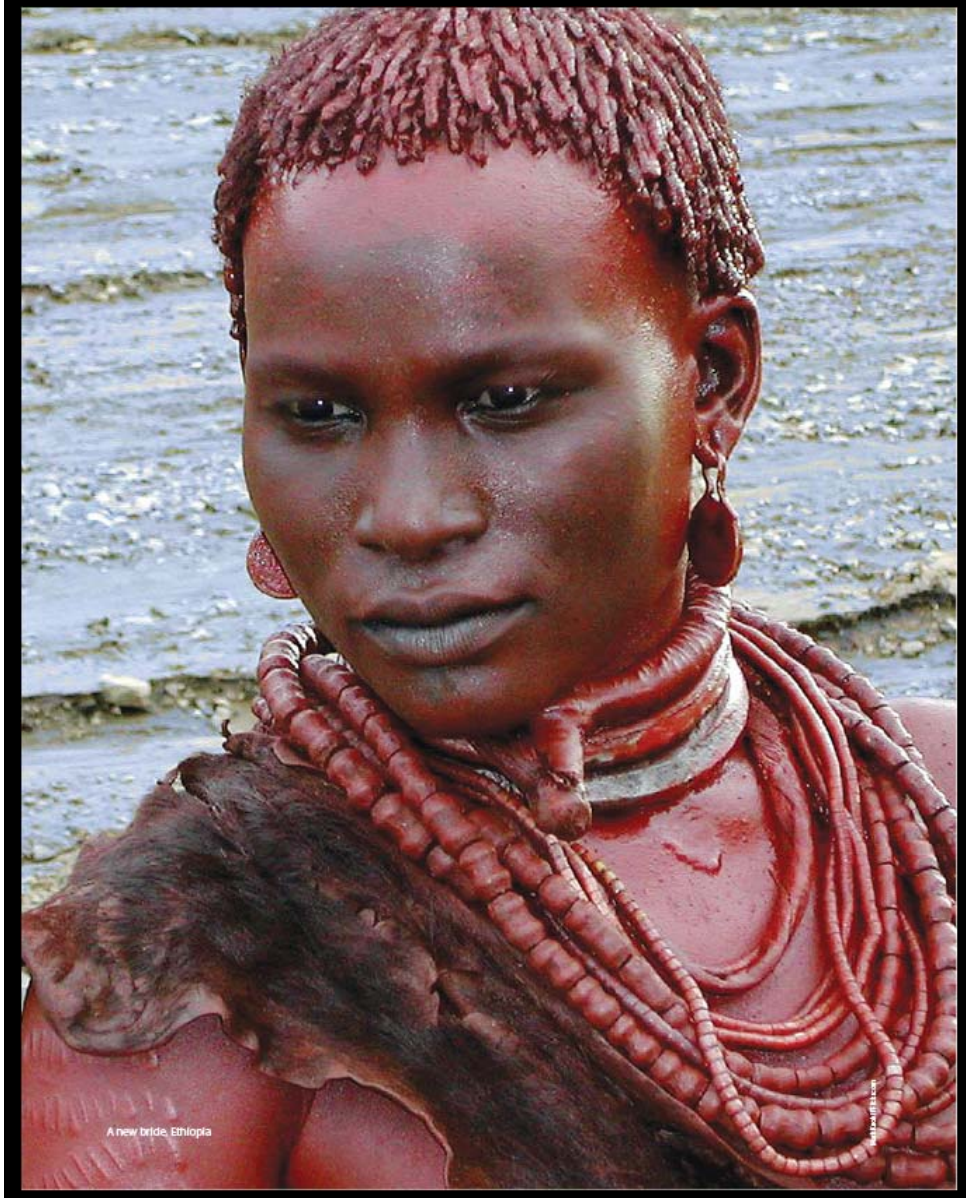
UNEP

Questions addressed

- **What is status and trend of environment in Africa?**
- **What are transboundary issues which needs international cooperation?**
- **What are important environmental issues in each of African Countries?**
- **What progress countries have made towards MDG7: Environmental Sustainability?**
- **What are "scientific evidence" of significant local environmental changes in countries?**
- **What are some interesting facts and figures about African countries?**

Africa Atlas :Vital Statistics

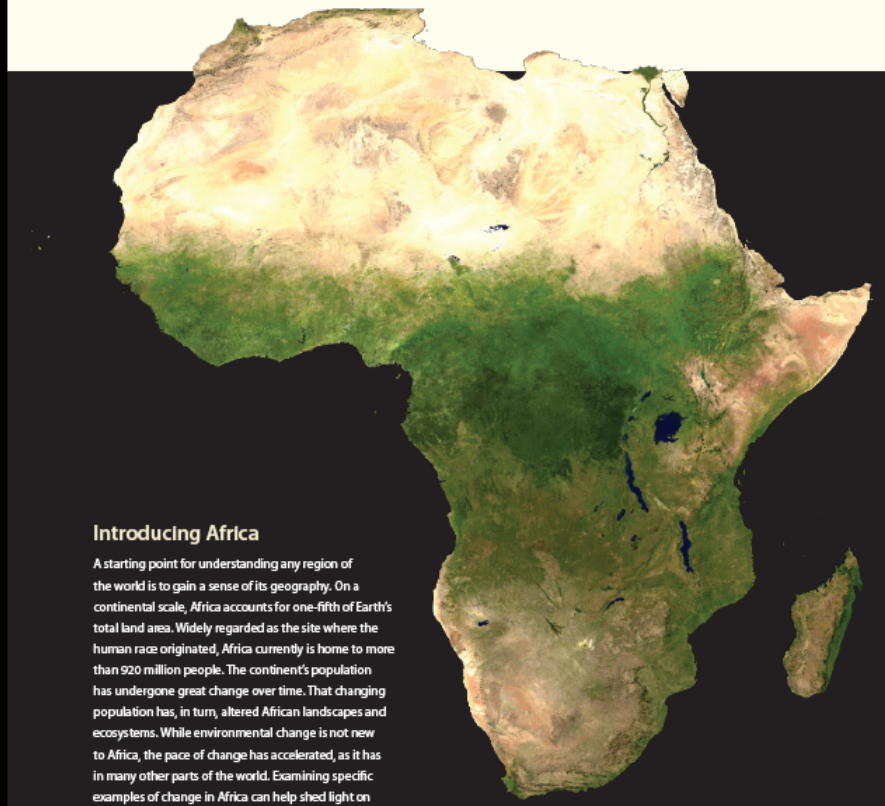
- **390 pages**
- **123,000 words**
- **316 Satellite images**
- **104 locations of environmental changes**
- **319 Ground photos**
- **151 Maps**
- **Printed in English and French same time**
- **All materials are non copy-righted, available for free use**



A new bride, Ethiopia

Chapter 1

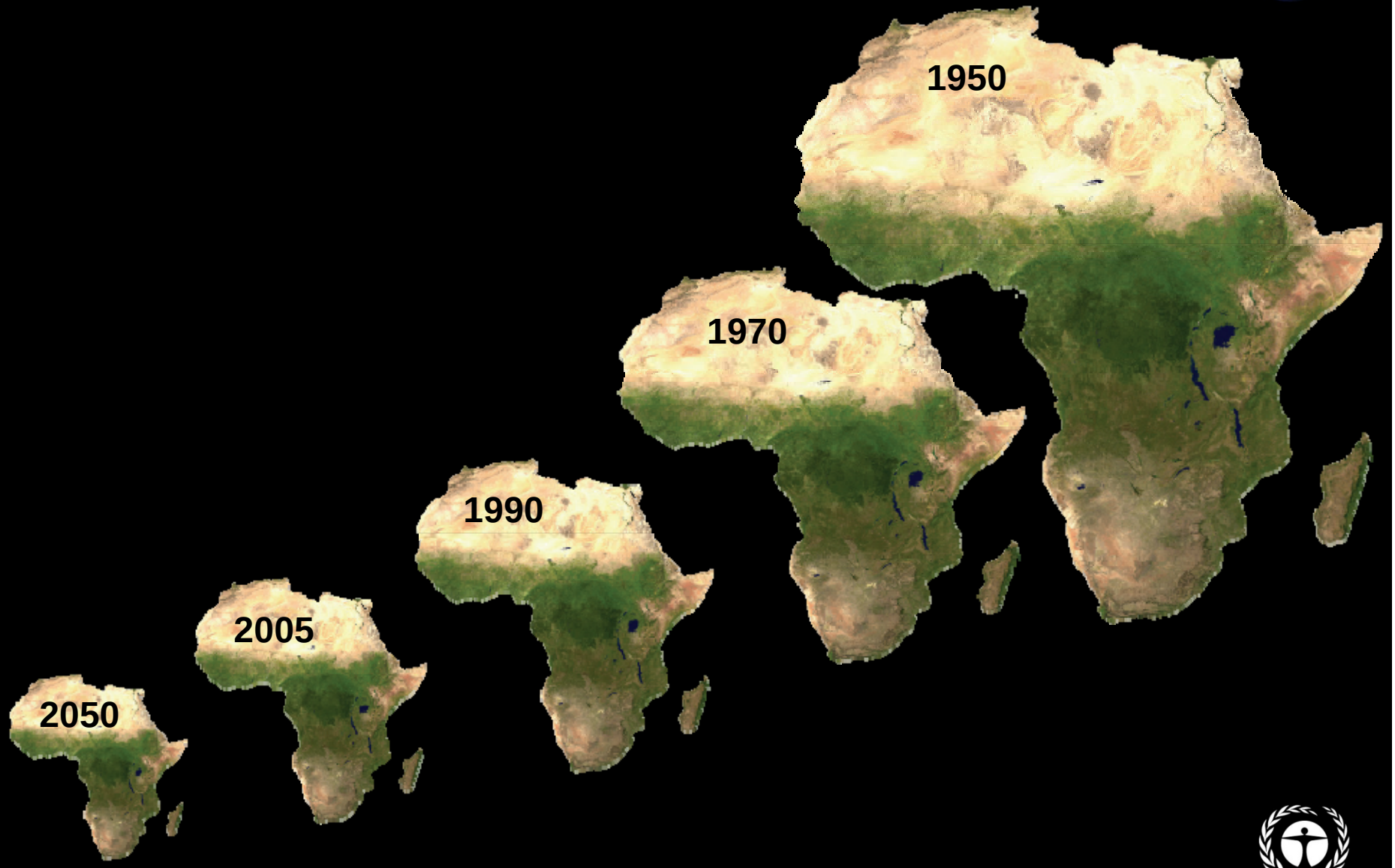
Africa—The Continent



Introducing Africa

A starting point for understanding any region of the world is to gain a sense of its geography. On a continental scale, Africa accounts for one-fifth of Earth's total land area. Widely regarded as the site where the human race originated, Africa currently is home to more than 920 million people. The continent's population has undergone great change over time. That changing population has, in turn, altered African landscapes and ecosystems. While environmental change is not new to Africa, the pace of change has accelerated, as it has in many other parts of the world. Examining specific examples of change in Africa can help shed light on both the causes of change and possible solutions to the problems that change can engender. Earth observations, particularly those made using the tools of satellite remote sensing, are essential to such an endeavour.

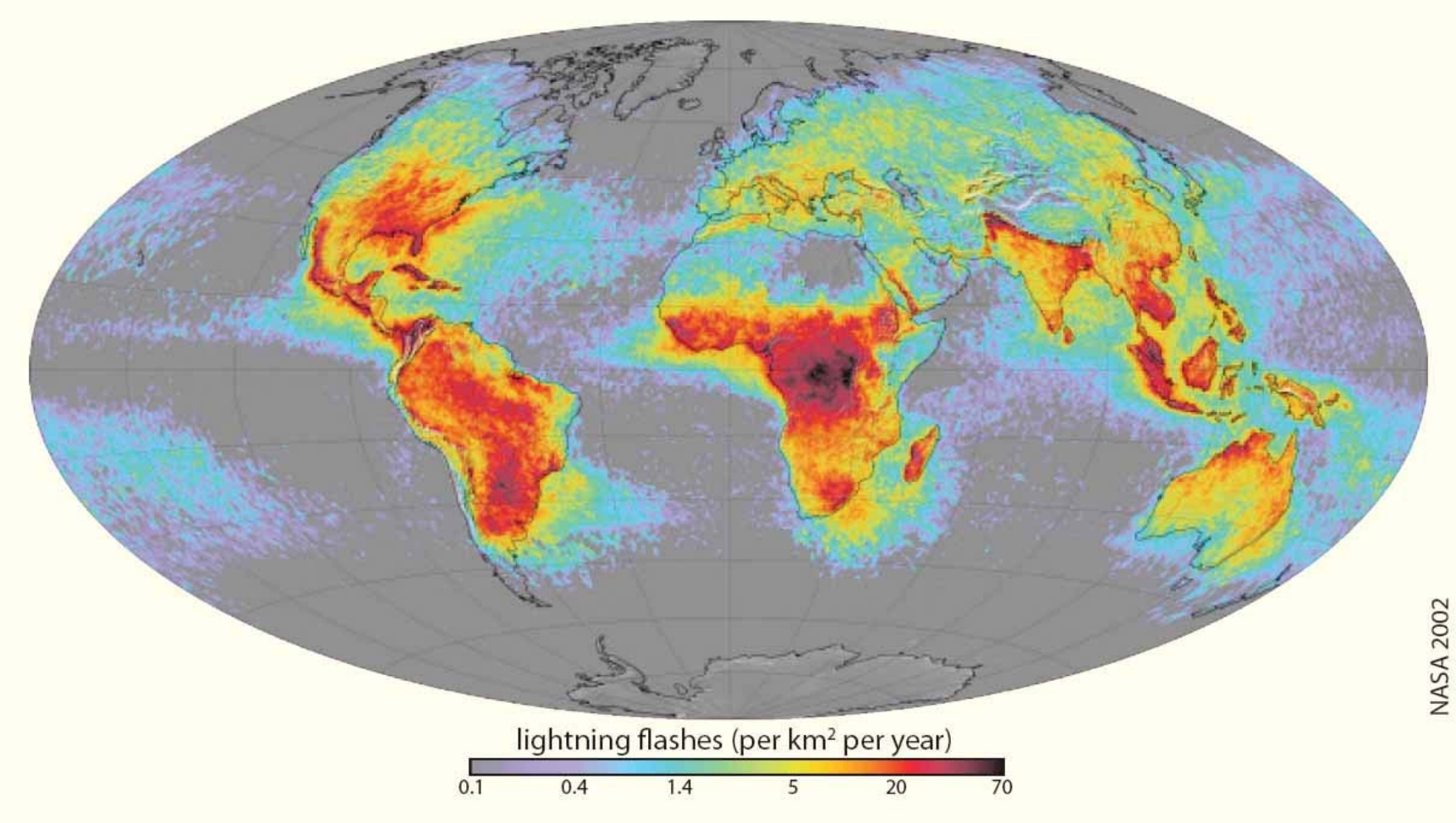
AFRICA's Shrinking land base



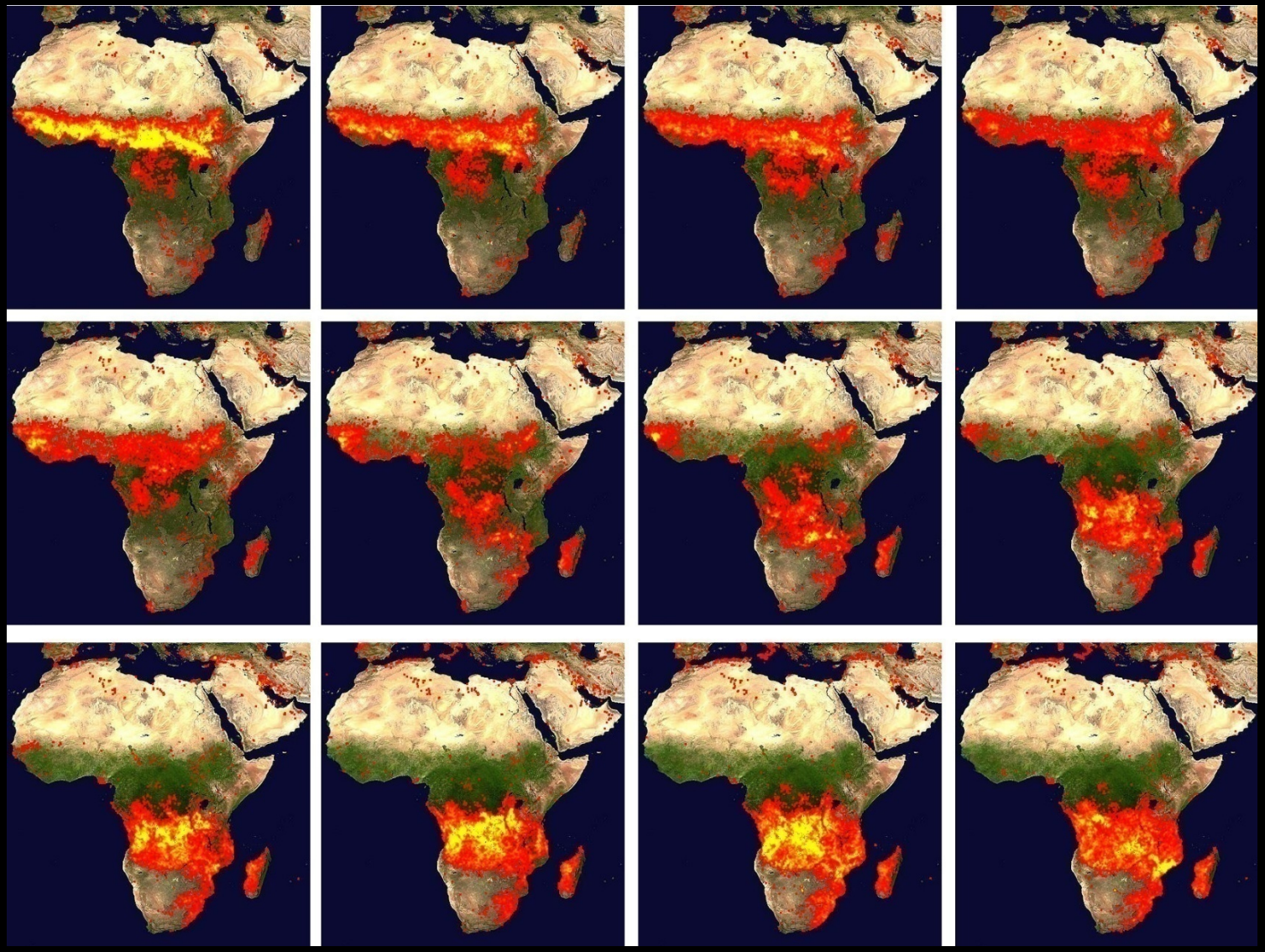
AFRICA: Atlas of our Changing Environment

UNEP

Africa - Lightning Centre of the World



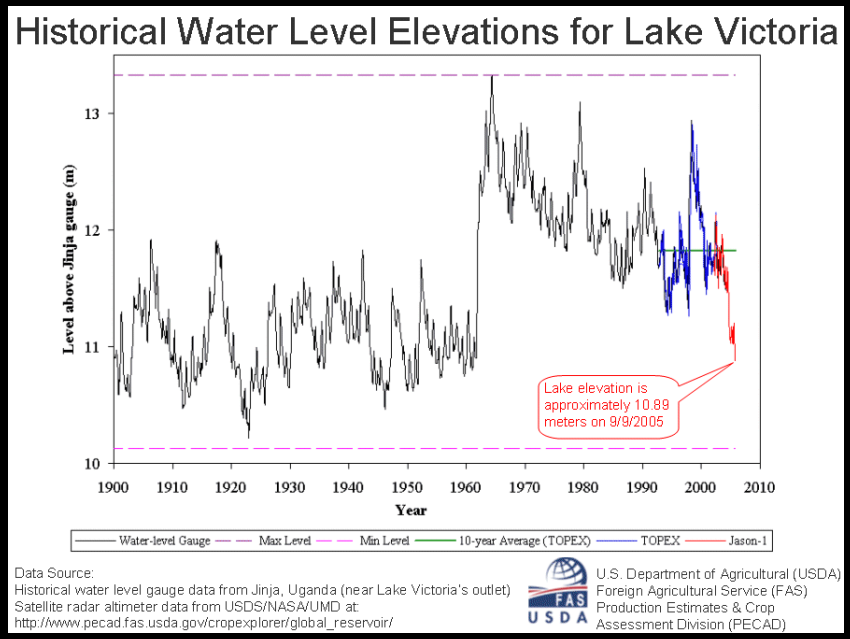
Seasonal Pattern of Wildland Fires

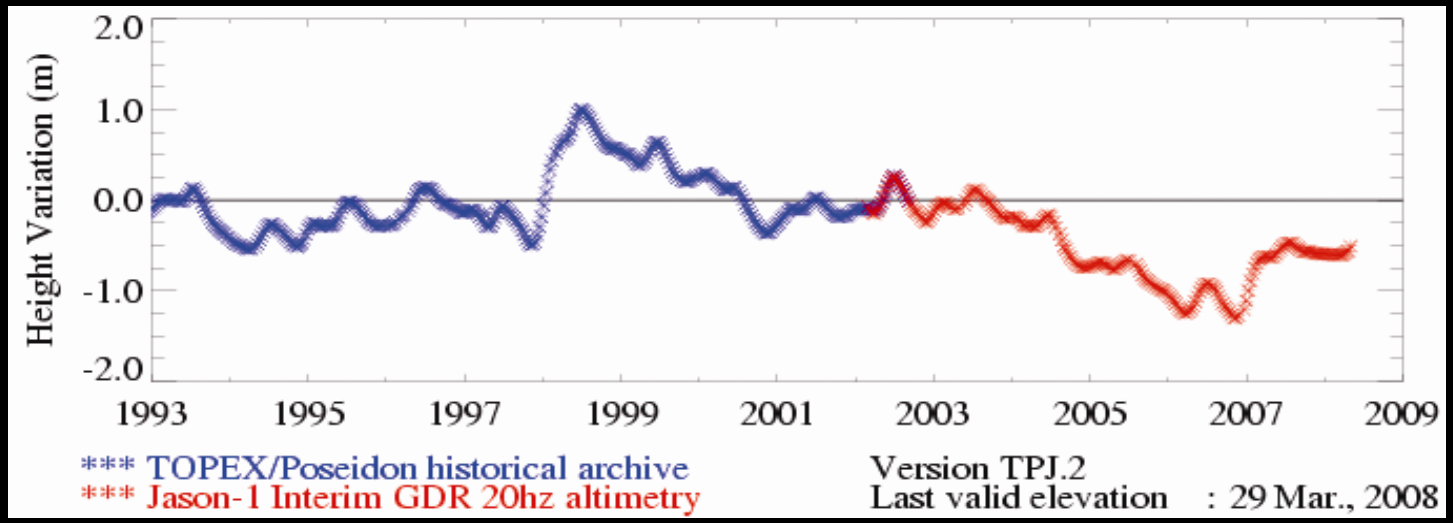


Falling water level in Lake Victoria

Lake Victoria

- ✓ Since December 2005, water levels dropped to alarmingly low levels
- ✓ Current water levels in Lake Victoria are below normal and the lowest level since September 1961
- ✓ The lake is a crucial resource to the more than 30 million people

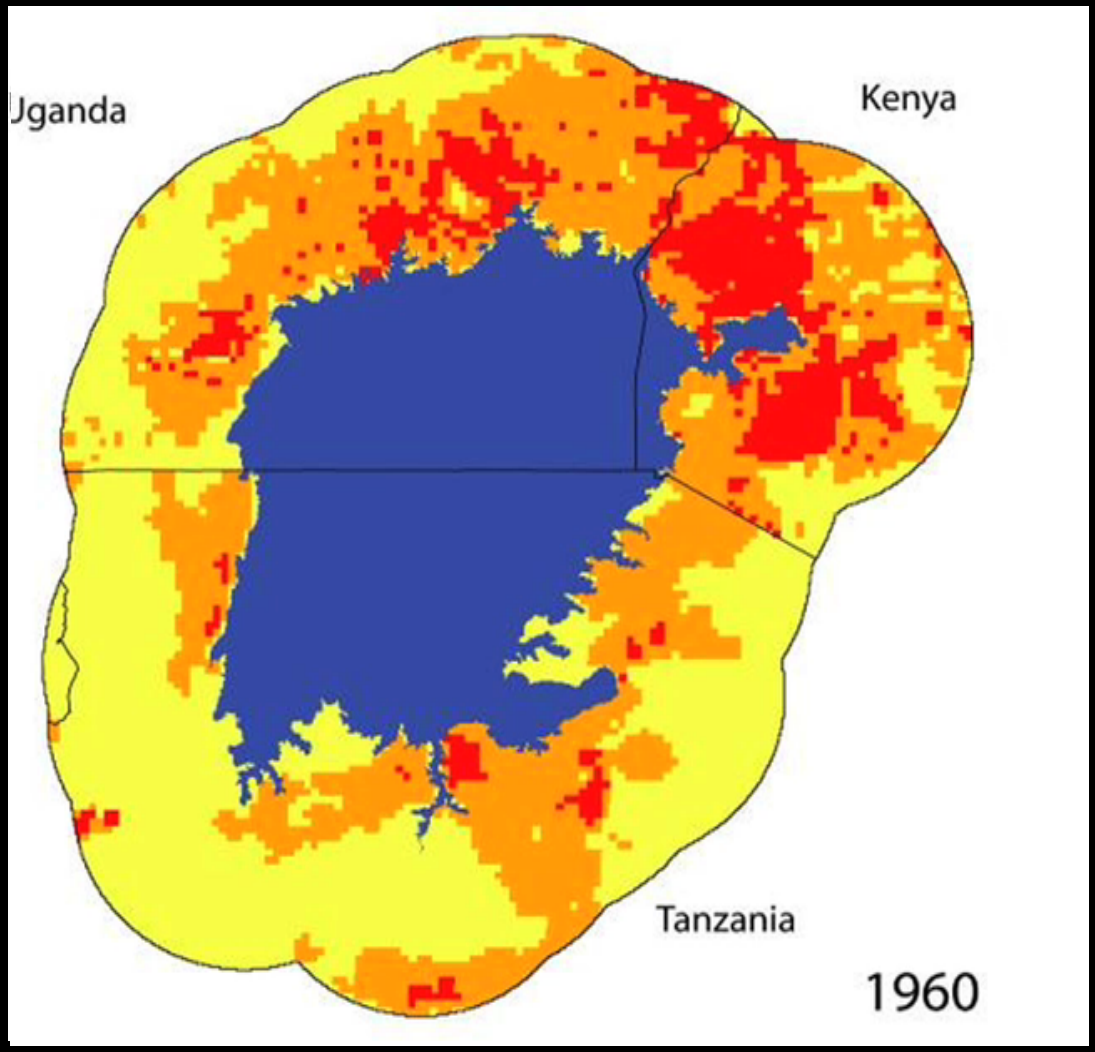




UNEP

Population growth around 100 km lake Victoria

Lake Victoria: Africa's Largest Freshwater Lake



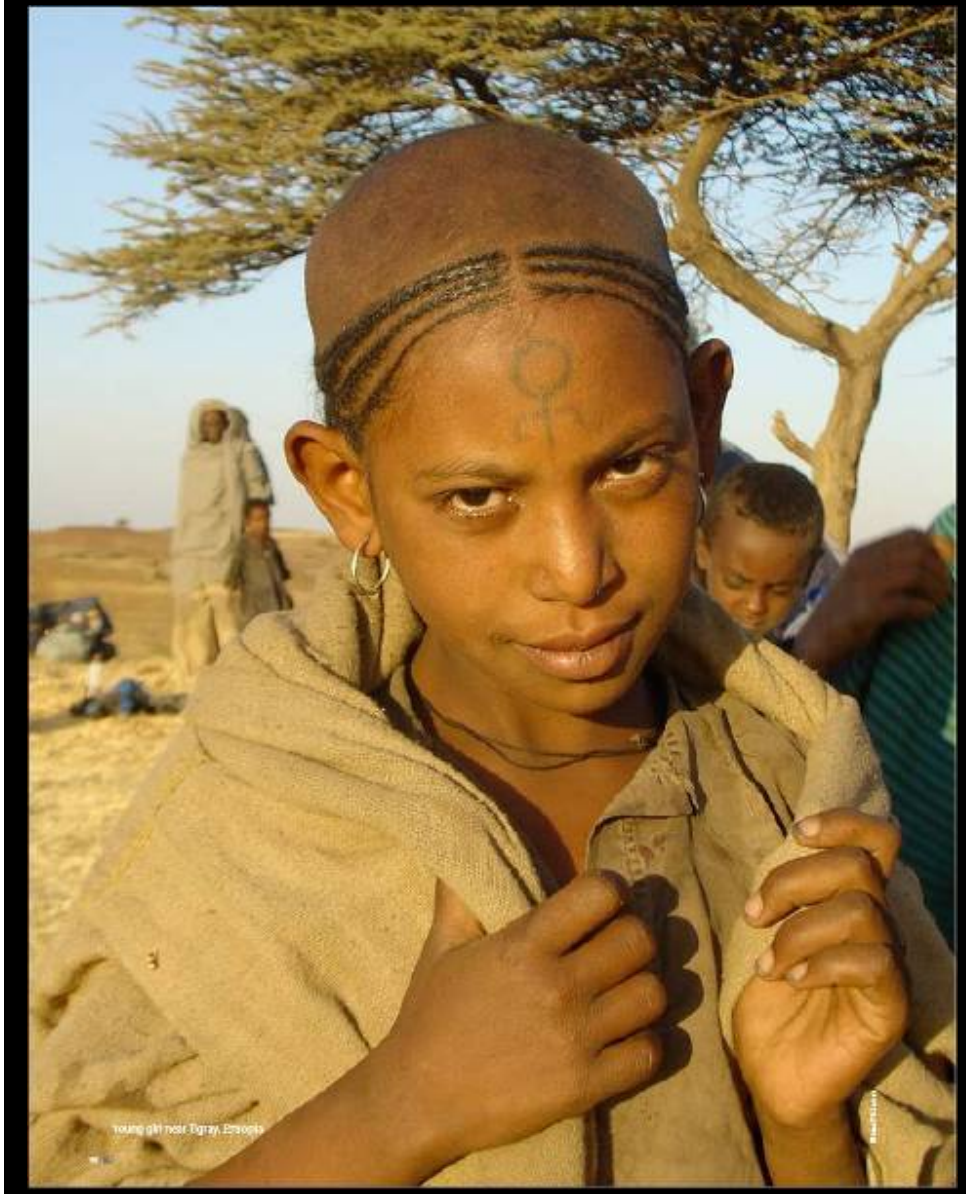
- Population growth around Lake Victoria, East Africa, is the highest in Africa

Population Density
(people / km²)
High (>100)
Medium (25-100)
Low (<25)

movie

AFRICA: Atlas of our Changing Environment

UNEP



Chapter 2 Transboundary Environmental Issues

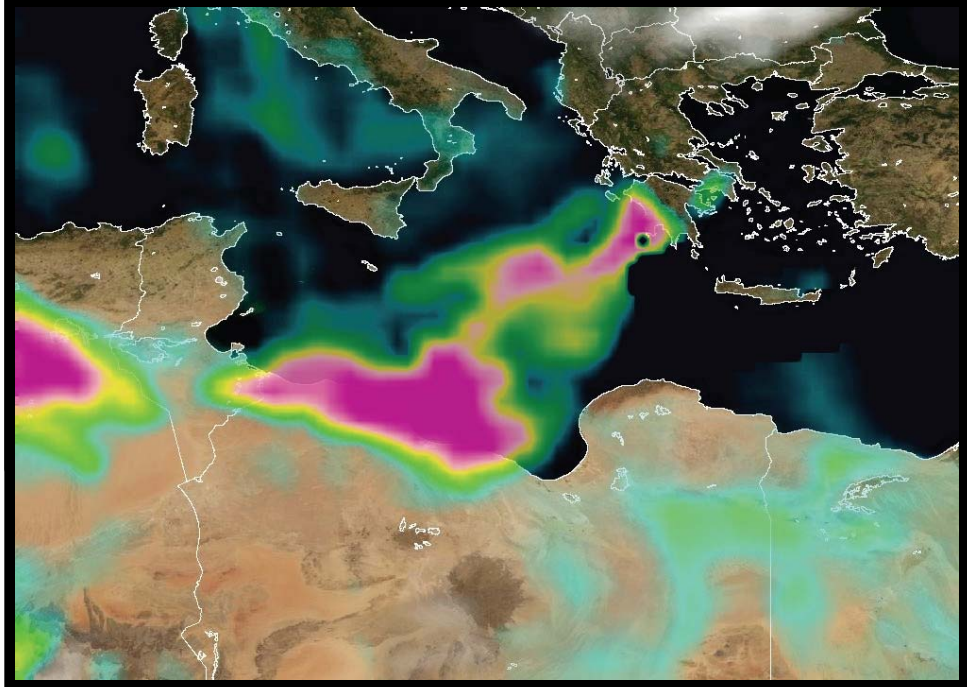
Across Country Borders

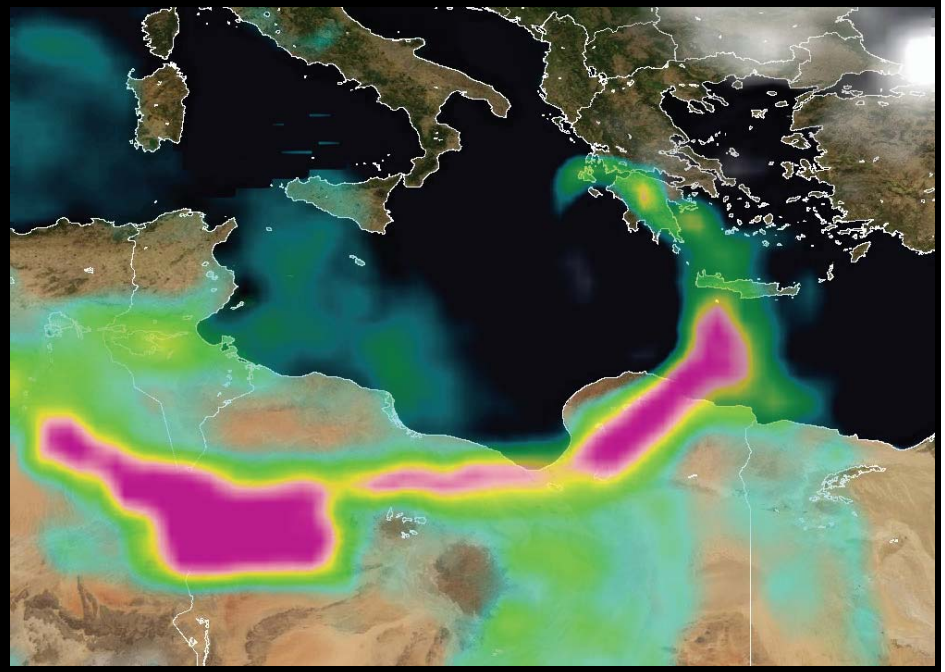
Politically, the African continent is divided into 53 countries and one "non-self-governing territory." Ecologically, Africa is home to eight major biomes— large and distinct biotic communities— whose characteristic assemblages of flora and fauna are in many cases transboundary in nature, in that they cross political borders. Most of the continent's major rivers and many of its large bodies of water are also transboundary features of the landscape. For example, nine countries lie within the Congo River basin and ten countries share the Nile River basin (FAO 1997). The transboundary nature of these and many other ecosystems, together with the natural resources they contain, is the source of diverse environmental issues and presents unique management challenges throughout Africa and, in some cases, beyond the continent itself.

Chapter 2, a look at transboundary issues.

Transboundary Movement of Pollutants

Smoke Spreading From Greece to Africa in 2007





Chapter 3

Tracking Progress Towards Environmental Sustainability

United Nations Millennium Development Goals

The Millennium Declaration

In September 2000 147 heads of State and Government, and 189 nations in total, in the United Nations Millennium Declaration committed themselves to making the right to development a reality for everyone and to freeing the entire human race from want. They acknowledged that progress is based on sustainable economic growth, which must focus on the poor, with human rights at the centre. The objective of the Declaration is to promote "a comprehensive approach and a coordinated strategy, tackling many problems simultaneously across a broad front."

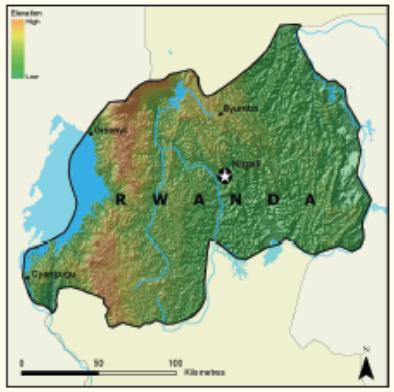
The Declaration calls for halving by the year 2015, the number of people who live on less than one dollar a day. This effort also involves finding solutions to hunger, malnutrition and disease, promoting gender equality and the empowerment of women, guaranteeing a basic education for everyone, and supporting the Agenda 21 principles of sustainable development. Direct support from the richer countries, in the form of aid, trade, debt relief and investment is to be provided to help the developing countries.

Millennium Development Goal Seven: Ensure Environmental Sustainability

Republic of Rwanda

Total Surface Area: 26 338 km²
Estimated Population in 2006: 9 230 000

Rwanda is a small, mountainous country located only a few degrees south of the equator, but its high elevation provides for a tropical temperate climate with two rainy and two dry seasons. Terrain is dominated by the hills and valleys of the central plateau, which are bordered to the east by marshy lowlands, to the north by a chain of volcanoes, and to the west by a mountain system that forms the boundary between the watersheds of the Nile and Congo River Basins. Surface water is relatively abundant in Rwanda, covering over eight per cent of the country (FAO 2005).



Important Environmental Issues

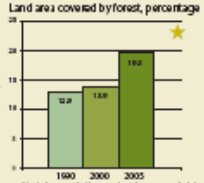
- Population Pressure on Land
- Soil Erosion and Sedimentation
- Deforestation and Threats to Biodiversity

Progress Towards Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

The slum population in Rwanda has seen an increase between 1990 and 2001, alongside an urban population growth rate of 4.2 per cent from 2000 to 2005. Rwanda is the most densely populated country in mainland Africa. Rwanda's protected area increased by 3.7 per cent between 1990 and 2005. Volcano National Park is one of the last existing habitats of the mountain gorilla.

Land area covered by forest, percentage



Carbon dioxide (CO_2) emissions, metric tonnes per capita

★ Indicates progress

Protected area to total surface area, percentage

Proportion of total population using improved drinking water sources and sanitation facilities, percentage

Slum population as percentage of urban

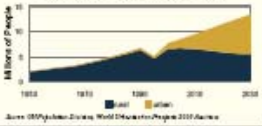
Nyungwe National Park is the largest block of montane forest in East and Central Africa, and among the largest on the continent.

Population Pressure on Land

Rwanda is the most densely populated country in mainland Africa. Rwanda's current population density is 382 people per square kilometre (Earth Trends 2006, FAO 2005a). Approximately 80 per cent of the population is rural and engaged in agriculture, placing significant pressure on land resources and biodiversity. Modification and destruction of natural ecosystems for agriculture, and particularly the drainage and reclamation of wetlands, has resulted in the loss of many plant and animal species. An estimated 115 different plant species are threatened with extinction (CBD 2005).

As a result of a declining availability of arable land, the urban population is increasing by nearly 12 per cent per year, the highest urbanization rate in Africa (UNESA 2006). Nearly nine out of ten urban residents in Rwanda are slum dwellers, where access to improved sanitation facilities barely exceeds 50 per cent (UN 2007).

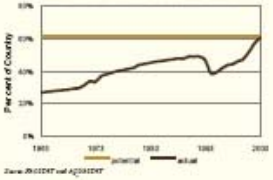
Population Growth and Urbanization



Soil Erosion and Sedimentation

Rwanda's rich volcanic soils are historically fertile, but population pressure has resulted in over-cultivation and expansion onto marginal lands and steep slopes. As of 2003, arable land accounted for over half of the country's surface area and approximately 98 per cent of all potentially cultivatable land in the country (FAO 2006b). An estimated 71 per cent of land is considered to be severely degraded (FAO AGL 2003) and approximately 500 metric tonnes of soil are lost to erosion each year, an amount that could support crops to feed 40 000 people (USAID 2004). Excessive siltation resulting from erosion constitutes a major threat to many of Rwanda's lakes and wetlands.

Actual Versus Potential Cultivatable Land



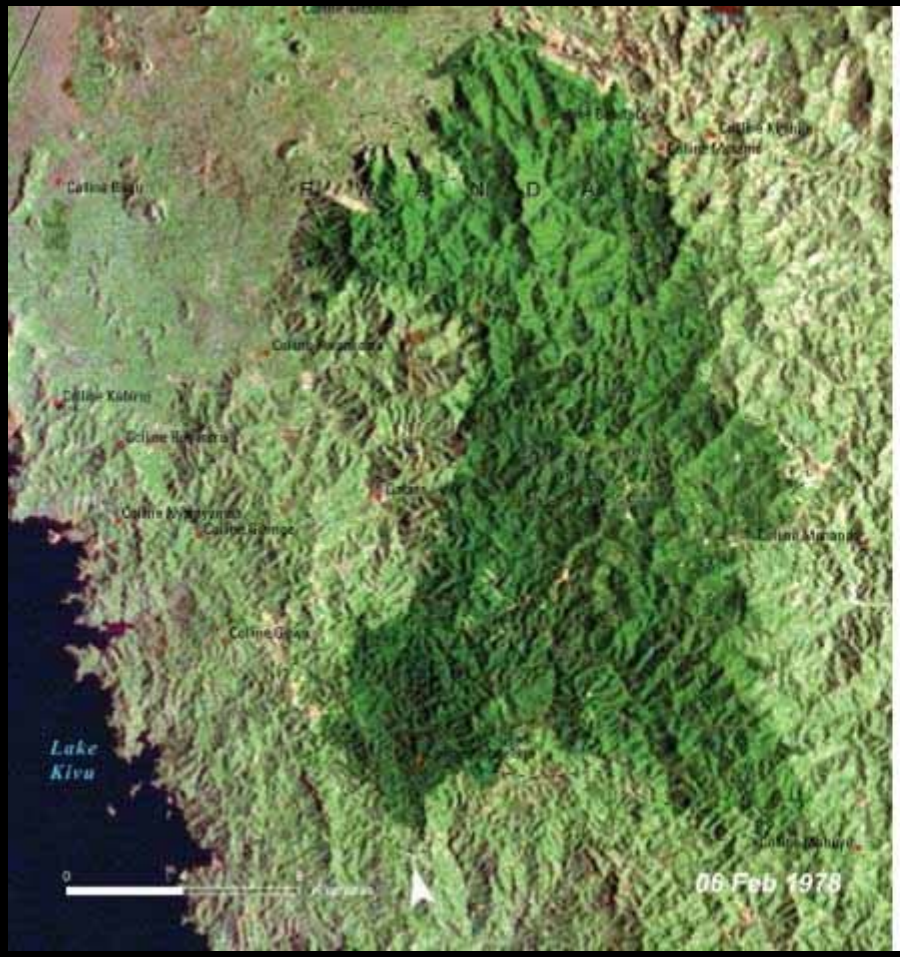
Deforestation and Threats to Biodiversity

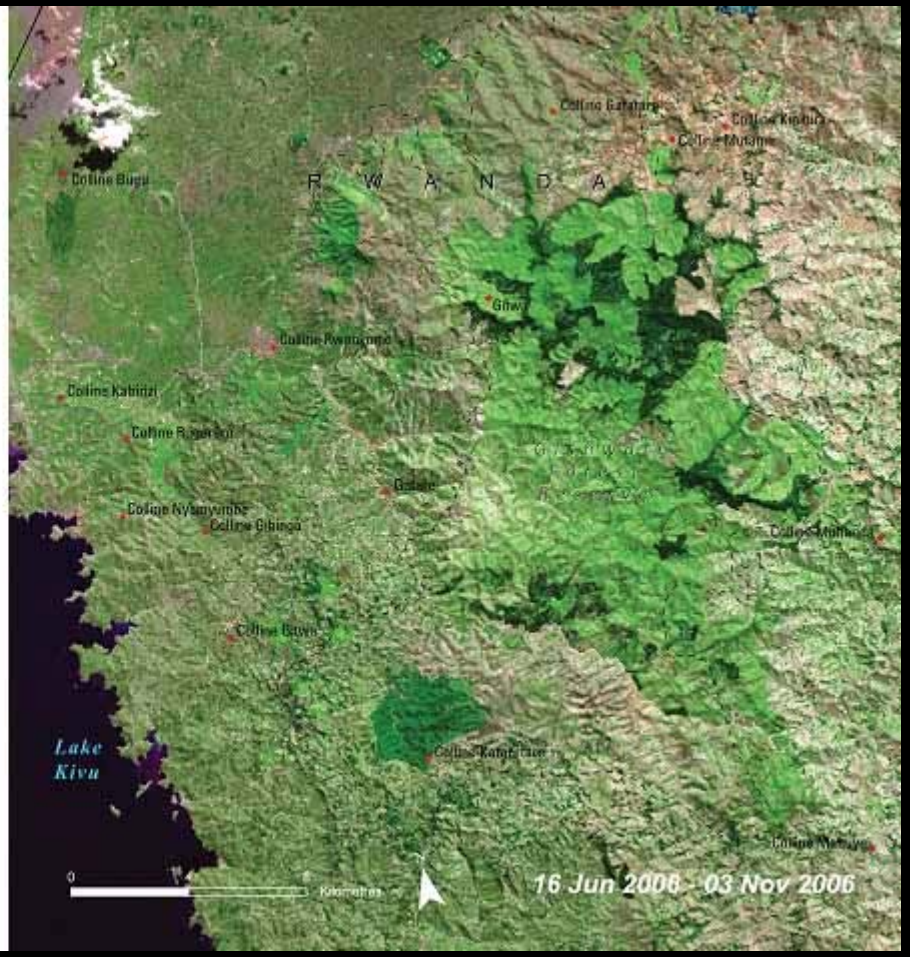
Forests were once extensive throughout Rwanda, but they are now concentrated primarily in the western mountains. The swampy gallery forests that historically characterized the eastern lowlands now exist only in small stands. Despite recording a net increase in overall forest cover since 1990 (UN 2007), natural forests remain threatened by human encroachment and high dependence on fuelwood and charcoal.

Nyungwe National Park is the largest tropical montane forest in Africa, covering over 1 000 km² of rain forest, bamboo, grassland, swamps, and bogs. It harbours 13 different primate species, 62 Albertine Rift endemic species, and one of the largest surviving populations of chimpanzees (WCS 2007). Buffalo and elephants have been extirpated due to human encroachment and illegal poaching, and fires started by honey collectors have damaged large tracts of forest.

Fuelwood Production

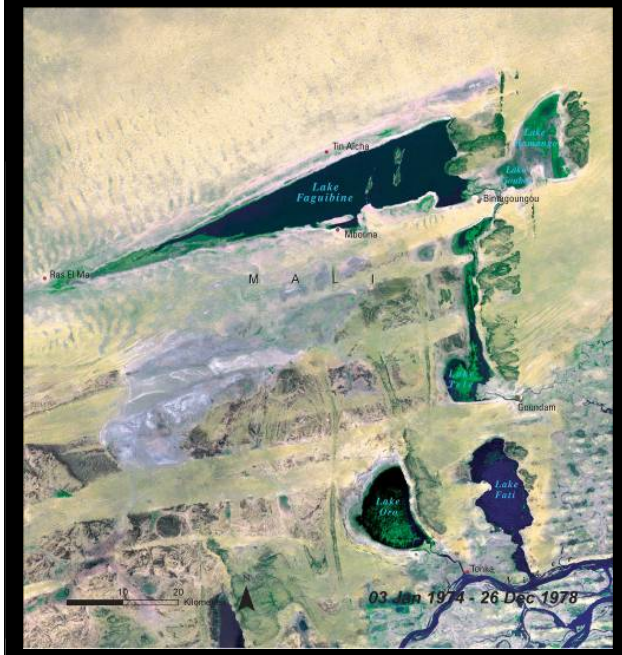
Dramatic Deforestation: Gishwati Forest, Rwanda

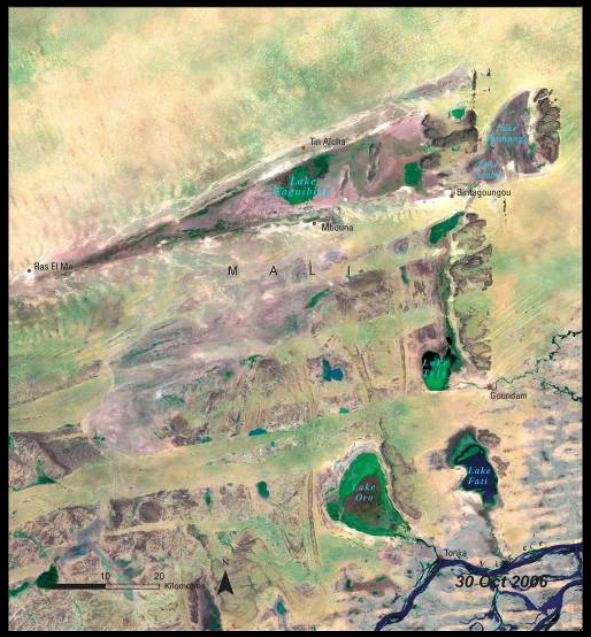




Republic of Mali

The Drying Up of Lake Faguibine



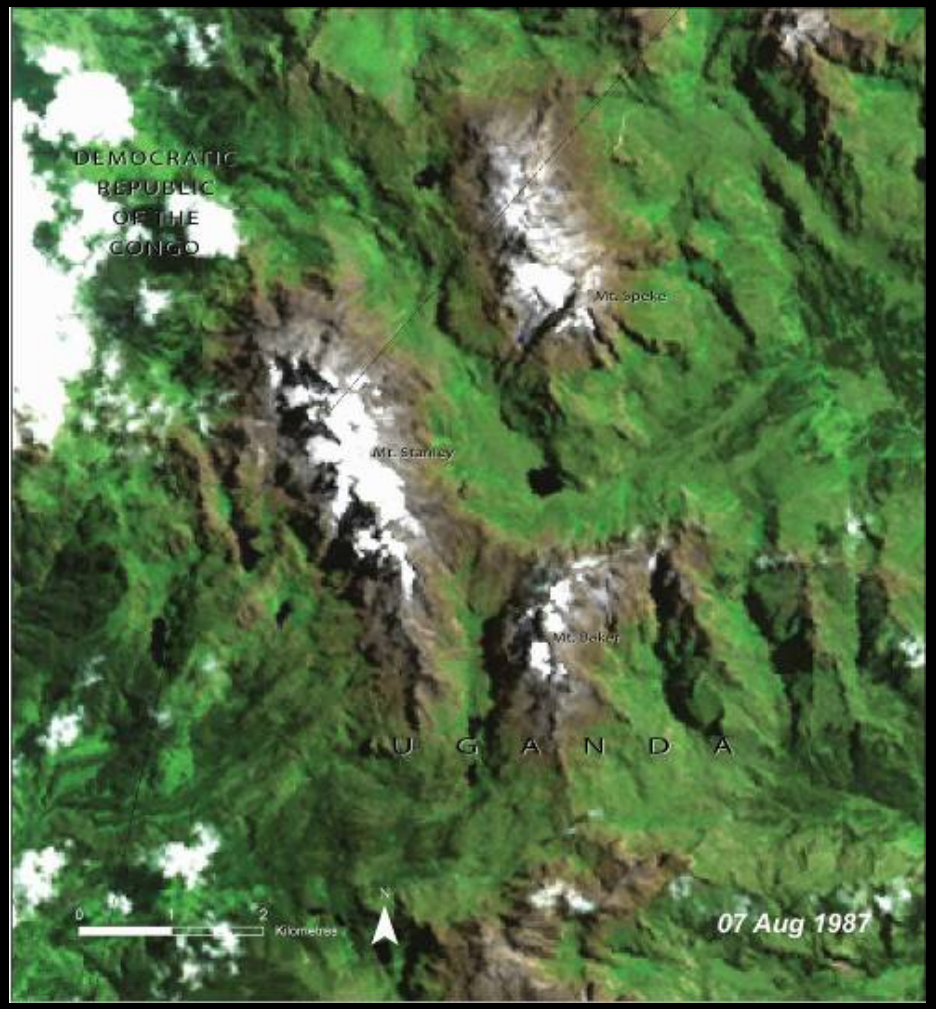


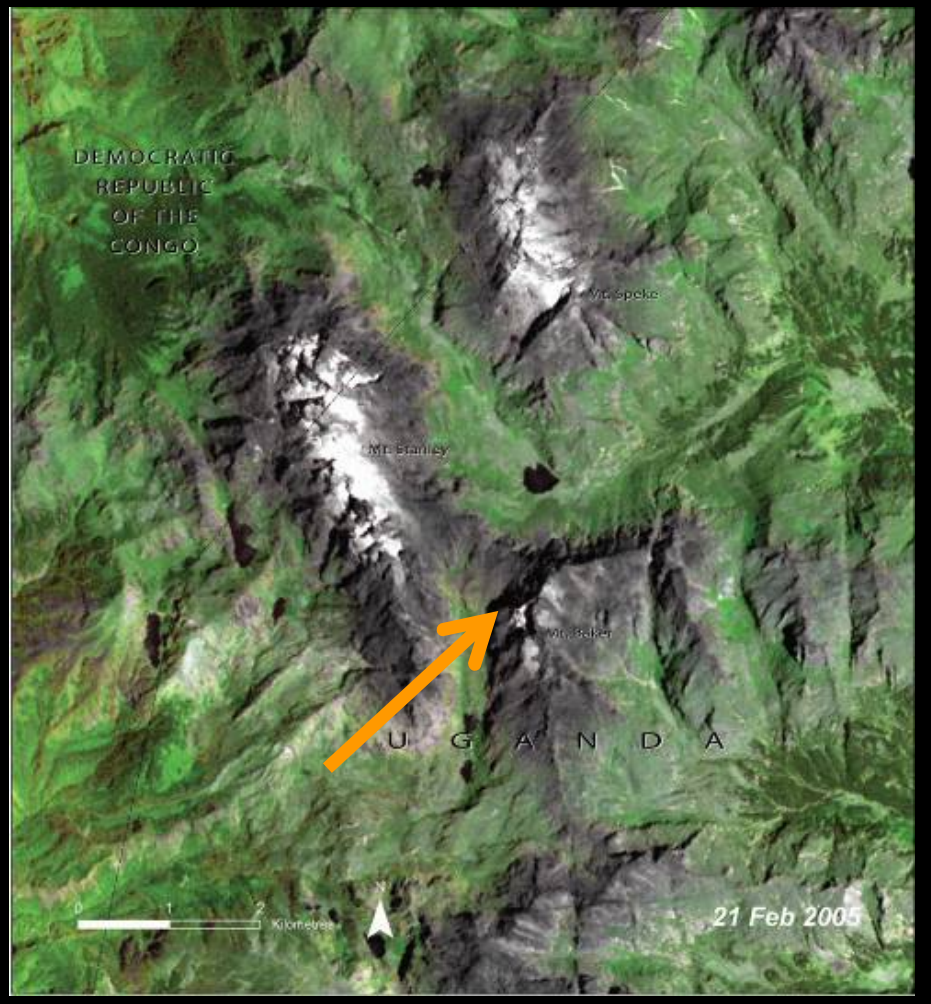
Water levels have fluctuated widely in Lake Faguibine since the beginning of the 20th century

In the late 1980s, an extended period of reduced precipitation led to a complete drying up of the lake in the 1990s

As global warming intensifies, there may be more change in store for the people who depend on water resources such as Lake Faguibine for their livelihoods

Melting Glaciers: Rwenzori Mountains,Uganda





Glaciers declined by 50% between 1987 and 2003

AFRICA: Atlas of our Changing Environment

UNEP

Wetlands restoration around Diawling National Park: Mauritania

Launch on Google Earth

- **Web version (http://na.unep.net/), blogs**

- **Release on Google Earth "UNEP Atlas of our changing environment" on 4th September (300 million users)**

(National Geographic Magazine started in 1890 has 10 millions circulation; GE started in 2005 has 300 million users)

- **4000 CDs, Mouse pads, Screen server, Powerpoint etc…**

- **Capacity building training workshops in Africa on ecosystem change monitoring and data visualization for decision making…**

Challenges in selecting sites

• How do we know what significant environmental changes taking place and where?

1- Wall to wall mapping of the whole country and change analysis

Too expensive ; time consuming and outdated by the time completed

2 - Sampling strategy

Good for deriving quantitative figures

3- Focus on hotspots and gathering information from multiple sources

- Literature search, journal and media article
- Personal knowledge
- Suggestions from local institutions, visiting scientists
- Google Earth
- Availability of cloud free high quality current and historical images
- Compelling story line and visuals with significant changes

Challenges

- Technical capacity exists but enabling environment is lacking; (refer to success of mobile phones);

- Access and use of earth observations is still too complicated and expensive;

- Fusion of EO and GIS is critical but simple user interfaces are needed;

(ERDAS, or ENVI + ArcGIS + Adobe Photoshop/Illustrator)

- Access to Broadband Internet for data download is a major handicap ; better data compression techniques needed;

- Packaging and communication (Natural color versus FCC) of policy relevant information is needed .i.e. linkages with MDGs, Poverty Reduction Goals, Food Security etc…

Grand Challenge

A comprehensive capability is needed to pull together and analyze the rich data collections available from multiple sources i.e. economic, social, cultural and environmental-and present results which both specialists and non-specialists can comprehend

Challenges in Knowledge visualization

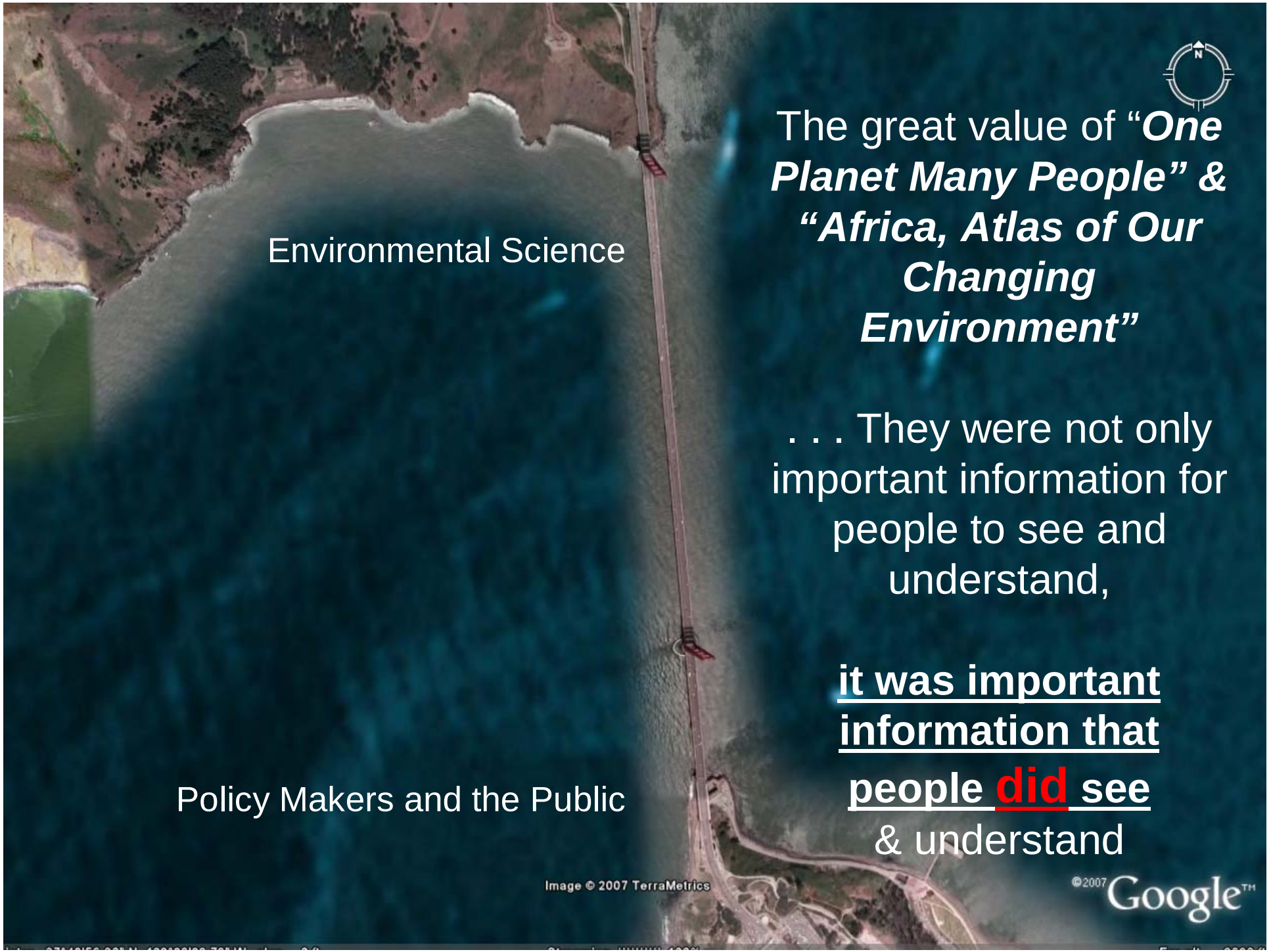
The Parsons Institute for Information Mapping (PIIM) established in 2002 in New York is a one-of-a-kind university research and real-world development facility within The New School — a global university.

Co-founded by Former Senator Robert Kerrey (D-NE), PIIM's core mission is to discover and promote new ways for people to rapidly understand, analyze and respond to large amounts of complex data.

He Came

He Saw


United Nations Millennium Development Goals (MDGs)
AFRICA
GEO4



The great value of "***One Planet Many People" & "Africa, Atlas of Our Changing Environment"***

. . . They were not only important information for people to see and understand,

it was important information that people did see & understand

THANK YOU