e on Earth Observation Satellites

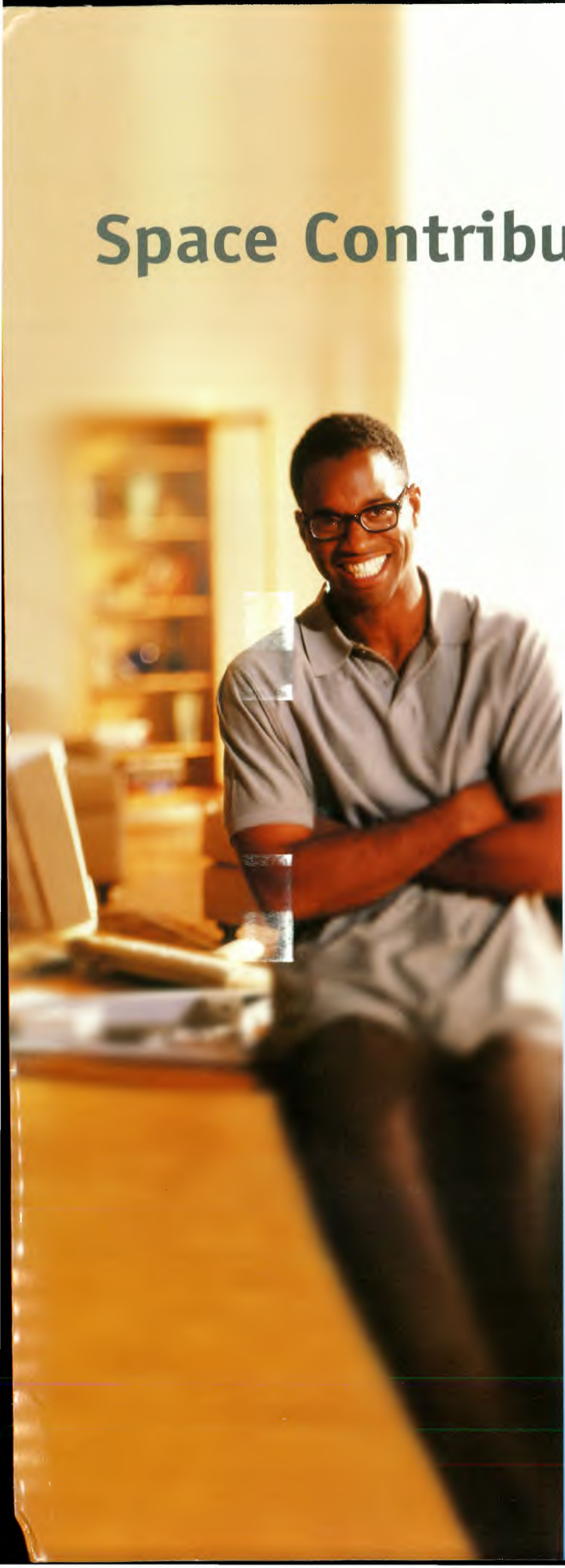
Fact Sheets

ble Development
The Space Contribution

Fact Sheets

Sustainable Development
The Space Contribution

Committee on Earth Observation Satellites



Space Contributes to Build a Better Future

To find out how space can help you in your daily work – please have a look at these fact sheets!

Poverty Eradication and Sustainable Livelihoods

Protecting and Managing the Natural Resource Base

Sustainable Development Initiatives for Africa

Sustainable Development of Small Island Developing States

Copies of the fact sheets can be obtained from:
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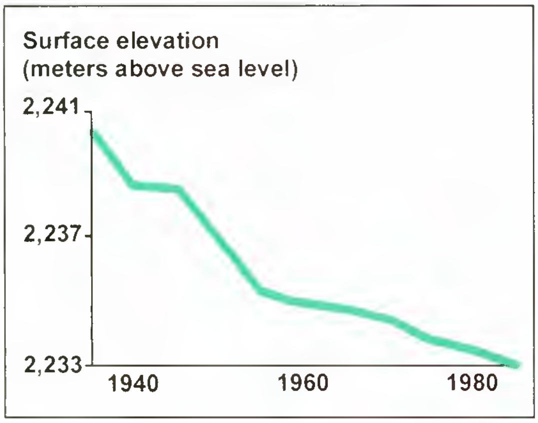
8-10, rue Mario Nikis, 75738 Paris Cedex 15, France
http://www.esa.int mailcom@esa.int

Combating Poverty and Promoting Sustainable Livelihoods

Continuous land subsidence poses a major threat to buildings and transport structures. The sinking of Mexico City is among the most remarkable cases in the world.

1. **Subsidence in Mexico City**



Courtesy of WRI

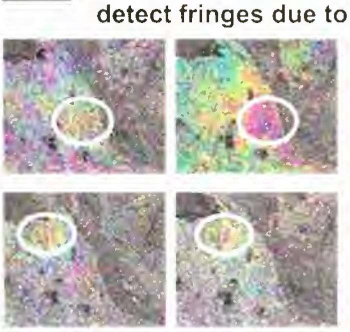
The graph in image 1 shows that Mexico City has sunk by an average of 7.5 meters in the period from 1930 to 1980. This sinking is caused by heavy ground water pumping.

In order to avoid further damages, plan new structures and manage a rational aquifer supply, the implementation of systems that continuously monitor subsidence is needed.

Differential interferometry from ERS and RADARSAT satellite data is an operational technique to map subsidence in urban areas at high accuracy and low costs. Thus vertical movements of a few millimetres from 800 kilometres above can be identified. Images 2 and 3 illustrate Hanoi and Mexico City areas of little subsidence in blue; areas with larger displacements are shown in yellow, purple and red - according to the scale of subsidence.

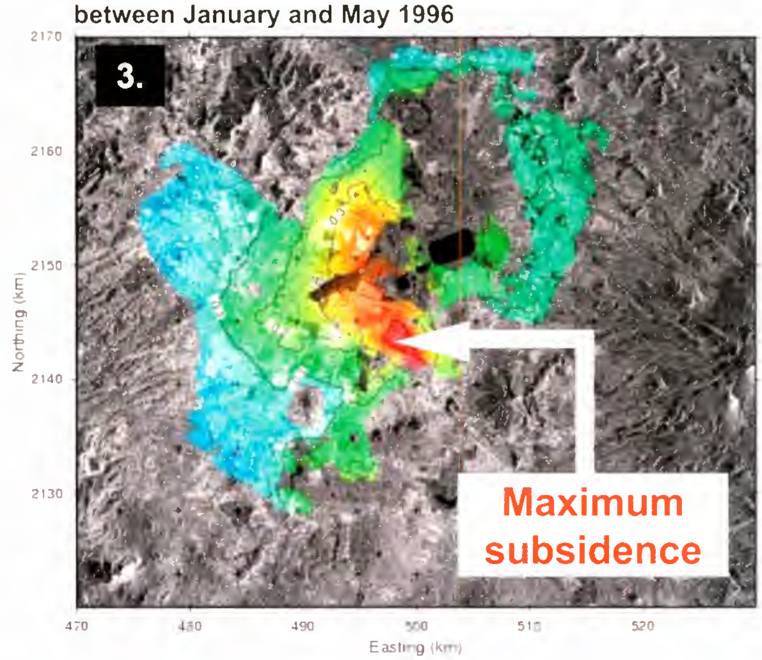
In Mexico City satellite data helped to identify maximum sinking velocities of up to 47 cm/year.

2. **Hanoi: Extracts of interferograms built to detect fringes due to subsidence**



Courtesy of MegaCities: ESA

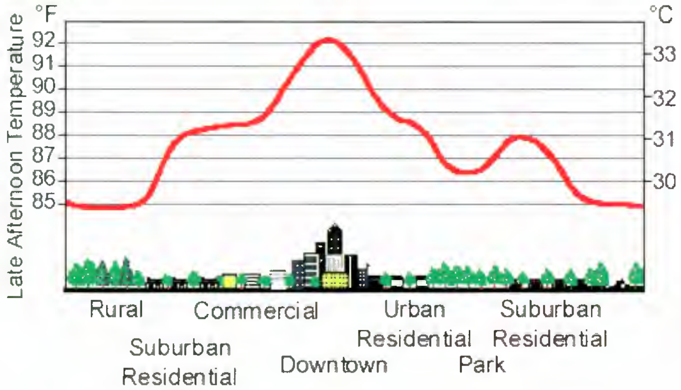
Land subsidence rate (in m/year) in Mexico City between January and May 1996



Courtesy of Gamma Remote Sensing; ESA

On summer days, urban air temperatures can be 1 to 5°C higher than in the surrounding countryside. This effect is referred to as the "urban heat island" (United States Environmental Protection Agency).

1. **Urban heat island profile**



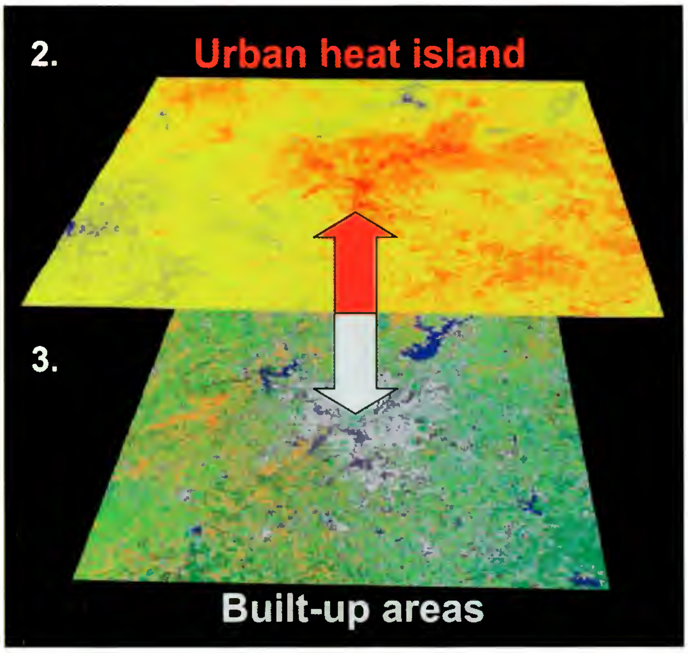
Courtesy of US - EPA

The graph in image 1 shows the profile of this increased ambient air temperature in cities. The urban heat-island effect is mainly caused by

- limited vegetation cover and few open water areas in cities and/or
- solar heat absorption enhanced by building walls, lacking air circulation and human heating sources.

In warm regions and seasons, urban heat islands can have adverse effects on citizens and the environment. Results are increased near-surface ozone levels as well as increased energy consumption for air-conditioning.

Thermal infrared data provided by satellites such as LANDSAT enable mapping of the urban heat island at an intermediate scale. In combination with ground reference data this information from satellite data is a useful input into urban planning (e.g. allocation or conservation of open spaces to maintain, enable or improve the air circulation in cities).



Courtesy of NASA; USGS

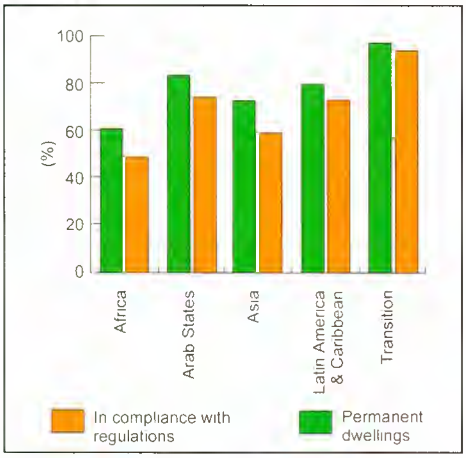
Images 2 and 3 are LANDSAT-derived temperature and land cover information layers of Atlanta (Georgia).

The image of the thermal channel (image 2) shows that hot areas (red) correspond with urban built-up areas (grey) in the false-colour data set (image 3).

Combating Poverty and Promoting Sustainable Livelihoods

Two key objectives of the Habitat Agenda are the provision of adequate shelter and the improvement of living conditions in urban areas and environments.

1. **Shelter adequacy in cities**



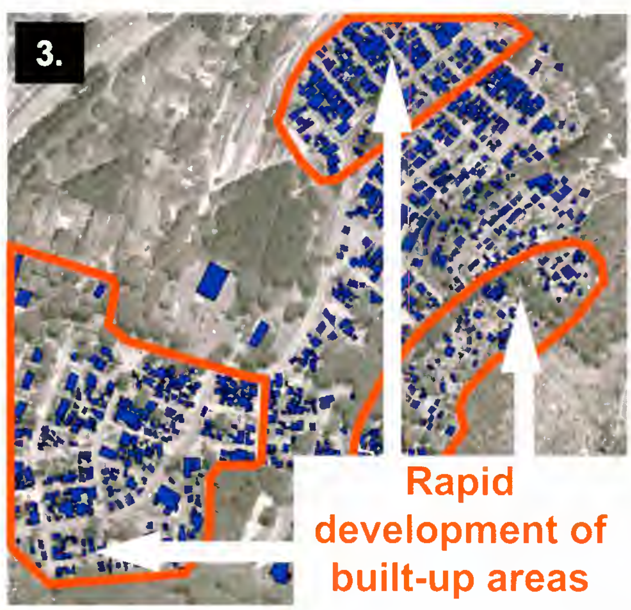
Courtesy of UNCHS

The extent of informal settlements varies from country to country and can comprise 20 to 80% of urban growth – thereby affecting 15 to 70% of the urban population of developing countries (United Nations Centre for Human Settlements – UNCHS, New Delhi Declaration).

The graph in image 1 shows the shelter adequacy in different parts of the world. The example of Africa illustrates that only slightly more than 60% of all urban houses are permanent dwellings on this continent.

Informal settlements are not officially recognized and very often lack adequate access to basic services such as water and sanitation. In order to provide for an improvement of the situation accurate up-to-date spatial data are of crucial importance.

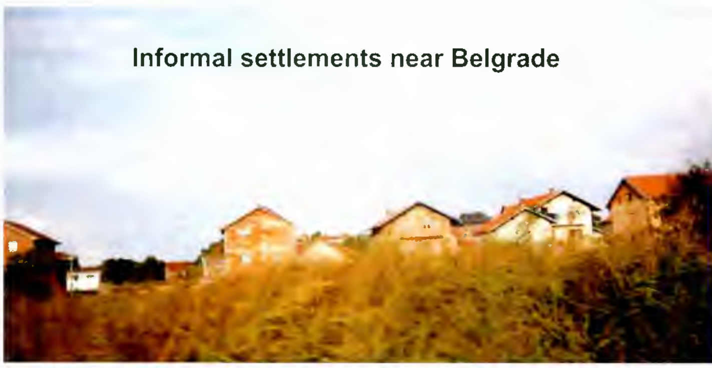
As informal settlements grow and change quite rapidly, terrestrial mapping techniques are neither practical nor economical. Aerial photography and very high resolution satellite imagery (e.g. IKONOS, QUICKBIRD) are therefore appropriate and cost-effective sources for monitoring the expansion of these settlements. The below images show the rapid growth that occurred within three years in the Cape Town Hout Bay area.



Courtesy of Universities of Melbourne, Cape Town and Western Cape; AusAid

Combating Poverty and Promoting Sustainable Livelihoods

Central themes of the Habitat Agenda are secure land tenure and the problem of squatter and informal settlements. The United Nations Centre for Human Settlements (UNCHS) has issued the below data for selected cities illustrating the percentage of households belonging to squatter and informal settlements.



Courtesy of GeoVille

1. **Squatter and informal settlements in selected cities**

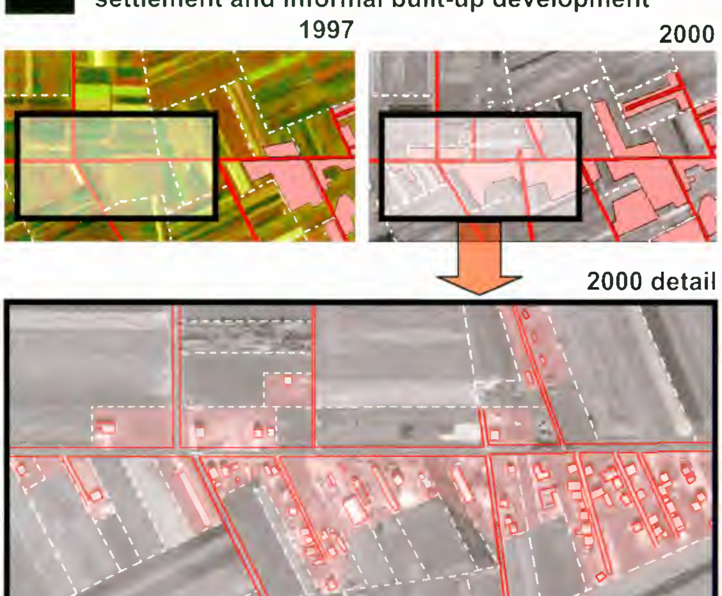
City	Country	Percent of households
Ulaanbaatar	Mongolia	48.40%
Monrovia	Liberia	42.00%
Lima	Peru	18.80%
Bangkok	Thailand	17.90%
San Salvador	El Salvador	9.50%
Buenos Aires	Argentina	5.70%
Belgrade	Yugoslavia	2.30%
Valparaiso	Chile	1.67%
Kuwait	Kuwait	0.80%
Ljubljana	Slovenia	0.10%

Courtesy of UNCHS: The State of the World's Cities Report 2001

Information derived from high-resolution satellite data can assist city administrations to plan new housing developments and to upgrade informal and squatter settlements.

In Belgrade, the city administration used these data to detect urban change and informal settlements for establishing a new urban master plan. Image 2 shows settlement and informal built-up developments between Batajnica and Zemun, Belgrade, in the period from 1997 to 2000. The information was derived from high-resolution IRS (1997) respectively very high-resolution IKONOS data (2000).

2. **Belgrade - settlement and informal built-up development**



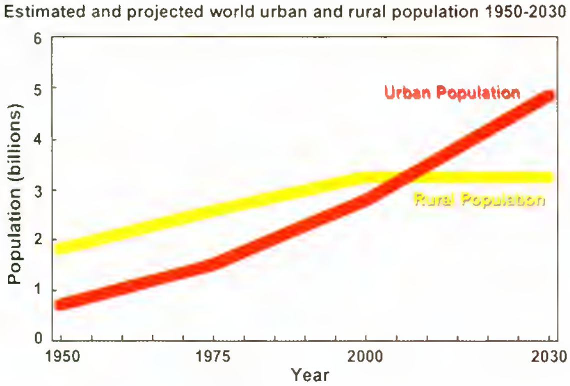
Legend
- Discontinuous sparse urban fabric
- Roads
- Border of real estates

Courtesy of GeoVille; Space Imaging (2000), ISRO/ANTRIX/SI/euromap (1997); EC - JRC

Combating Poverty and Promoting Sustainable Livelihoods

It is estimated that by 2030, over 60% of the world's population will be living in cities (United Nations Centre for Human Settlements 2001).

1. Urban population grows rapidly



Courtesy of UN Population Division (2000)

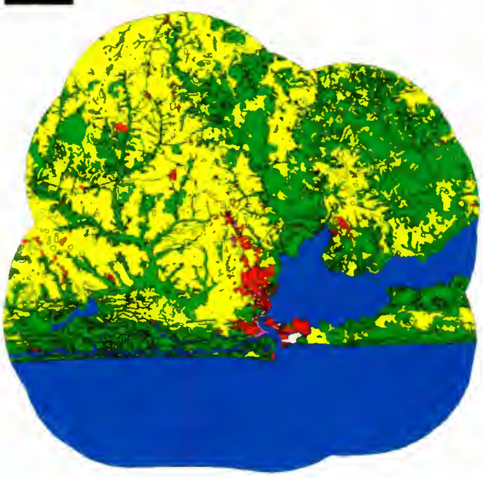
As shown in image 1 most of the population growth will take place in urban areas – from roughly six billion in 2000 to eight billion people in 2030.

In the late nineties the Joint Research Centre of the European Union initiated MOLAND (Monitoring Land Use/Cover Dynamics) to monitor the dynamics of European cities and a number of MegaCities in developing countries.

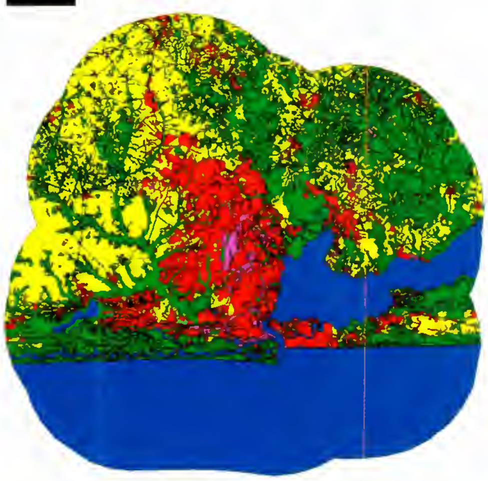
A homogeneous land cover and land use legend has been applied to receive comparable results for the different cities and to detect changes over the past fifty years.

Images 2 and 3 provide an example of such a MOLAND database. They show land use databases derived from aerial photography and satellite data for the city of Lagos (Nigeria). An increment of the residential (red) and industrial (magenta) land use categories and a decrease of agricultural use (yellow) are notable.

2. Land use 1962



3. Land use 2000



Urban fabric | Industrial/commercial/transport | Green urban areas | Agricultural areas | Natural areas (forests, wetlands, etc.) | Water bodies

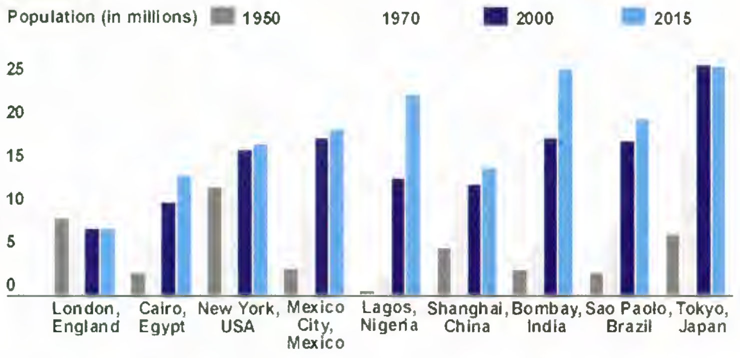
Courtesy of HUGIN: Space Imaging: EC - JRC

Combating Poverty and Promoting Sustainable Livelihoods

Between 2000 and 2025 a doubling of the overall urban population will occur in Latin America, the Caribbean, Asia and Africa.

Managing this tremendous urban growth is one of the great challenges of the new millennium (Statement by Dr. Klaus Töpfer, Acting Executive Director of the United Nations Centre for Human Settlements).

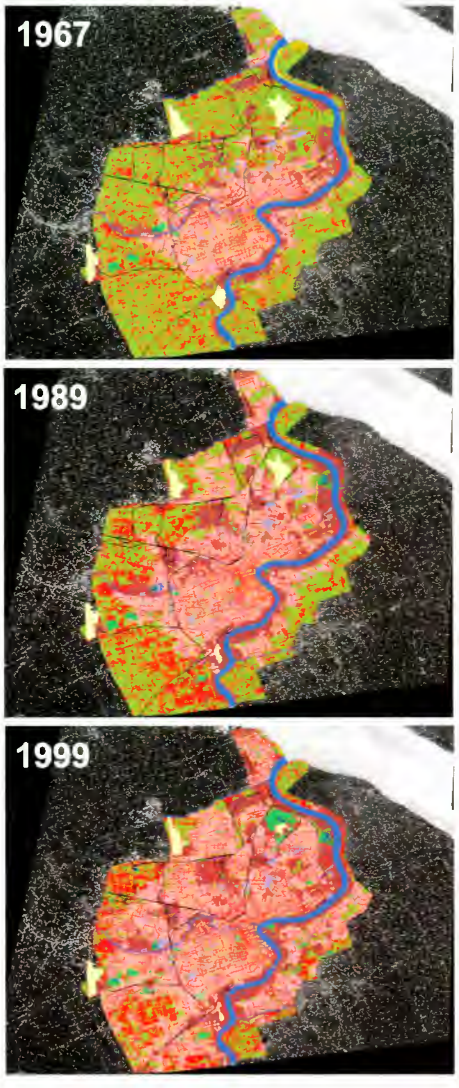
1. Growth of urban agglomerations, 1950 - 2015



Courtesy of United Nations

The chart in image 1 shows urban growth for selected cities.

2. Urban growth in the Shanghai Region



Earth observation data can be an effective source for monitoring land use and its changes. This information is valuable for developing scenarios of urban growth and can be used as an input to formulate and evaluate long-term strategies for sustainable urban development.

The maps in image 2 show the change of land cover and land use in the Shanghai region from 1967 to 1999 derived from CORONA- (1967), SPOT- (1989) and IRS-satellite data (1999).

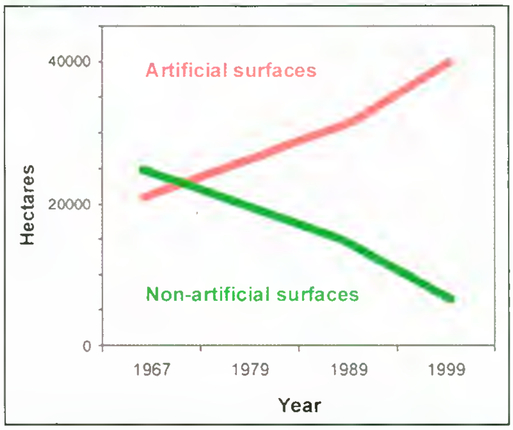
The graph in image 3 demonstrates the immense gain in artificial surfaces (e.g. built-up and industrial) over the last 30 years.

Legend

Landuse classes

- Continuous settlement
- Discontinuous settlement
- Industrial/Commercial
- Cultivated land
- Green urban areas
- Public facilities
- Sport and leisure areas
- Harbours
- Lakes
- Airports
- Railway tracksystem
- Other land
- Reclamation of land
- Tidal land
- Rivers

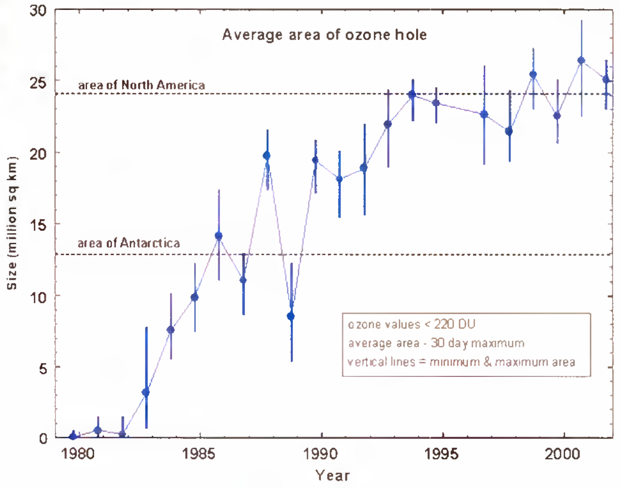
3. Land cover change in the Shanghai Region



Courtesy of GeoVille/ IIASA - Laxenburg; ISRO/ANTRIX/SI/euromap (1999); Spot Image (1989); USGS (1967)

The Montreal Protocol sets the "elimination" of ozone-depleting substances as its final objective and specifies timetables for the stepwise reduction of relevant substances to reach finally zero in 2010. The Annex of the Treaty states that the parties are to provide for adequate global measurement techniques to monitor and verify the implementation of the Protocol.

1.

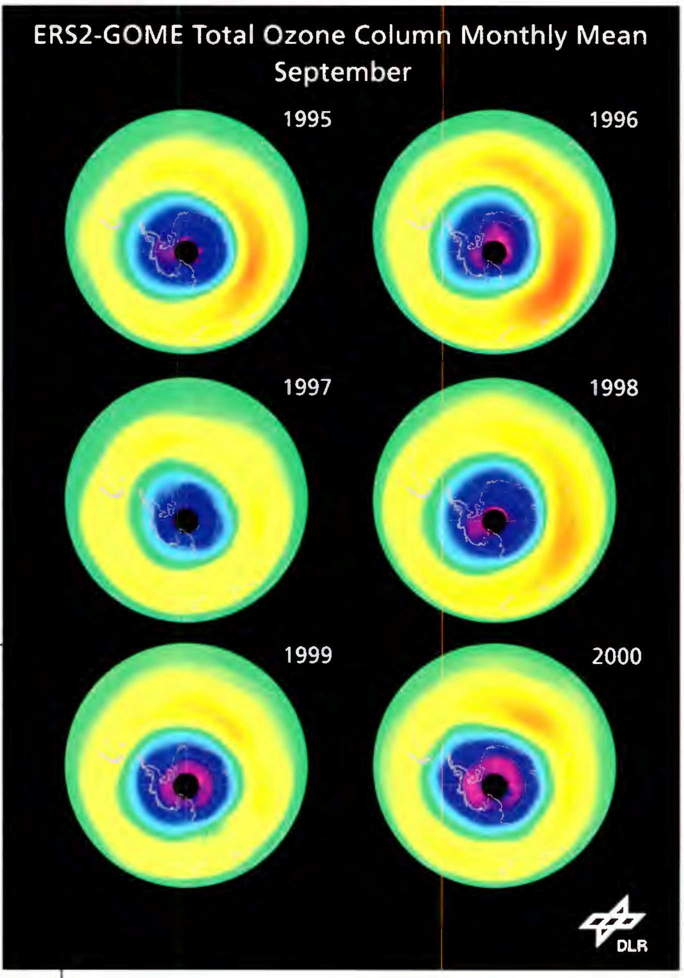


Courtesy of NASA

The chart in image 1 shows the growth of the average area of the ozone hole in millions of square kilometres from 1979 to 2001.

Main advantages of satellites in this ozone-monitoring scheme are their global view of our planet, their continuous and accurate observation capabilities, their near-real time monitoring capabilities and their long-term archives.

2.



Courtesy of DLR; ESA

Such satellite archive-based observations are depicted in image 2 and illustrate changes in the ozone hole over the Antarctic between 1995 and 2000. The measurements were made by the GOME instrument on board ERS-2.

Legend

Dobson Units

<100 200 300 400<

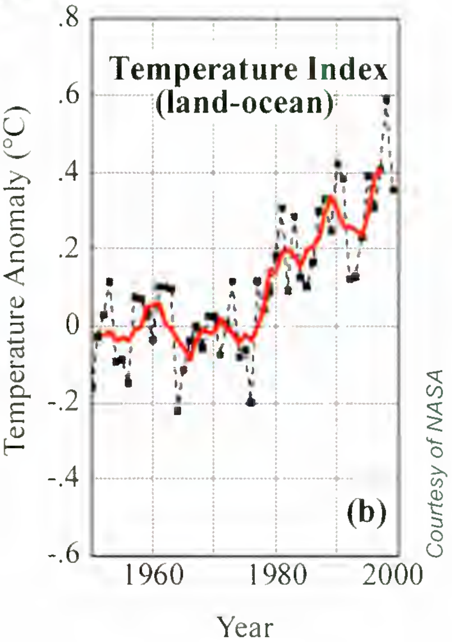
The violet and the blue colours indicate low Dobson Units and thus the extent of what is commonly known as the Ozone Hole.

Protecting and Managing the Natural Resource Base

Oceanographic information requirements of the Global Climate Change Observation Systems (GCOS; adopted at COP 5) specify the needs for a systematic observation of parameters such as

- sea surface temperature,
- sea level and
- temperature and salinity profiles at various depths.

1.



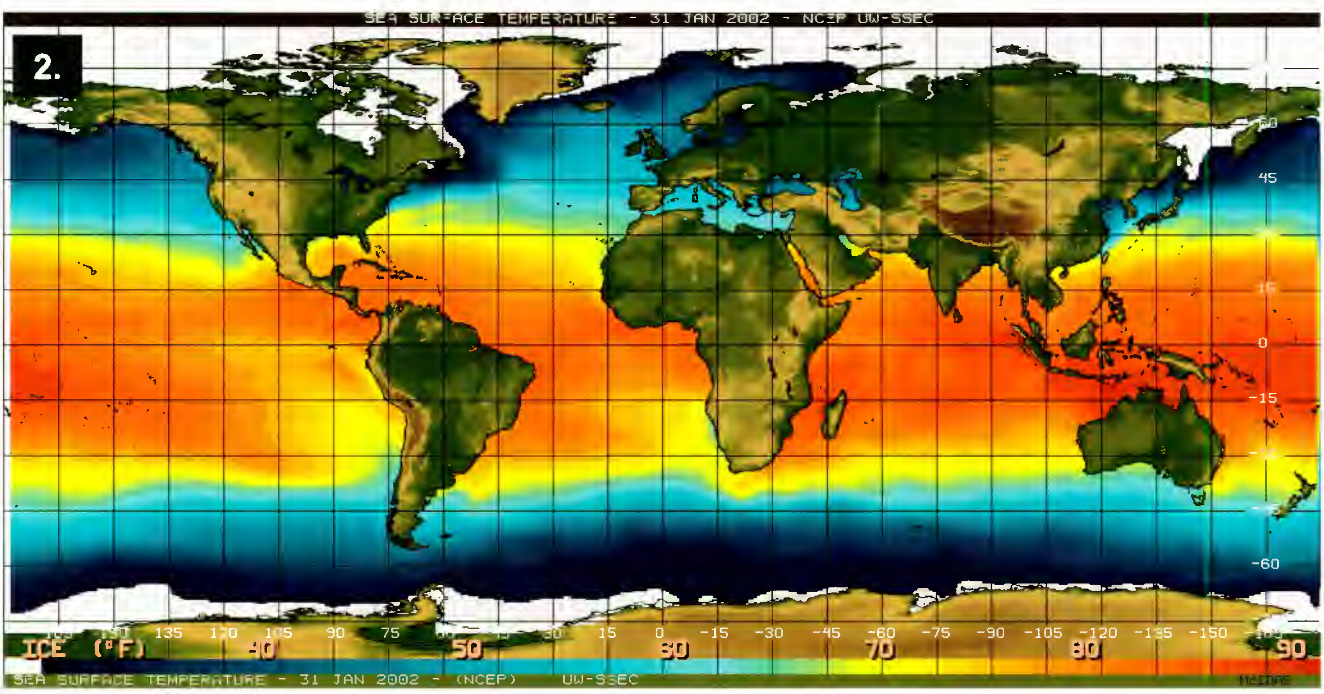
Courtesy of NASA

The global land-ocean surface temperature index is formed by combining the meteorological station measurements over land with Sea Surface Temperatures (SST) obtained from satellite measurements.

The graph in image 1 shows that there has been a long-term global warming trend since the early 1960s (global record setting reached in 1998).

In this context satellites provide for an excellent real-time data collection tool to derive global SST data. The combination of data from different satellites and archives thereby helps to derive long-term assessments, which are a prerequisite for determining the drivers of climate change.

Image 2 depicts the global Sea Surface Temperature on 31 January 2002 as derived from the NOAA GOES-8 Imager.

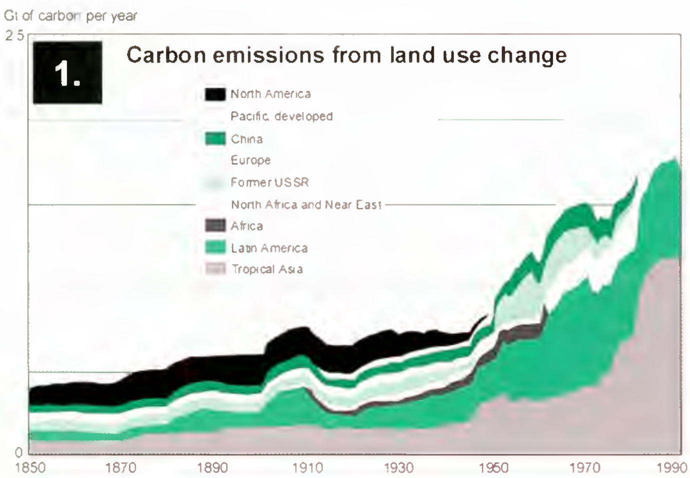


Courtesy of the University of Wisconsin-Madison; NOAA

Protecting and Managing the Natural Resource Base

Terrestrial information requirements of the Global Climate Change Observation Systems (GCOS; adopted at COP 5) specify the needs for a systematic observation of parameters (e.g. forests, wetlands, permafrost), which

- are affected by climate change or climate variability,
- serve as indicators of climate change and
- relate to impacts of climate change.



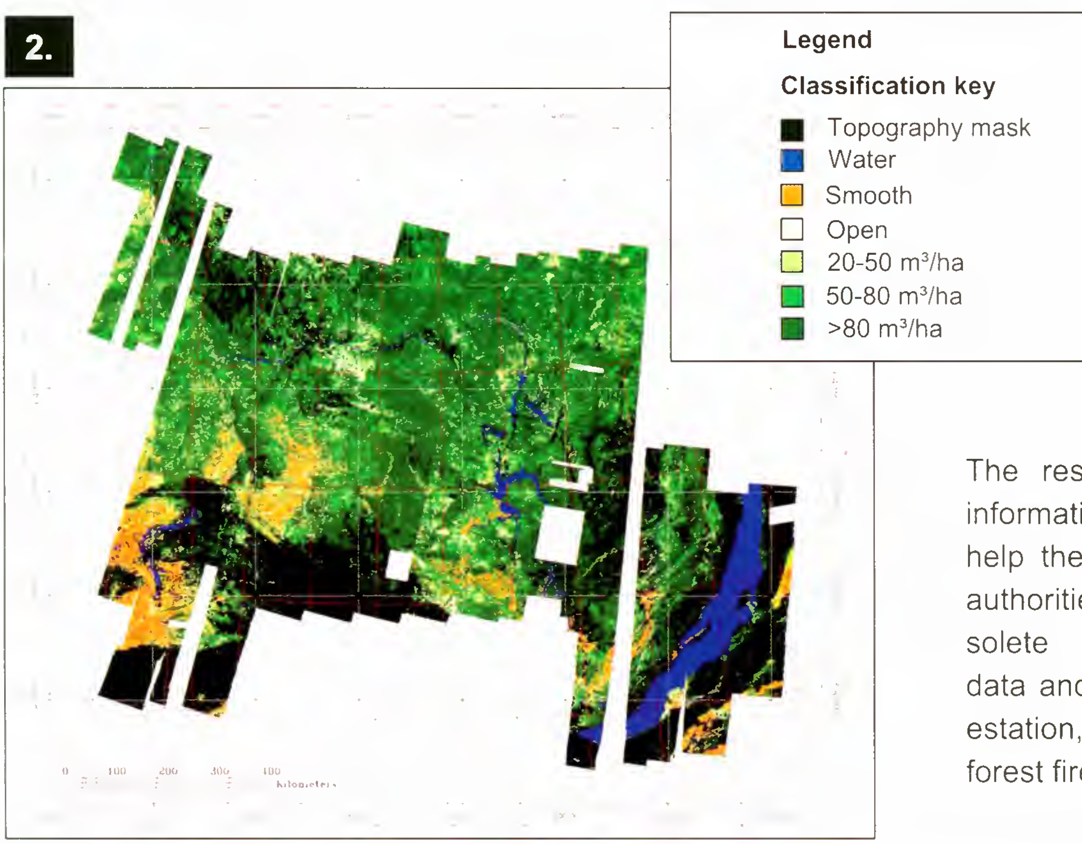
Courtesy of Houghton 1999, in FAO (2001)

The graph in image 1 shows the development of carbon emissions caused by the change of land use in different regions of the world.

Net carbon emissions resulting from land use change in the eighties are estimated to contribute 23 to 27% to all anthropogenic emissions (Food and Agriculture Organization of the United Nations, State of the World's Forests 2001).

Image 2 demonstrates an example of a satellite-derived forest stem volume and land cover classification map of Siberia. Data from three satellites – ESA's ERS-1 and 2 and Japan's JERS-1 – were collected simultaneously throughout autumn 1997 and the summer of 1998.

2.



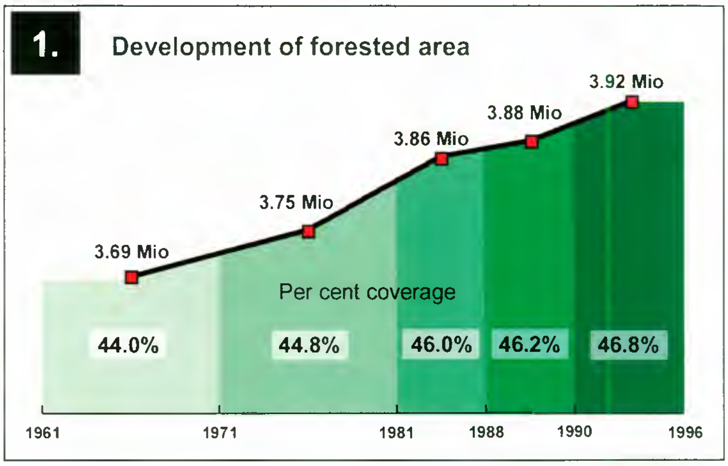
Courtesy of SIBERIA project team: ESA, NASDA GBFM, DLR; EC

The resulting maps and information products will help the Russian forestry authorities to update obsolete forest inventory data and to monitor reforestation, for example after forest fires.

National Kyoto-based reporting will require the submission of information on anthropogenic emissions by sources and removals by sinks of all greenhouse gases. Land Use, Land Use Change and Forestry (LULUCF) reporting issues comprise:

- 1990 terrestrial carbon-stock baseline
- Quantification of above ground biomass stocks and changes therein

These data are usually derived from terrestrial national forest inventories, which show a continuous increase in the forested area in Austria (image 1). On the basis of this inventory a study estimated that the Austrian forests (3.9 mio. ha) sequestered a C-stock of 320 ± 42 mt C (biomass) in 1990.



Courtesy of Austrian BFW

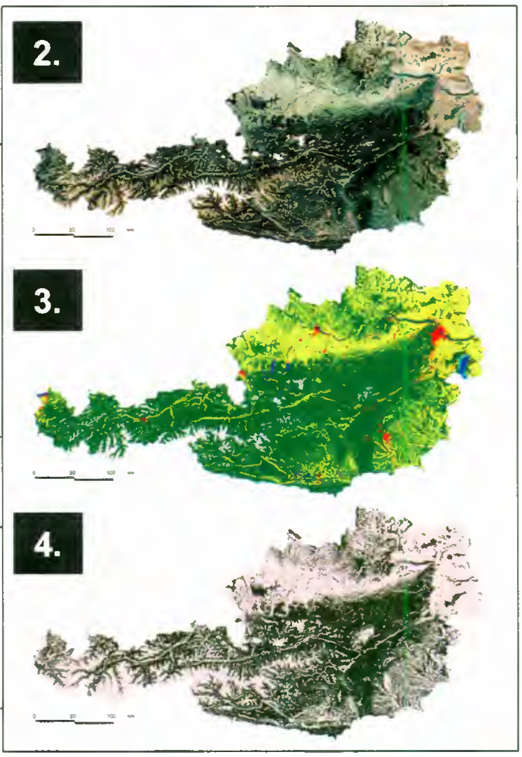
In this context EO data can help to provide 1990 baseline information in case no traditional inventory data are available or to verify the reported values of carbon stock and changes therein. Main advantages of EO data are the long-term archives going back to the seventies and the world-wide uniform data availability.

Image 2 shows a LANDSAT-image mosaic of Austria.

Images 3 and 4 depict EO image-derived information layers and illustrate the 2001 land cover as well as forest and natural vegetation of Austria.

Austria land cover 2001 (acc. to CORINE Legend)
- Artificial surfaces
- Agricultural areas
- Forests and seminatural areas
- Wetlands
- Waterbodies
- Bare rock and glaciers

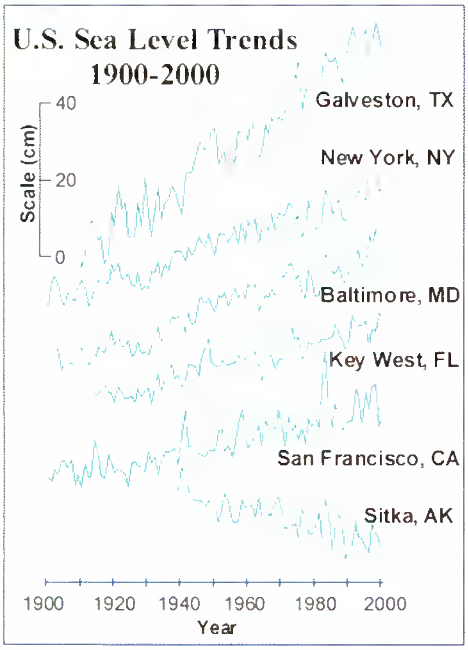
Austria forest area 2001
- Forest
- Natural vegetation
- National forest inventory units



Courtesy of GeoVille; BFW; USGS

Protecting and Managing the Natural Resource Base

1.



Courtesy of US - EPA

Estimates regarding the degree of sea level rise vary considerably:

- The US-EPA estimates that all effects together have led to a world-wide rise of 15-20 cm in the last century.

http://www.epa.gov/globalwarming/climate/trends/sealevel.html

- Scientists from the University of Colorado in turn estimated that glacier melting could contribute 0.65 feet or more to the rise of sea level in this century (1-foot rise in sea level will cause a retreat of shoreline of 100 feet or more).

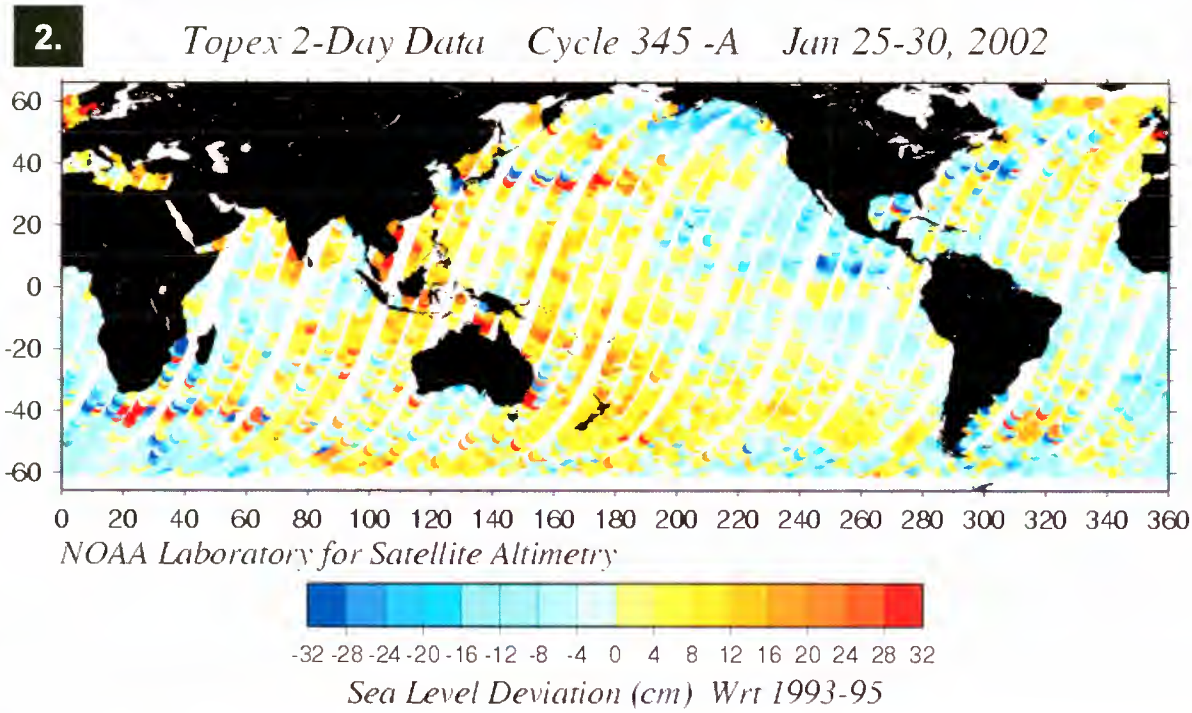
http://www.colorado.edu/PublicRelations/NewsReleases/2002/1614.html

- The graph in image 1 shows U.S. sea level trends from 1900 to 2000 as measured by gauges, buoys, ships or aircraft.

Altimetry satellites such as TOPEX/POSEIDON can detect changes of the sea level in the millimetre range. These daily data, together with archive data of the nineties, are a crucial aid for observing variations in mean sea level height. Thus, trends can be confirmed and attempts to mitigate their effects can be made.

The map in image 2 shows sea level deviations, relative to the 3-year mean (1993-1995), derived from TOPEX altimeter data collected in near-real time (2-day delay). The analysis is updated automatically every day.

2.

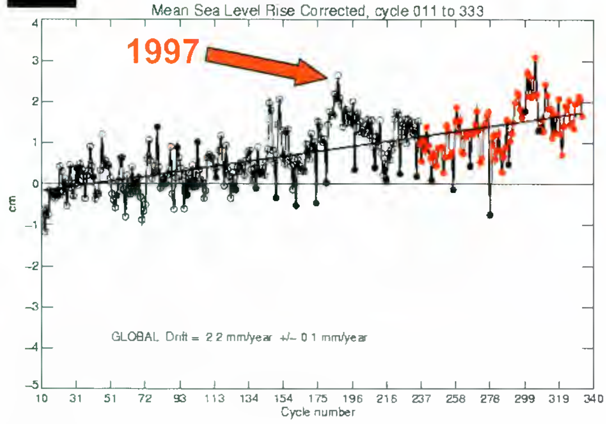


Courtesy of NOAA: CNES/NASA

Protecting and Managing the Natural Resource Base

The abnormal atmospheric and oceanic conditions during the El Niño phenomenon perturb marine life in the Pacific and influence weather patterns throughout the world.

1.



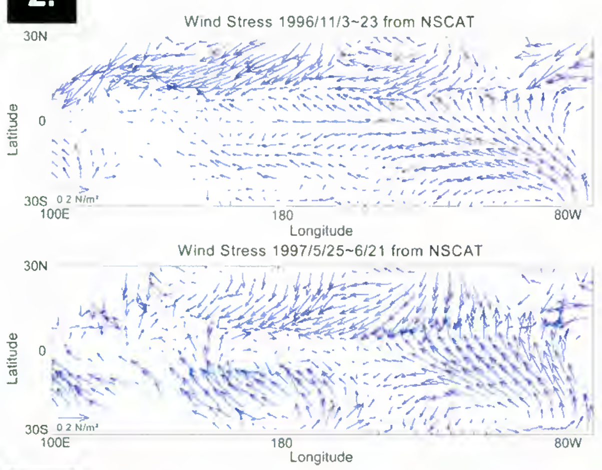
Courtesy of CLS; CNES

The graph in image 1 shows the global mean sea level since 1992 as measured by the TOPEX/POSEIDON satellite.

The rise in 1997 was a direct consequence of El Niño rather than the indication of a clear trend towards global warming.

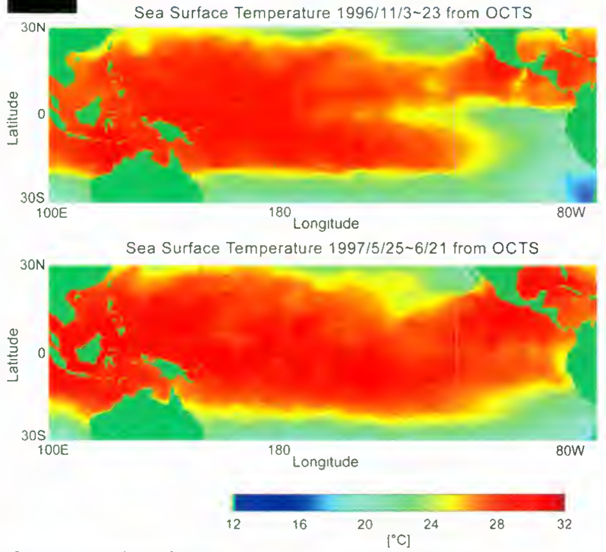
The ADEOS-OCTS and NSCAT satellites were used to observe the 1997 El Niño transition phase from November 1996 (below top images) to May 1997 (below bottom images).

2.

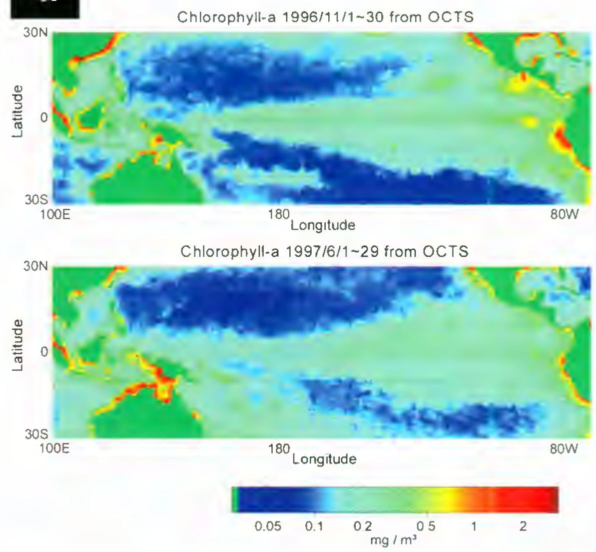


The images show the El Niño transition phase. A westward wind stress weakening in the equatorial Pacific is illustrated in image 2. Images 3 and 4 demonstrate the rise of sea surface temperature in the eastern part and the lowering of the chlorophyll-a concentration in the central part of the Pacific ocean.

3.



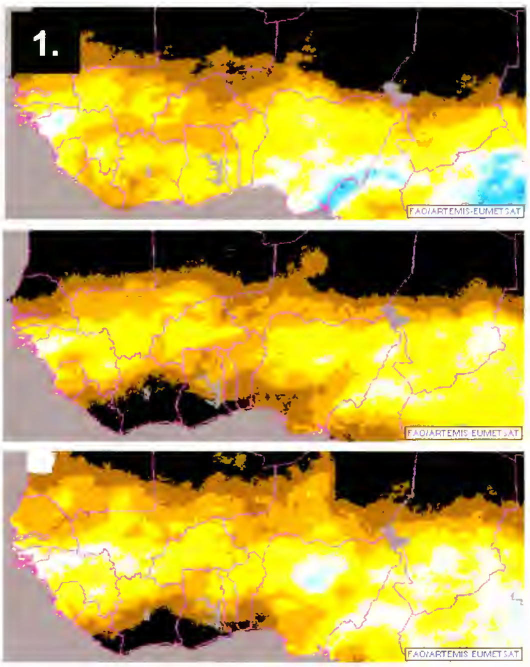
4.

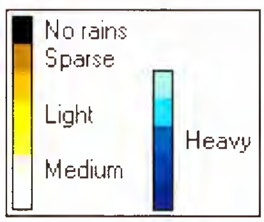


Courtesy of NASDA; NASDA/NASA

Protecting and Managing the Natural Resource Base

The use of satellite data has a long tradition in operational drought monitoring for food security - one of the major objectives of the UNCCD. In this context FAO's Global Information and Early Warning System (GIEWS) and the Famine Early Warning System (FEWS) of the U.S. Agency for International Development have "saved lives" (E. Rodenburg, World Resources Institute).





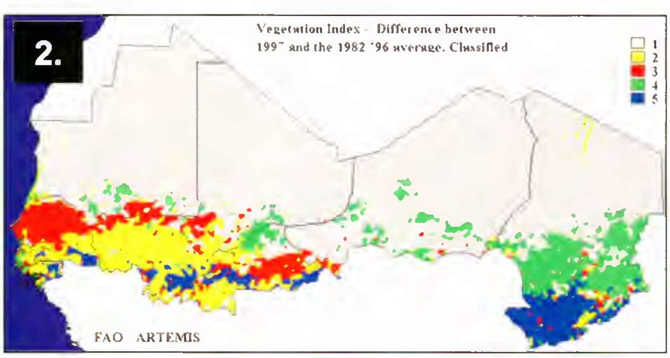
Courtesy of FAO (ARTEMIS); EUMETSAT

In order to support GIEWS, FAO established ARTEMIS, which uses satellite data from:

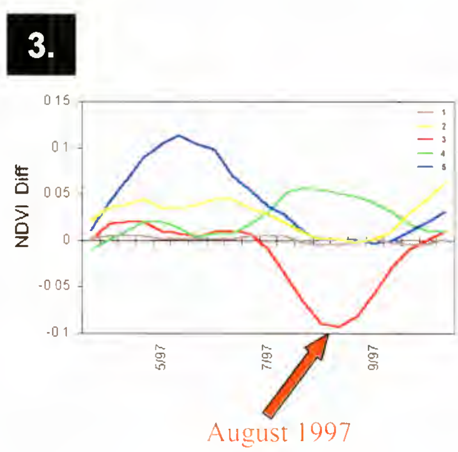
- METEOSAT-TIR to estimate rainfall as shown in the three images of Western Africa from June - August 1997 (image 1). Rainfall intensities can be derived from Cold Cloud Duration (CCD); blue shows highest, brown lowest values.
- NOAA AVHRR GAC or SPOT VEGETATION to derive vegetation development via the Normalised Difference Vegetation Index (NDVI).

The figures in images 2 and 3 provide an assessment of the 1997 cropping season, based on a classification of the evolution of the NDVI compared to the 1982 to 1996 average. The five classes show the seasonal 1997 development – whereby areas in red, for example, indicate a substantially lower vegetation development in August.

Classification of the evolution of the NDVI during the 1997 season compared to the 1982-96 average



Courtesy of FAO (GIEWS); NOAA



This information provides for spatially complete and quick analysis of the agricultural situation and allows to derive expected harvest levels.

Courtesy of Milich, L. (1997)

Recurrent droughts are a major factor in the degradation of cultivated land and rangelands in many parts of Africa and have a severe impact on food security (UNEP 1999).

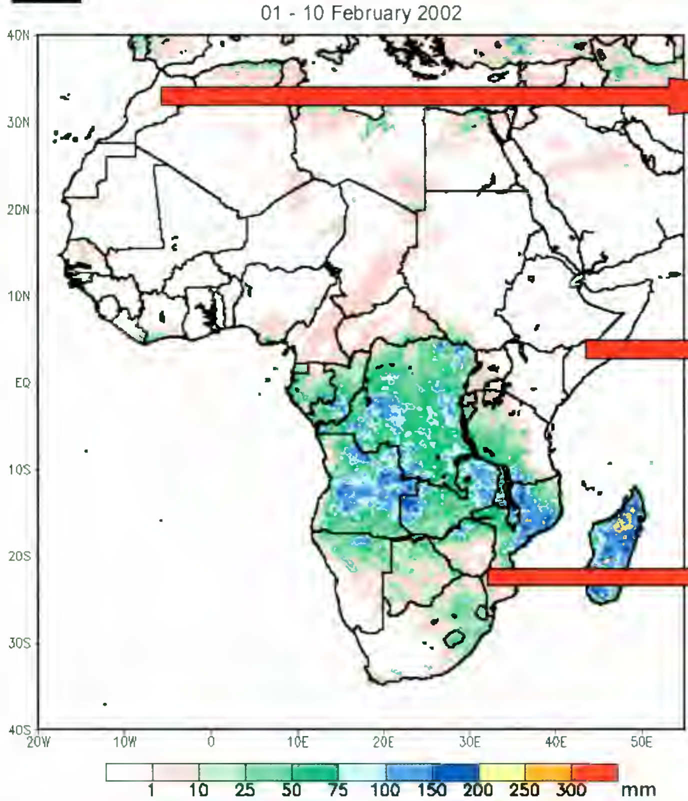
To assist in drought monitoring efforts NOAA's Climate Prediction Center (CPC) operationally prepares rainfall estimates for the African continent as part of USAID's Famine Early Warning System (FEWS).

The UN World Meteorological Organisation data taken from approx. 1,000 stations provide accurate rainfall totals. These data are combined with METEOSAT-7 satellite infrared data acquired every 30 minutes and special satellite microwave sensors. The data are used to generate 10-day precipitation estimates as shown in image 1.

This information is the basis for the operational production of weekly meteorological threat assessments for the African continent as shown in image 2. Subsequently these assessments serve as an input into early warning systems.

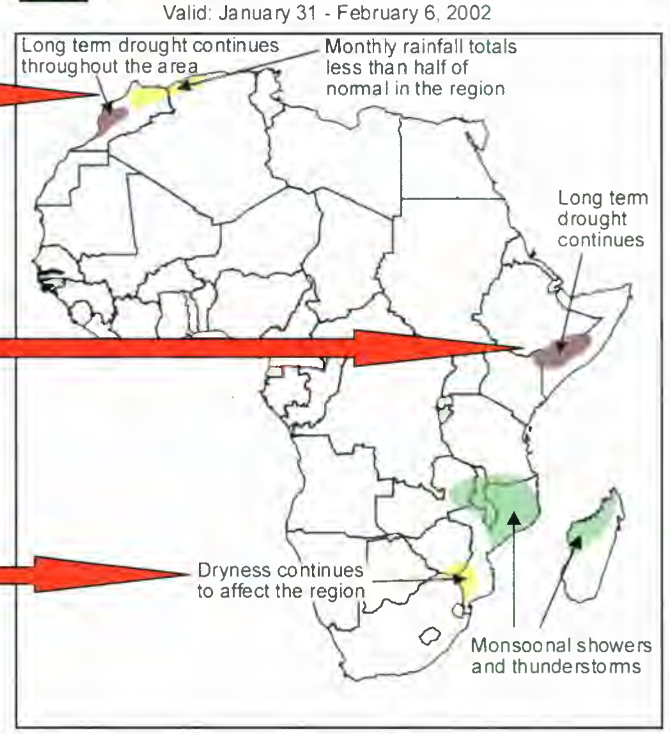
1. **NOAA Precipitation Estimate**

01 - 10 February 2002



2. **Africa Threat Assessment**

Valid: January 31 - February 6, 2002



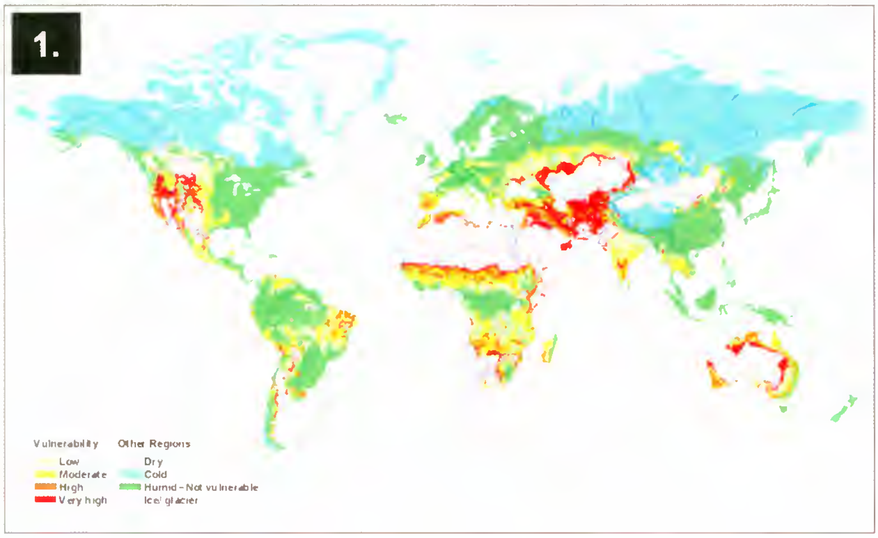
Courtesy of NOAA-CPC, USGS; EUMETSAT; USAID (FEWS)

Protecting and Managing the Natural Resource Base

A main objective of the UNCCD is the prevention and reduction of land degradation.

In global dimensions, desertification is estimated to affect about 70% of the susceptible drylands, amounting to 3.6 billion hectares or one fourth of the land surface (Down to Earth, UNCCD Secretariat).

Global desertification vulnerability



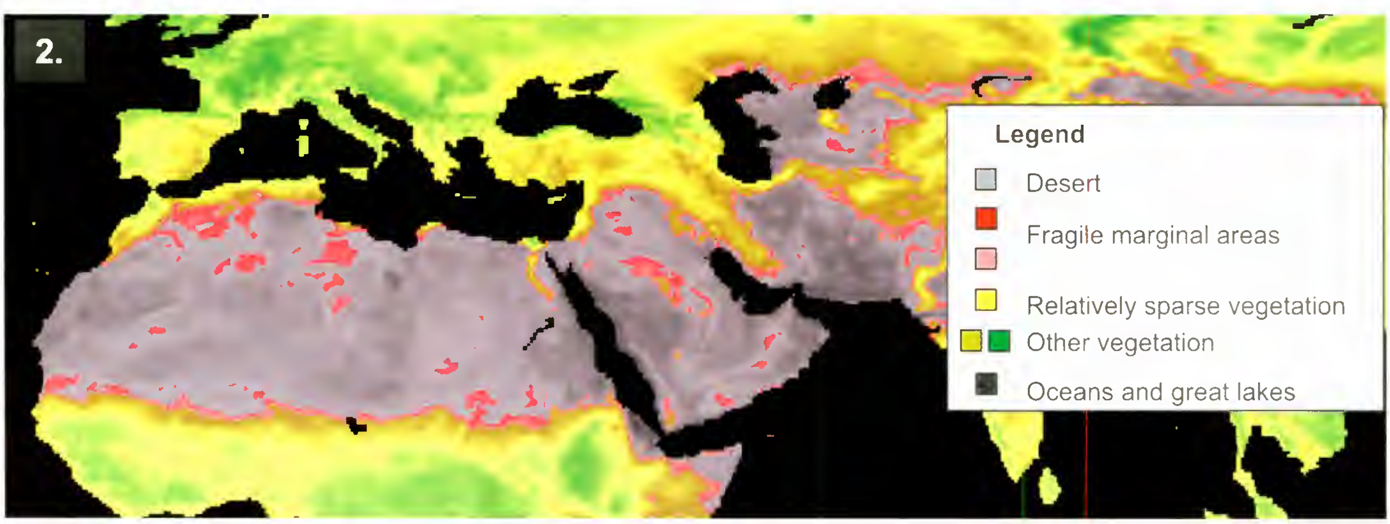
Courtesy of USDA-NRCS World Soil Resources

Image 1 shows a desertification vulnerability map.

Areas in red are at a very high risk of desertification.

Repetitive measurements from sensors such as AVHRR, MODIS and MERIS are useful to monitor the distribution and status of fragile areas. Image 2 depicts the mapping of a "fragile fringe" marginal zone between desert and non-desert in North Africa and the Middle East using global data sets derived from NOAA's-AVHRR sensor.

Detailed maps generated from higher resolution satellite data can subsequently serve as a decision support tool to implement appropriate measures against soil erosion and degradation.



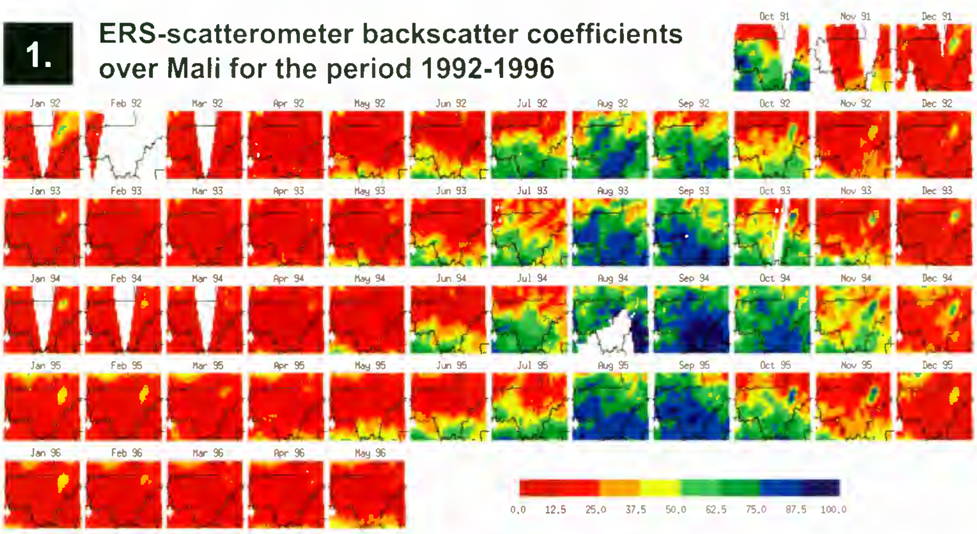
Courtesy of NOAA - NGDC. University of Colorado; NOAA

Protecting and Managing the Natural Resource Base

The UNCCD asks for an enhancement of national climatological, meteorological and hydrological monitoring capabilities and the implementation of means to provide for drought early warning (UNCCD, Part III, Article 10, 2 (d)).

Soil moisture is an important parameter needed to develop national action plans in this context. Due to their broad and frequent coverage, ERS-scatterometer data are an unmatched source of reliable and cost-effective information for regional measurements of top soil humidity.

1. ERS-scatterometer backscatter coefficients over Mali for the period 1992-1996

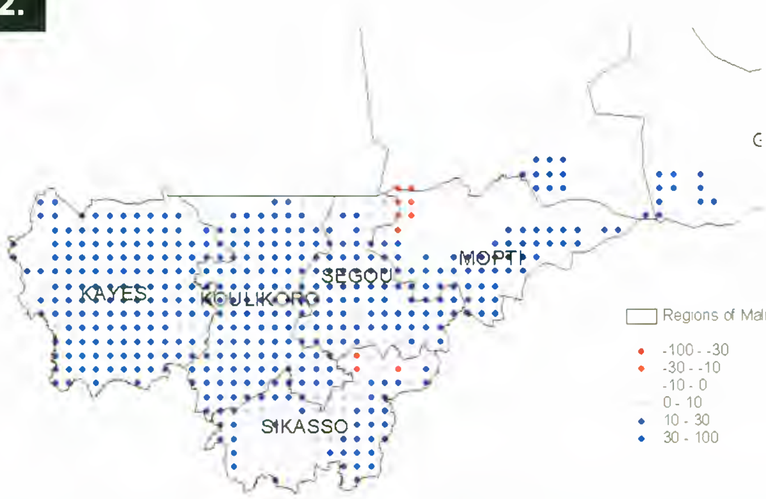


Courtesy of NEO, Catholic University Leuven, IER, Technical University Vienna; ESA

Image 1 depicts soil water maps of south - western Mali, part of the Sahel, for the period from October 1991 to May 1996 derived from ERS-1 and ERS-2.

Along with other indicators (e.g. crop performance indices) these maps provide for timely information on drought and allocation of measures for drought relief in an early stage.

2. Drought Warning for Week 37 (03-09-1998 / 09-09-1998)



Courtesy of NEO, Catholic University Leuven, IER, Technical University Vienna; ESA

Image 2 shows crop stress conditions in Sept. 1998. The data were delivered in near-real time and provided valuable input for decision-making when the drought conditions occurred.

Protecting and Managing the Natural Resource Base

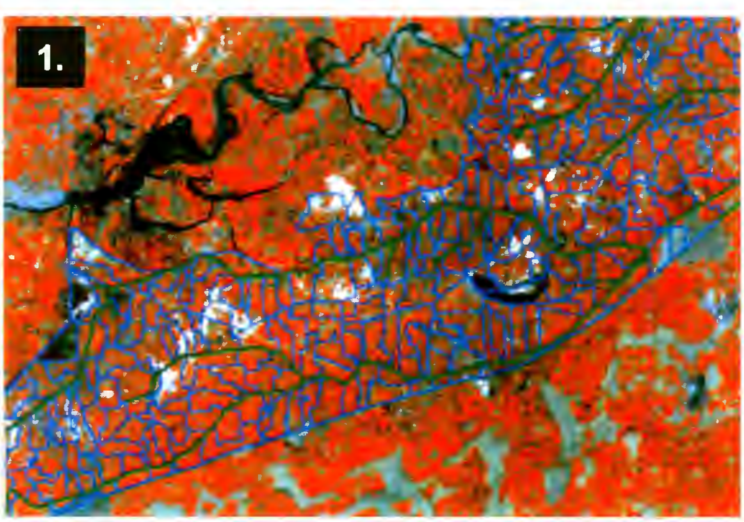
About one-third of the world's food crops are produced on land which is permanently irrigated. In Pakistan, irrigation farming faces the following challenges:

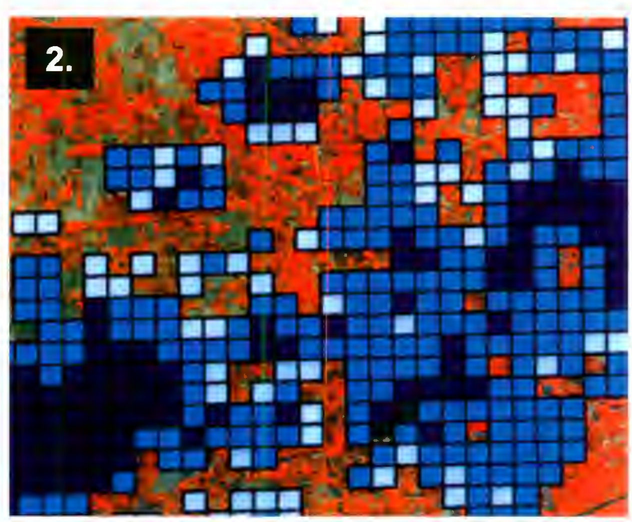
- Productivity is often lower than expected due to the lack of water.
- Increase in soil salinity threatens millions of hectares of irrigated land.

Courtesy of A. Meyer

In the Indus river plain SPOT satellite data were used to detect and map the spatial distribution of changes in yields and to assess the sustainability of agricultural practices following changes in water management. A time series of images acquired in 1986, 1994 and 1995 served to monitor areas subject to high soil salinity risk.

Image 1 depicts the density of irrigation channels superimposed over a SPOT image. The processed SPOT scene in image 2 shows the aggregated surface salinity as derived from satellite.



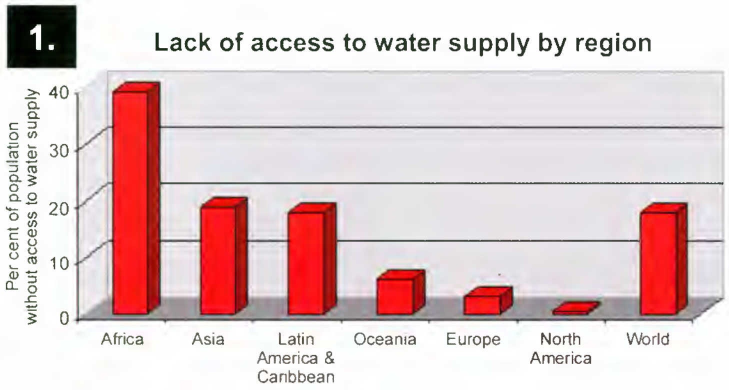


Courtesy of Cemagref - Maison de la Télédétection; Spot Image

Protecting and Managing the Natural Resource Base

Freshwater is a scarce resource :

- Only 2.5% of the water on earth is freshwater – but most of it is locked in the polar ice caps or stored as fossil ground water.
- Not more than 0.26% is directly accessible in rivers, lakes and reservoirs (International Water and Sanitation Centre 2002).



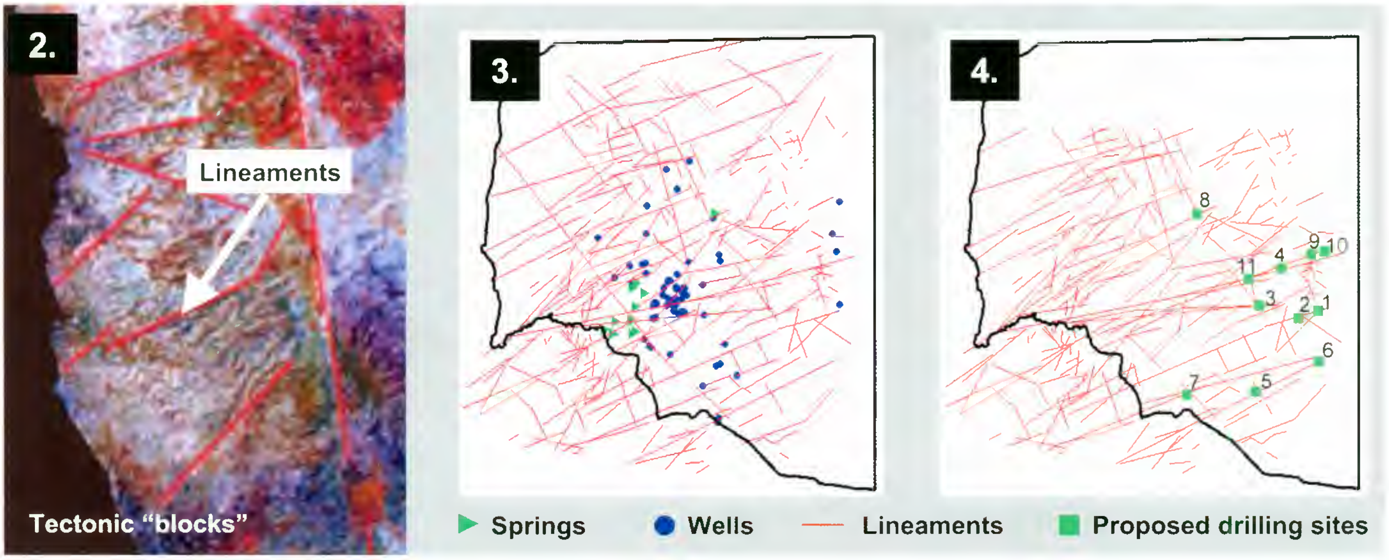
Courtesy of UN Economic and Social Council 2000

Almost 40% of the population in Africa and about 19% in Asia are without access to safe water supply (image 1).

The FAO Remote Sensing Centre has conducted a number of projects to identify potential ground-water areas through satellite remote sensing in semi-arid countries (e.g. Burkina Faso and Yemen) and karst terrain (e.g. Philippines and Syria). The aim of the project in Syria was to locate karst "waterways" and to identify areas with high ground-water probability.

LANDSAT data, acquired at the end of the summer, were used because of the reduced masking effect of vegetation. Subsequently ERS data were used for terrain and lineament analyses.

ERS-based detection of major lineaments (image 2) overlaid with the information of existing wells and springs (image 3) allowed for the identification of suitable sites for drilling (image 4).



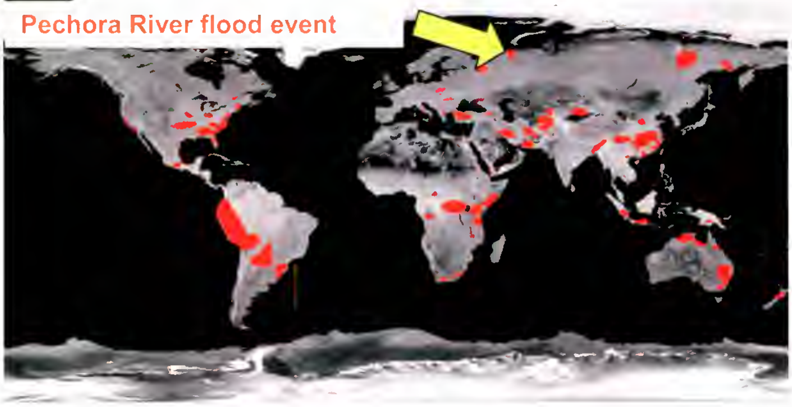
Courtesy of FAO - SDRN, General Organization of Remote Sensing Syrian Arab Republic; ESA

Protecting and Managing the Natural Resource Base

Water scarcity is a major problem in several parts of the world - in turn too much of it can be a threat.

Though extreme floods such as one hundred-year events are obviously uncommon for any given river, many take place around the globe each year and affect more regions and more people than any other natural disaster (WHO 2000).

1. **Location map of extreme flood events in 1998**

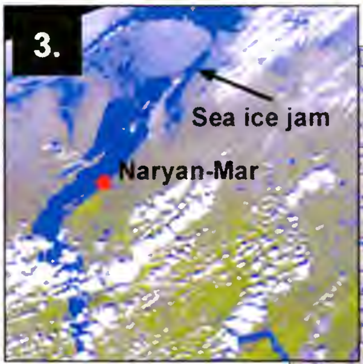


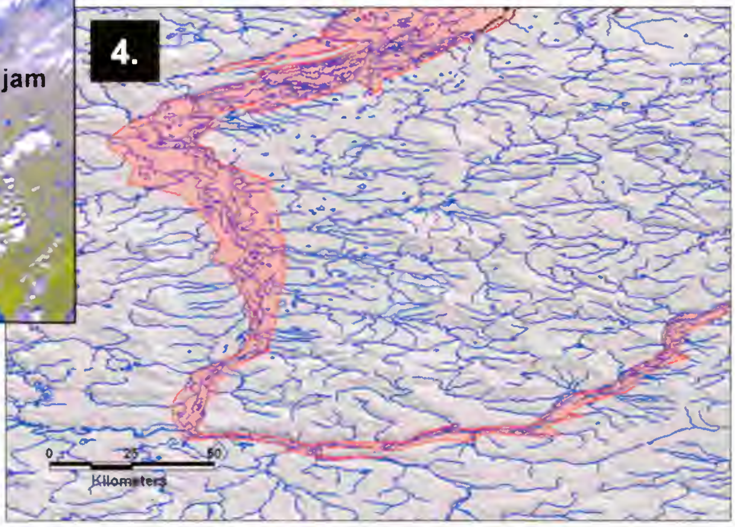
Courtesy of Dartmouth Flood Observatory; NASA

Millions of people around the world are not aware of the fact that they live on a floodplain and will not find out until it is too late due to a lack of cartography.

The map in image 1 indicates the locations of extreme flood events in 1998 - one affecting the Pechora River in Northern Russia. The Dartmouth Flood Observatory used satellite imaging technology to determine the shape and size of the flooded area in real time. The AVHRR images 2 and 3 depict the Pechora River prior to and during the flood. Image 4 demarcates the flood extent (red) on 14 June 1998.

Satellite data cannot only be useful to monitor a flooding event but can also contribute to generating flood risk maps. This information better helps hydrologists and flood-plain managers to predict which lands will be under water during future floods and to generate evacuation plans.





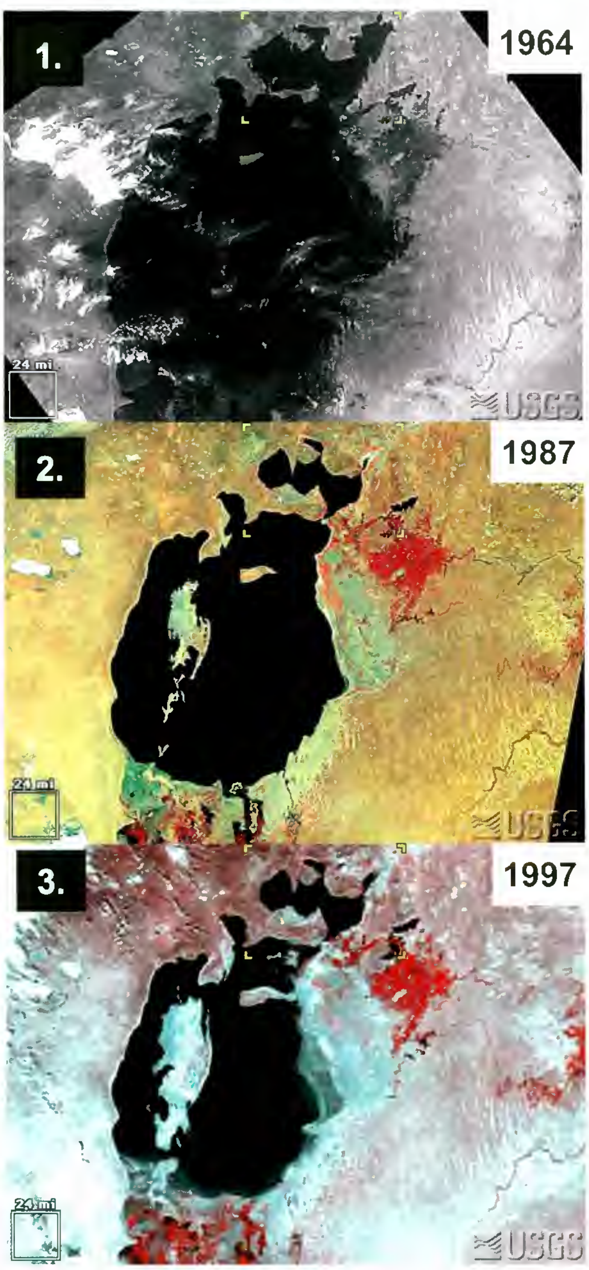
Courtesy of Dartmouth Flood Observatory; NOAA; NASA

Protecting and Managing the Natural Resource Base

The intensive use of freshwater for irrigation purposes can have disastrous results on the environment. In the case of Lake Aral huge amounts of water have been used for the irrigation of the surrounding cotton- and rice fields.

Courtesy of H. Kawlath

As a result, what was the world's fourth largest lake in 1960 is mostly desert now.



Courtesy of USGS; USGS(image 1and 2), NOAA (image 3)

As the water retreated, salty soil remained on the exposed lake bed. Dust storms have blown away up to 75,000 tons of this exposed soil annually, dispersing its salt particles and pesticide residues.

This air pollution has caused widespread nutritional and respiratory ailments. In addition, salinity has diminished crop yields in the irrigated fields.

Satellite data from different time periods are an ideal tool to assess and monitor the changes.

Images 1-3 show how the Aral Sea has shrunk. The data derived from the satellites ARGON, LANDSAT and NOAA-14 indicate that the lake has lost more than half of its original size of 65,000 km² over the last 30 years.

Sustainable Development Initiatives for Africa

Fire is a vital and natural part of several ecosystems and has been used by humans for thousands of years as a land management tool (Secretariat of the Convention on Biological Diversity, 2001).

Nevertheless, uncontrolled wildfires endanger human lives, cause property and resource losses, speed up the extinction of species, disturb the composition and chemistry of the atmosphere, upset the economy and – in general – cause great damage to the environment.

Courtesy of NASA

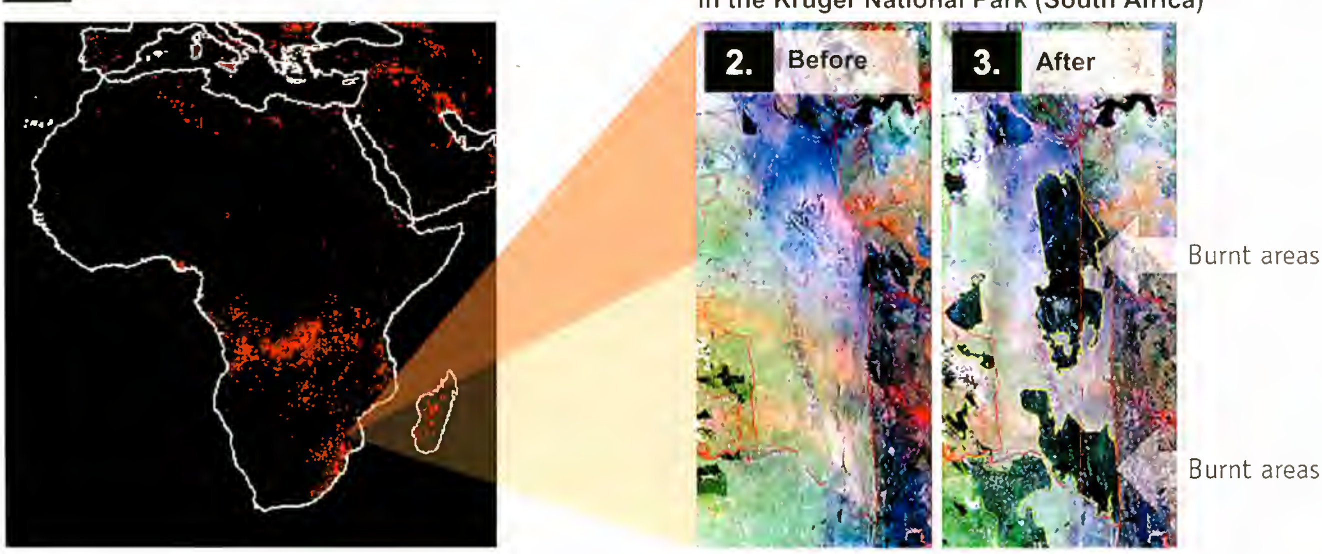
To counterbalance these negative effects the New Partnership for Africa's Development (NEPAD) calls for an integrated fire management system.

Such a fire management system can – besides other information – rely on remote sensing and GIS-based mapping for inventorying and monitoring techniques.

Image 1 shows an example of operational, long-term and regular hotspot fire mapping for Africa from ERS satellite data (World Fire Atlas). Satellite data such as LANDSAT taken before (image 2) and after (image 3) a fire can subsequently be used for damage assessment.

1. **World fire map - Africa**

Fire damage assessment in the Kruger National Park (South Africa)



Courtesy of ESA - World Fire Atlas: ESA (image1); SAC/CSIR; USGS (images 2 and 3)

An estimated 29% of the world's uranium, 27% of bauxite, 20% of copper, 8% of petroleum and 66% of phosphorites are located in Africa. Furthermore, iron-ore, chromium, manganese, cobalt, titanium and platinum are found in large quantities and nearly half of the world's supply of diamonds and gold come from Africa.

http://library.thinkquest.org/16645/overview.shtml

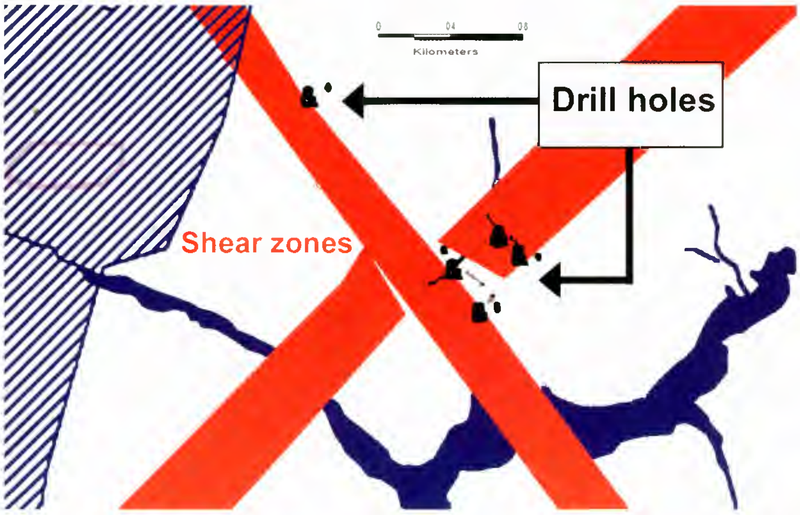
In the Kangaré region of Mali none of the traditional prospecting campaigns were able to determine the ideal location of drilling sites and to conclude whether ore mining in the area would prove economically viable.

Courtesy of P. Wijnsema

The image on the left shows a 'so-called' micro-lineament along with tall grasses. The frequent occurrence of such lineaments in the Kangaré region can serve as an indicator for shear zones, which are likely to contain ore deposits.

RADARSAT and SPOT satellite data were used in this region to identify such shear zones and helped to pinpoint the locations of seven drilling sites in key areas covered by prospecting licences.

1. Drilling location map



Courtesy of Radar Technologies France; CSA & RSI, Spot Image

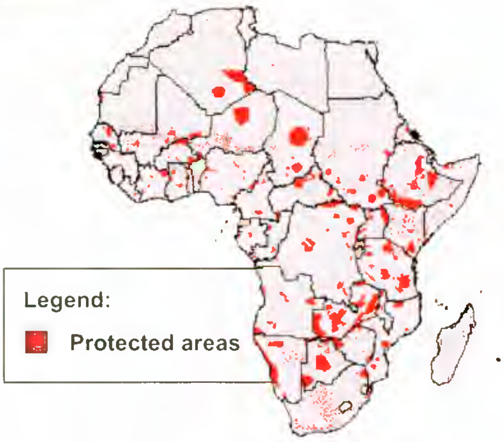
Image 1 shows a drilling location map. The direction of the satellite-derived micro-lineaments defining shear zones are shown in red. Prospective drill holes are marked as black spots.

Sustainable Development Initiatives for Africa

Africa has a large and diverse heritage of flora and fauna and is home to more than 50,000 known plant species, 1,000 mammal species and 1,500 bird species.

This large and diverse biological heritage is at risk in all regions in Africa (United Nations Environment Programme 1999). However, it is estimated that 85 to 90% of all species can be protected by setting aside areas of high biodiversity (UNEP Environment Information and Assessment Programme).

1. **Africa - Protected areas and land cover classes**



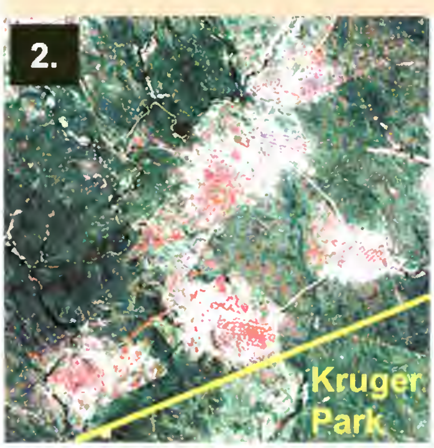
Courtesy of UNEP Environment Information and Assessment Programme

A study based on Geographic Information System (GIS) techniques estimated that approx. 7% of the total land area of Africa are protected (image 1).

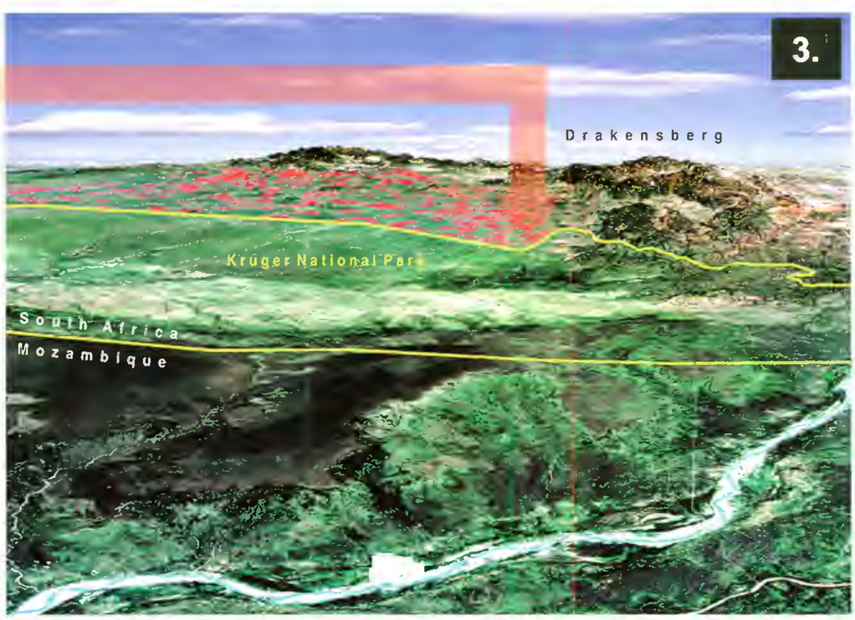
This is substantially more than the estimate of approx. 5%, compiled from official statistics (UNEP Environment Information and Assessment Programme) and amounts to more than half a million square kilometres.

This information deficit on protected areas highlights the urgent need for better environmental information infrastructures allowing to generate and maintain accurate and up-to-date data for planning and policy formulation purposes. In this framework satellite data can provide valuable information for environmental change detection and monitoring.

LANDSAT data were used to produce a three-dimensional view of the Kruger National Park (image 3). Images 2 and 3 show intact landscapes inside and the effects of intense human activities outside the park borders.



Courtesy of GeoVille; USGS



The Educational, Scientific and Cultural Organization of the UN has classified large areas of the mountain gorilla habitat located in Rwanda, Uganda and the Democratic Republic of Congo as a World Heritage Site (UNESCO, World Heritage Committee).

Courtesy of the Dian Fossey Gorilla Fund

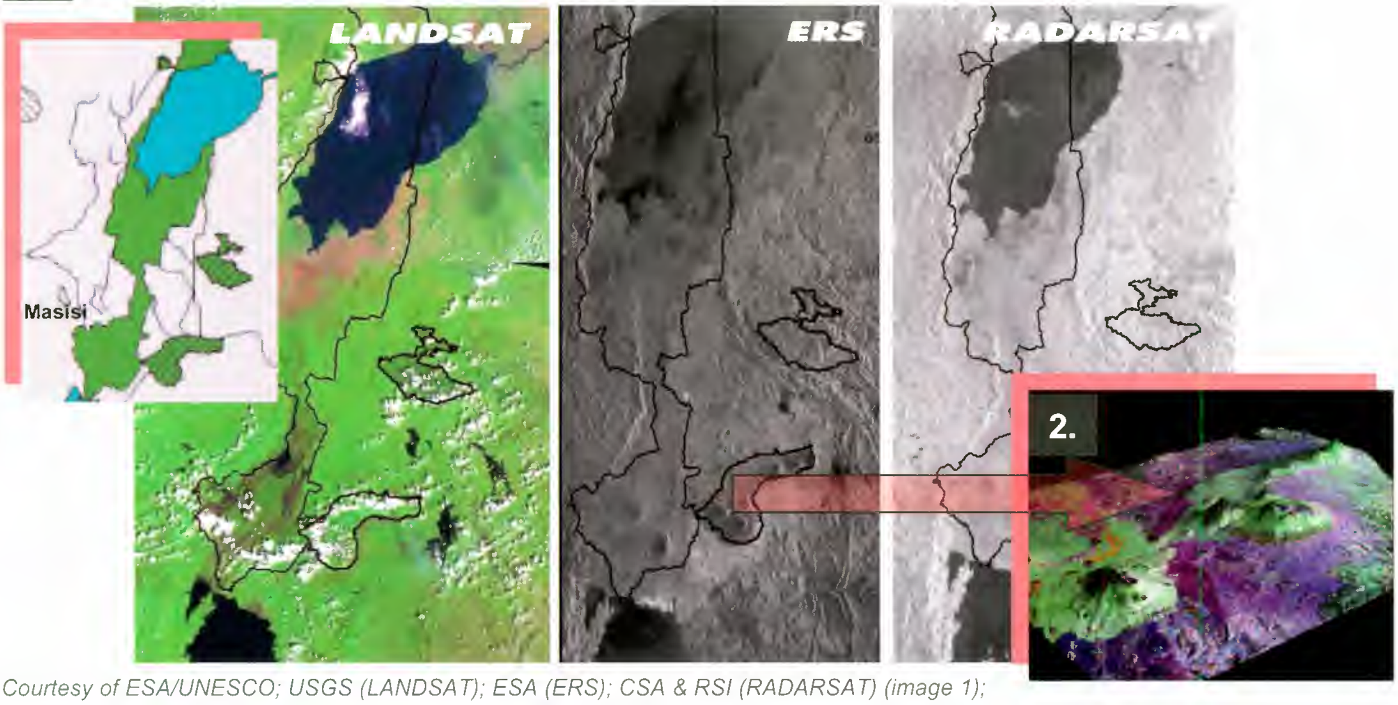
These habitats are increasingly coming under pressure and reduced living space is left for the world's last remaining mountain gorillas due to armed conflicts, settlement expansion, forest clearing and poaching. Recently UNESCO has placed the Virunga Park in Congo on the list of "World Heritage in Danger".

http://www.awf.org/wildlives/critical/gorilla.php
http://www.esa.int/export/esaSA/ESALBWF18ZC_earth_0.html

The habitats total more than 800,000 hectares, with long boundaries across barely accessible terrain. In order to support the wildlife workers on the ground, a joint ESA and UNESCO pilot project has been launched to monitor the environmental situation of the habitat from space.

Data from satellites such as ENVISAT, ERS, RADARSAT, LANDSAT and SPOT (image 1) can be combined with ground data and GIS information to create a complete picture of the rapidly evolving environmental situation. Satellite radar sensors are particularly useful since they allow to generate digital terrain models (image 2) and to identify illegal forest clearance or settlements despite heavy cloud coverage.

1. **International Gorilla Conservation Programme (IGCP) - Map and satellite data of the case study area**



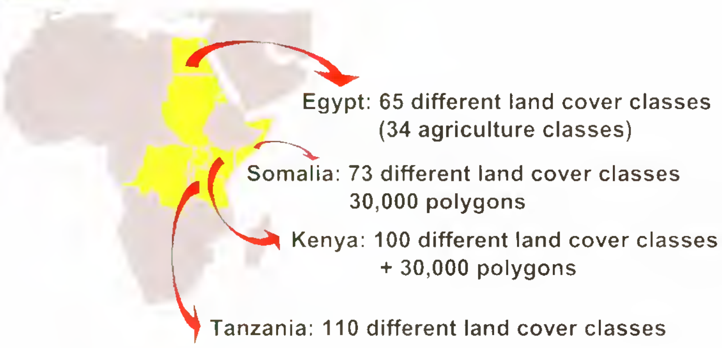
Courtesy of ESA/UNESCO; USGS (LANDSAT); ESA (ERS); CSA & RSI (RADARSAT) (image 1); Rutgers State University of New Jersey (US) for the Dian Fossey Gorilla Fund; NASA; ESA/UNESCO (image 2)

Sustainable Development
Initiatives for Africa

The project AFRICOVER of the UN Food and Agricultural Organisation is the answer to requests of a number of African organisations. They asked for technical and institutional assistance in the implementation of reliable and geo-referenced information on natural resources at local, national and supra-national levels.

The highest priority – within AFRICOVER – is given to the derivation of standardized and coherent geospatial information for the management and development of Africa's resources.

1. Status of AFRICOVER (June 2001)

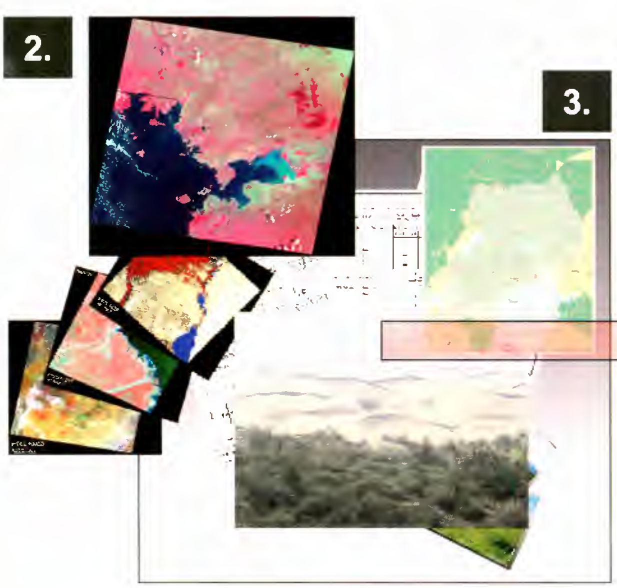


Courtesy of FAO - AFRICOVER

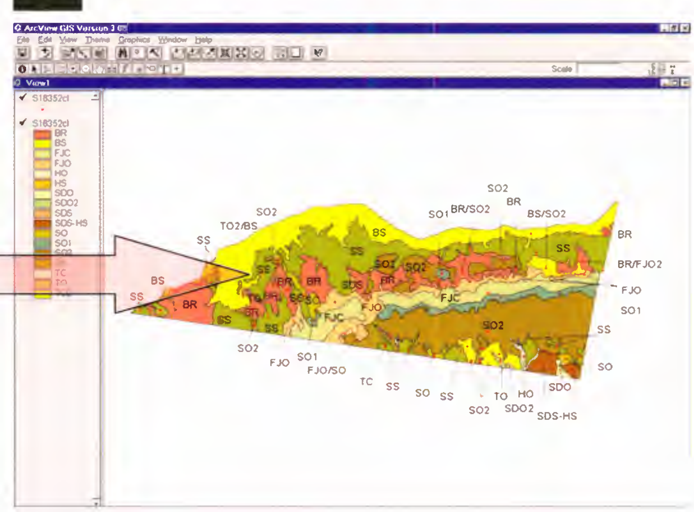
Initiated around 1994, AFRICOVER aims at preparing the basic digital geographic database on land cover for the whole of Africa. Image 1 shows the status of AFRICOVER in June 2001.

The AFRICOVER database is essentially produced by the interpretation of remote sensing data (image 2) such as LANDSAT and SPOT in Geographic Information Systems. Existing topographic maps and ground surveys serve for reference information. On the basis of field verification forms, photographs (image 3) and satellite positioning techniques, the final AFRICOVER land cover interpretation (image 4) is validated and corrected where necessary.

2. **3.**



4.

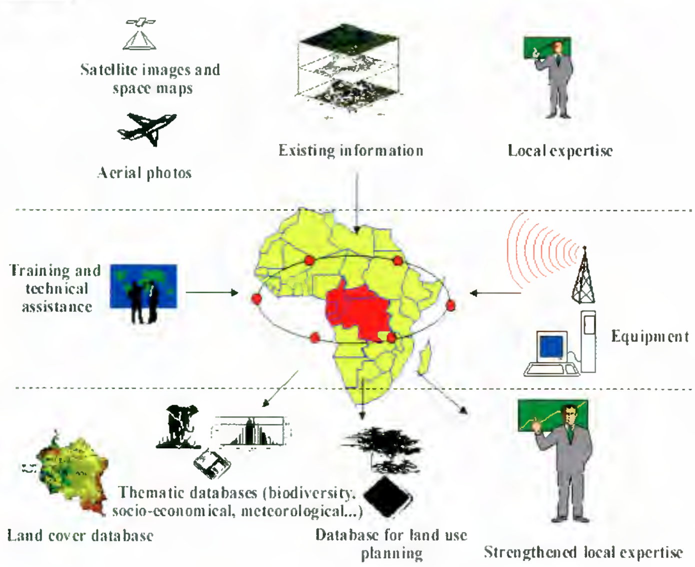


Courtesy of FAO - AFRICOVER, Spot Image, USGS

The Congo Basin Rainforest (CBR) is the second largest contiguous primary rainforest in the world. Estimates state that its size is shrinking at about 0.6% per year.

The World Bank identified the lack of accurate geospatial environmental information for accurate planning and management as a critical problem and launched the multilateral 'Regional Environmental Information Management Project' (REIMP).

1. The Regional Environmental Information Management Project (REIMP)



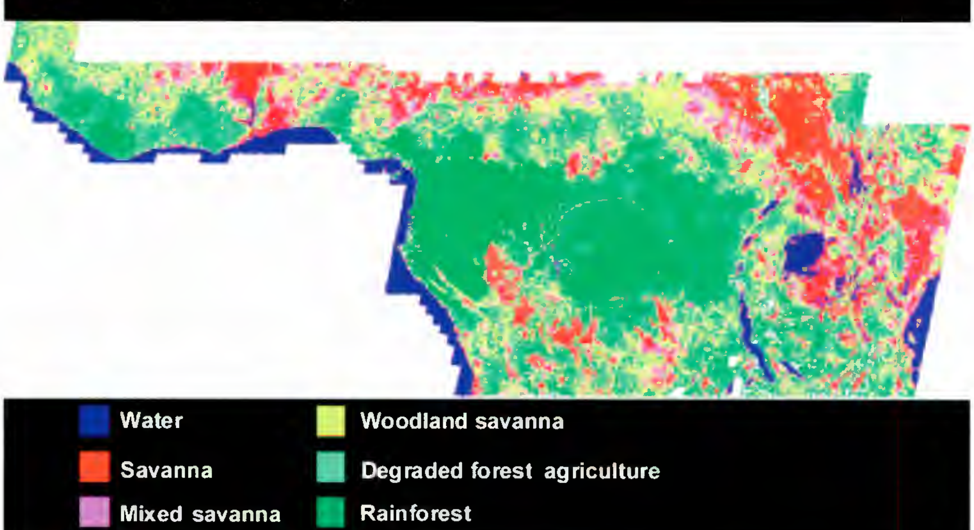
REIMP has the aim to improve and strengthen planning and management of natural resources in the Congo basin by providing the various stakeholders with appropriate environmental information (image 1).

Courtesy of The World Bank, Association pour le Développement de l'Information Environnementale

REIMP maintains close collaboration with existing operational projects using satellite data for forest planning and monitoring purposes (e.g. NASA's Pathfinder, NASDA's GRFM and the European Union's TREES).

In a pilot project ERS, JERS and LANDSAT data were used by REIMP for the mapping of land use and deforestation in the Central and West African tropical forests. Image 2 shows a land cover map derived from JERS satellite data.

2. JERS-1 Map of tropical forest of Africa

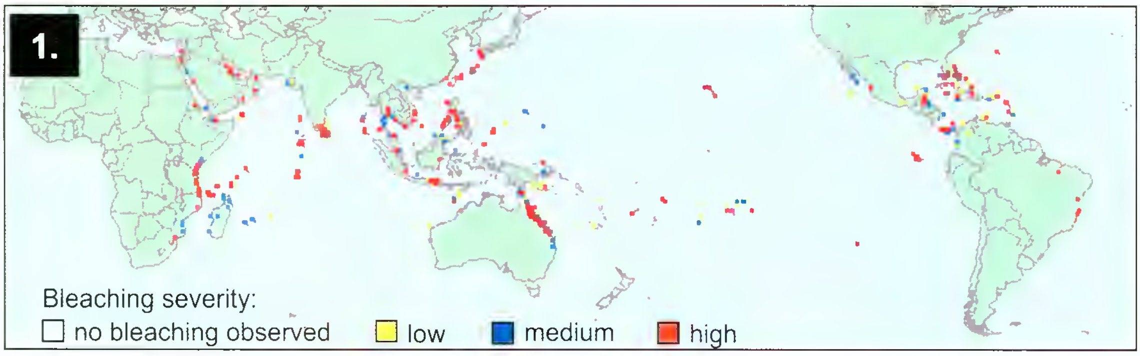


Courtesy of NASA/JPL, Global Rain Forest Mapping (NASDA, JPL, JRC); NASDA

Sustainable Development of Small Island Developing States

At the beginning of the millennium, an estimated 27% of the world's reefs had been lost. The largest single cause – the 1998 climate-related coral bleaching – destroyed 16% of the world´s corals in nine months (Global Coral Reef Monitoring Network 2000).

Coral bleaching



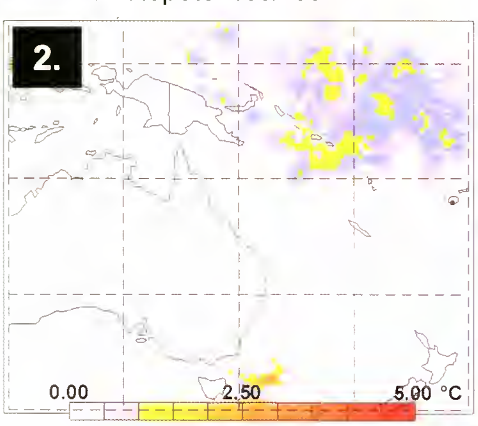
Courtesy of ReefBase, http://www.reefbase.org

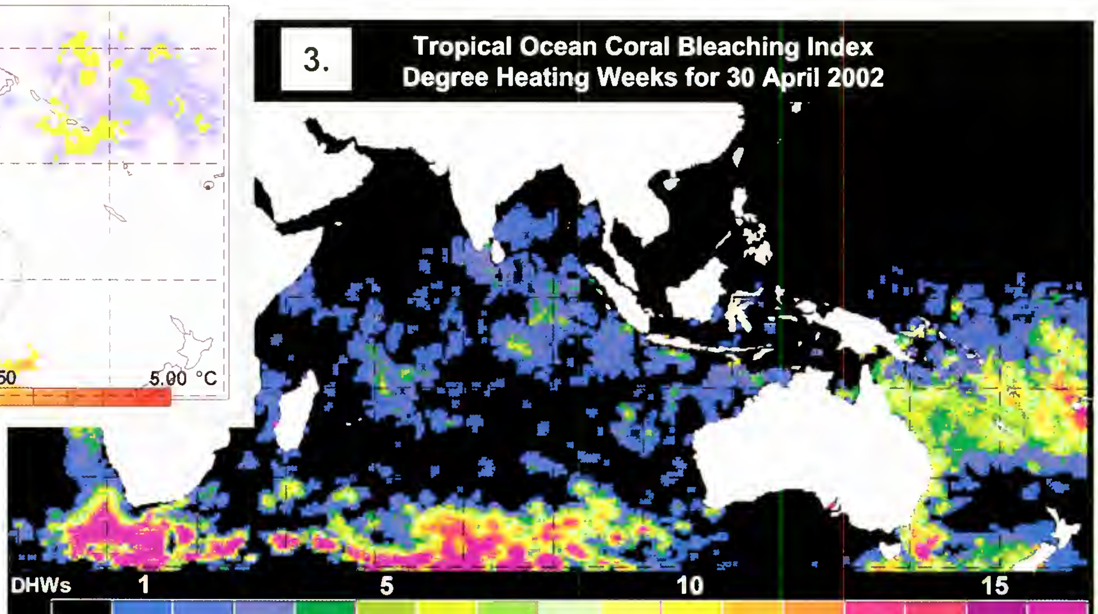
The destructive bleaching of coral reefs is caused by abnormally high water temperatures combined with low winds and still water. The map in image 1 identifies the bleaching severity.

Sea Surface Temperature (SST) data derived from NOAA's AVHRR satellites are available from 1982 to present and allow investigation of the phenomenon on a global scale. For this investigation satellite-derived hotspots, which are regions of very high sea surface temperature (image 2), are computed.

The results are then analyzed together with archive data for the generation of so-called Degree Heating Weeks (DHWs) – an experimental product indicating the accumulated thermal stress that coral reefs experience (image 3). It has been observed that DHWs of 10+ have been accompanied by severe bleaching and often mortality.

Current hotspots 4/30/2002





Courtesy of NOAA-NESDIS: NOAA

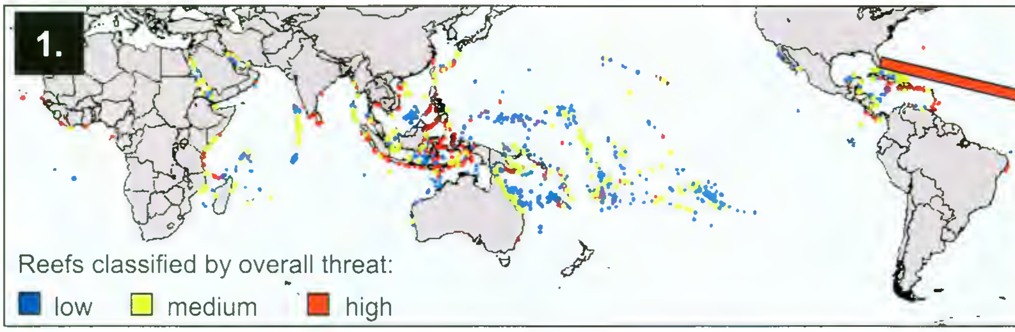
Sustainable Development of Small Island Developing States

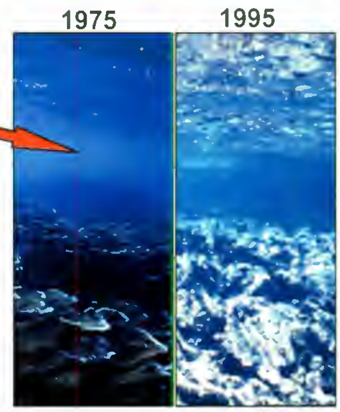
Coral reefs in many tropical zones are subject to severe environmental changes.

The map in image 1 shows reefs at risk due to coastal development, marine and inland pollution as well as exploitation. The photos on the right demonstrate the destruction of Carysfort Reef over the last 25 years.

Reefs at risk

1.



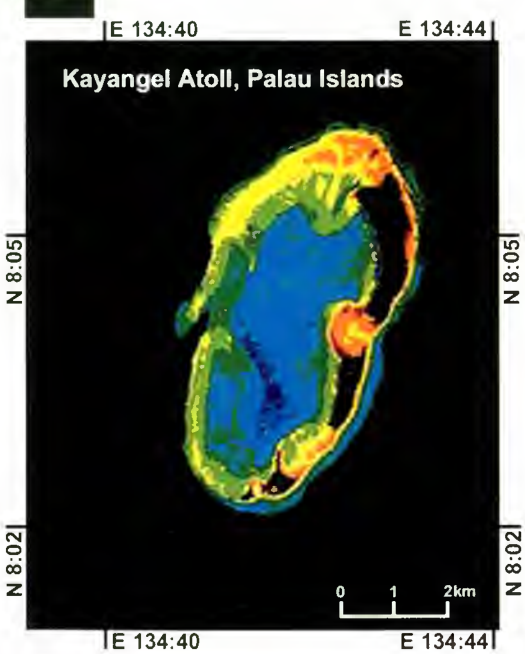


Map courtesy of ReefBase, http://www.reefbase.org
Photographs: Courtesy of College of Charleston

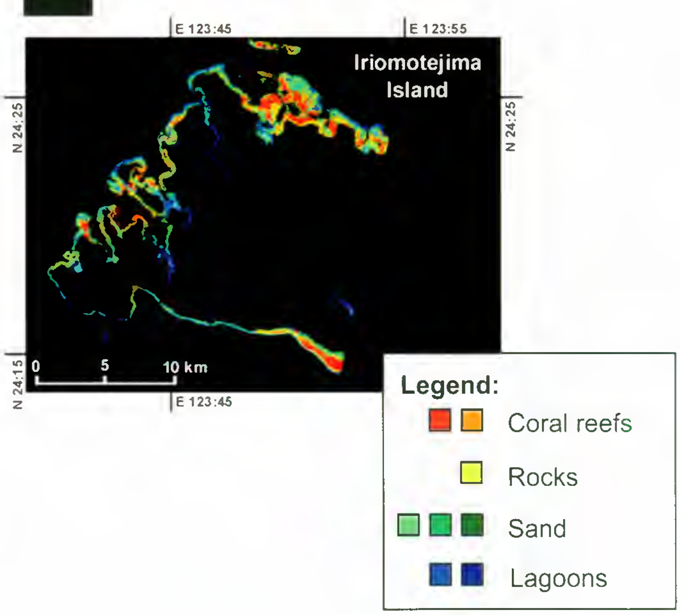
International co-operative efforts to develop an institutional Global-Scale Coral Reef Monitoring Network are supported by the TERRA (ASTER), LANDSAT, SPOT and JERS satellites.

The satellites assist in obtaining distribution maps of coral reefs. Such maps provide the most basic data for enhanced preservation and management and are necessary to monitor future changes in coral reef ecosystems. Images 2 and 3 show distribution maps and biotic community compartments on Pacific Islands prepared with SPOT and ASTER data.

2.



3.



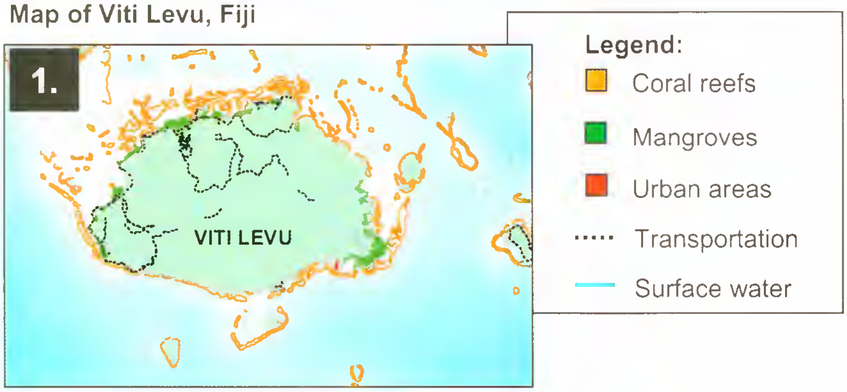
Courtesy of ASTER Science Project, METI/ERSDAC; Spot Image (image 2); NASA/METI (image 3)

Sustainable Development of Small Island Developing States

Climate change and sea level rise are expected to have profound effects on the Small Island Developing States and specifically on some very low lying Pacific Island Countries (PIC's), which – according to UNEP (1999 Pacific Islands Environmental Outlook) – have already experienced a range of impacts:

- A general alteration occurred in the South Pacific climate, starting in the mid-seventies.
- The intensity of extreme events, such as the 1998 El Niño, induced droughts in Papua New Guinea, the Federal States of Micronesia and Fiji and caused severe damage to food and export crops.

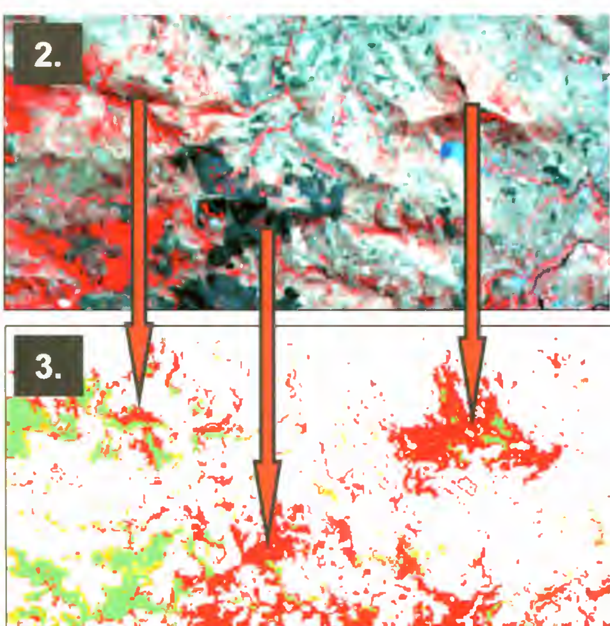
Map of Viti Levu, Fiji



Courtesy of ReefBase, http://www.reefbase.org

In 1998 the Fiji islands experienced a significantly dry summer. This caused vegetation fade and destruction, especially in the western part of Fiji's main island Viti Levu (image 1).

Satellite data were used by the South Pacific Applied Geoscience Commission (SOPAC) for vegetation monitoring on a regular basis and for mapping drought-affected vegetation. The 1998 SPOT data below (image 2) highlight areas of vegetation change on Viti Levu.



A pixel-wise arithmetic combination of the SPOT data and Fiji's forest map, used as reference for forest vegetation in 1991, allowed for the creation of the assessment map (image 3).

Legend:

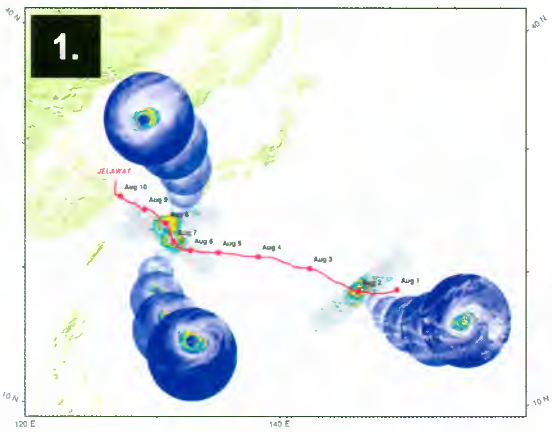
- No vegetation
- Forested areas in 1991 which were affected in 1998 by drought or deforestation
- Healthy forest and vegetation

Courtesy of SOPAC; Spot Image

Due to their size and location SIDS are extremely vulnerable to natural disasters. Among the extreme events affecting SIDS are cyclones, typhoons, floods, eruptions of volcanoes, droughts, landslides, earthquakes and tsunamis – to name but a few.

Vulnerability of SIDS to specific natural hazards

Courtesy of GeoVille

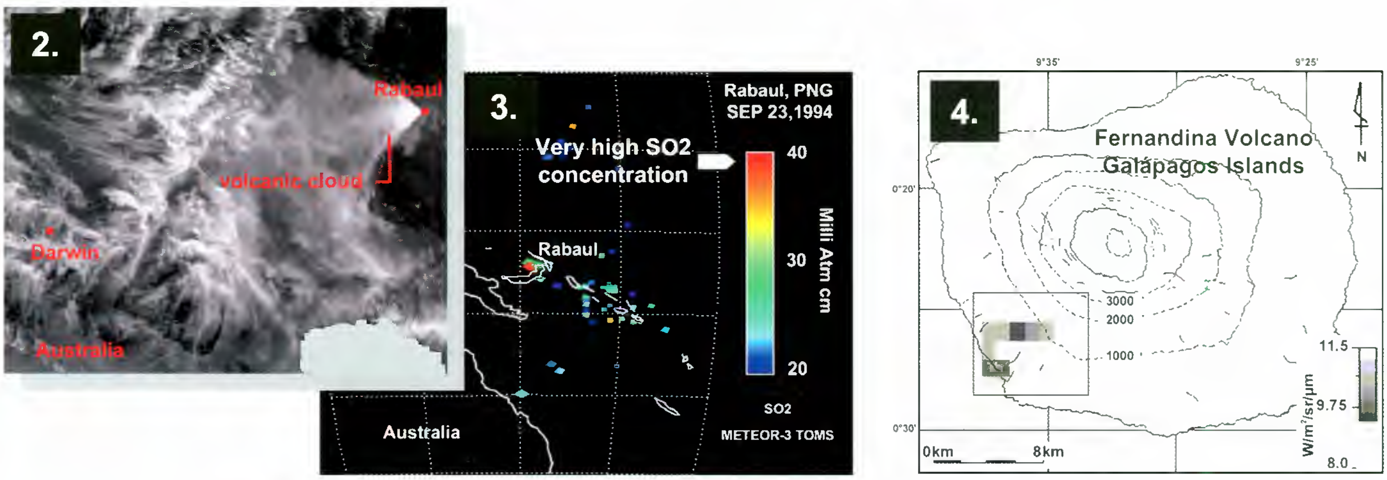


Courtesy of EORC/NASDA; NASDA/NASA

Satellite measurements can help to predict weather anomalies and certain natural disasters.

Image 1 shows a TRMM satellite-based observation of the Jelawat Typhoon in the Pacific. The typhoon occurred in August 2000.

The launch of new satellites has also improved the capability of scientists to monitor volcanoes. Applications below depict the tracking of eruption clouds (GMS-4, image 2), the measuring of sulphur dioxide gases in eruption clouds over Papua New Guinea (METEOR-3 TOMS, image 3) and the monitoring of lava streams on the Galapagos Islands (ERS-ATSR, image 4).



Courtesy of Michigan Technological University, NASA; NASDA (image 2); NASA (image 3); The Open University; ESA (image 4)