

## Biodiversity Indicators

Indicators of trends, status of biodiversity are essential to provide relevant information for policy-making and to assess the compliance of environmental management with international treaties. One example is the monitoring of the progress made toward the CBD strategic target to significantly reduce the rate of biodiversity loss by 2010. In the context of the CBD an indicator is defined as a measure on complex environmental issues to indicate the overall status and trends of biodiversity over time and space.

The signal of an EO sensor does not represent a biodiversity indicator in itself. EO images have to be translated for example into land cover maps from which, over time, a change of extent for certain biomes can be derived. Within DIVERSITY such an indicator has been developed for global dryland degradation.

## EO data for assessing the 2010 Biodiversity Target achievements on regional and global scale

## Project Participants

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## Project Users

UNESCO

⇒ [www.unesco.org]

The Secretariat of the UN Convention on Biological Diversity (CBD)

⇒ [www.cdb.int]

Centro American Commission for Environment and Development (CCAD)

⇒ [www.ccad.ws]

MarViva

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Fundacion Malpelo

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## Earth Observation from Space supporting Biodiversity Conservation



ESA satellites providing information over time and space

## The DIVERSITY project

Definition of appropriate benchmarks and indicators as well as the development of monitoring systems are indispensable to assess the progress made to achieve the 2010 Biodiversity Target adopted by the United Nations Convention on Biological Diversity (CBD) in 2002. On the last Conference of the Parties (COP8) the current indicator framework of the CBD has been established listing a provisional list of biodiversity indicators (Decision VIII/15). Earth Observation (EO) from space is considered to make a major contribution to the development and monitoring of these indicators. Such indicators allow further to enhance or understanding on the impacts and drivers of climate change.

The monitoring by EO of several different CBD indicators, mainly in the region of Central America, was addressed by a group of NGOs, UNESCO, the CBD secretary supported by the European Space Agency (ESA) and a team of European institutions. The DIVERSITY project, funded by ESA through its Data User Element (DUE) programme, demonstrates the contribution of EO to monitor the trends and status of different marine and terrestrial ecosystems relevant to biodiversity. DIVERSITY thus aims at studying, defining, and assessing geo-information services based on EO technology for supporting the user community involved in the implementation of the CBD.

GlobCover 300m May 2005/April 2006, ENVISAT MERIS

[www.esa.int/due]

[www.geoville.com/diversity]

European Space Agency  
Agence spatiale européenne

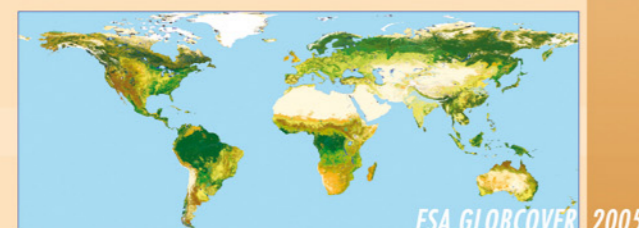
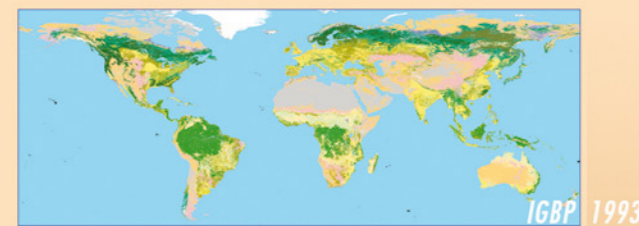
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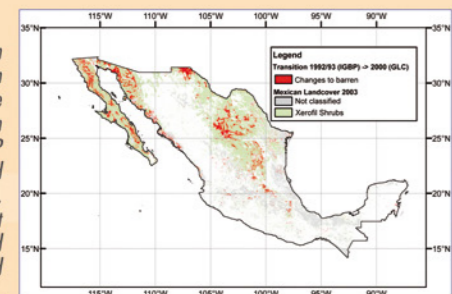
## Trends in extent of biomes: Global drylands degradation

According to the CBD, 47% of the land surface of the Earth constitutes drylands. Home to a richness of biological diversity, they are also central to the livelihoods of almost 2 billion people. Dryland ecosystems receive very erratic rainfall, and as a result are very fragile. Biodiversity in these ecosystems is under threat from a variety of human activities. The transformation of habitats for human use, mostly agricultural as well as increases in overexploitation, including overgrazing, has led to the degradation of up to 20% of dryland ecosystems – with stark results: desertification and drought, the endangerment of many species and strong economic losses. As a result, the objective of this service is to support the CBD with an up-to-date map on the extent of drylands (dry and subhumid lands) at global level and their changes. The product represents a status map of worldwide drylands as well as a trend of their changes over the past 13 years (1993 to 2005).

⇒ Trends of global dryland degradation are derived from the existing global land cover maps: IGBP (1992/93), GLC2000 (2000) and most recently the ESA GlobCover (2005).



⇒ Potential land degradation sites "Changes to barren land" in Mexico were derived from the comparison of IGBP (1992/93) and GLC land cover data (2000). Validation was carried out with existing Mexican land cover data sets and yielded an overall accuracy of 80%.

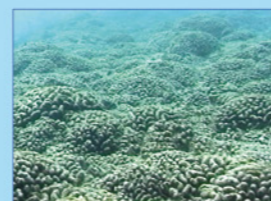


## Status of Ecosystems: Coral bleaching

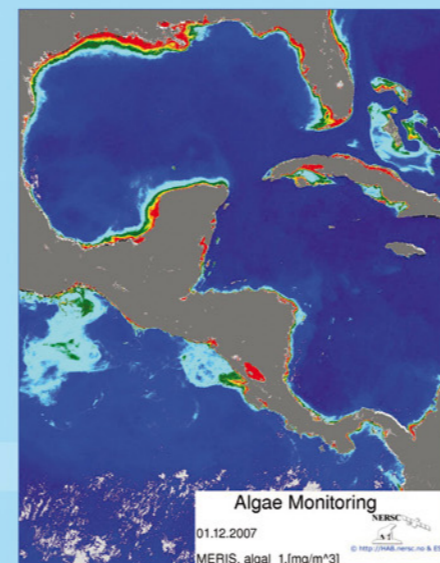
Coral reefs are one of the most biodiverse marine ecosystems on the Earth. At the same time coral reef ecosystems are very sensitive to natural, anthropogenic and climatic pressures. In fact coral reef bleaching is considered to be a climate change indicator as corals are sensitive to sea temperature rise. Thus there is a need for regional to global monitoring of the status of coral reef systems, in particular coral bleaching. Satellite EO data can significantly improve the effectiveness of coral monitoring due to the remoteness of coral reefs and transient nature of bleaching events. The coral reef mapping component of DIVERSITY provides regional habitat level maps of coral reef areas in the Mesoamerican area based on Medium Resolution Imaging Spectrometer (MERIS) and SPOT data for hotspot sites. Region-wide maps are produced for 2007 and early 2005, prior to a significant coral bleaching event in the Caribbean which occurred due to elevated surface temperatures in the second half of 2005. Additionally an ocean water quality and algae bloom monitoring service has been implemented based on satellite EO data to be integrated with other information for studies of the Mesoamerican Coral Reef in the Caribbean Sea. The service includes information about chlorophyll-a, sediments, dissolved organic compounds (DOC), turbidity, sea surface temperature (SST), and surface current expressions.



⇒ Habitat level classification of Glovers Atoll, Belize from SPOT and MERIS imageries. Both SPOT and MERIS give comparable accuracies, but MERIS is limited as its pixels are larger than the spatial extent of some reef features, such as the reef crest. These habitat level maps can be used in management programmes or to evaluate patterns of beta-diversity, reef connectivity and optimal locations for marine protected areas.



⇒ top: Effects of a coral bleaching event due to changing water conditions (e.g. sea temperature, water pollution).

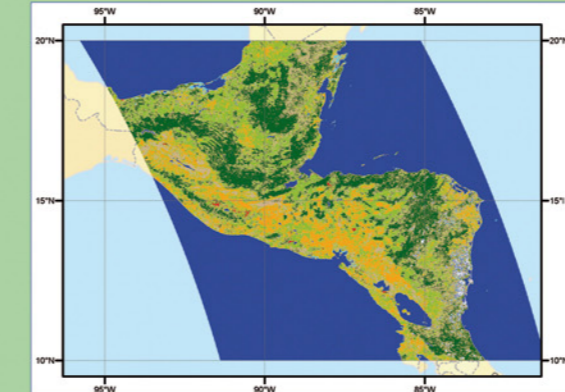


⇒ right: The monthly mean chlorophyll-a distribution for December 2007 based on the MERIS data. The available data resolves the seasonal variability of phytoplankton growth. The service is available online as daily, 7 days and monthly charts.

## Integrity of Ecosystems: Forests and Mangroves

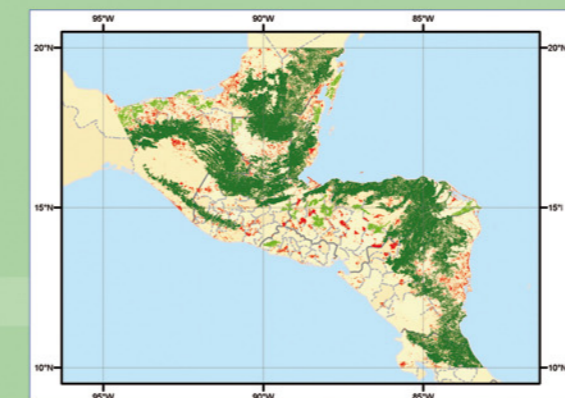
The seven Mesoamerican nations occupy a mere 0.51% of the planet's surface, but around 9% of the world's biological richness is concentrated in this region. Moreover the area hosts a large number of natural UNESCO World Heritage sites. For the 1980s, it was estimated that the region was losing 2.1% of its forests annually, one of the highest deforestation rates in the world. Accounting for this fact, Mesoamerican countries agreed on the foundation of the "Mesoamerican Biological Corridor" (MBC) to increase the sustainable development within the region. As a solid basis for planning, developing and surveying the MBC and the progress of its implementation, an adequate information base is necessary.

Within the DIVERSITY project regional land cover maps were produced for the years 2000 and 2007 covering the complete MBC based on MERIS data. Based on these maps the status and change in forest fragmentation is derived, which represents an important biodiversity indicator for ecosystem integrity. A similar study has been performed on the change on status of mangroves based on Synthetic Aperture Radar (SAR) data from the ERS sensors for two different areas in Mesoamerica. Mangrove forests are an integral part of the coastal environment but they are put at increasing risk through the consequent growth of intensively operated shrimp farms as well as by water pollution.



⇒ top: Land cover map using a MERIS full resolution acquisition from 12/04/2007. MERIS data was merged with MODIS (8-day composite) in cloudy parts of original MERIS acquisition. MERIS derived forest cover yielded an 85 % accuracy.

⇒ bottom: Based on the MERIS land cover classification fragmentation indicators such as patch size, distance between patches and patch shape were calculated as input for environmental monitoring and modelling.

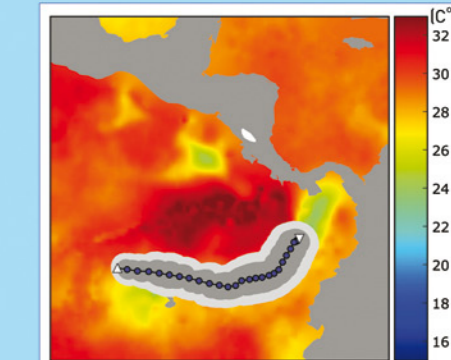


Forest Fragmentation Indicator Patch Size [hectares] to sustain critical forest biodiversity.

## Trends in distribution of species: Wildlife migration

Understanding how marine animals use the oceanic environment and its constraints is crucial for the development of sound management strategies for marine ecosystems that are threatened by climate change and direct anthropogenic pressure. This could not be achieved without the detailed observation of free-ranging organisms, which is now possible through the electronic tagging of individuals supported by satellite EO data.

Tracks of marine animals in the wild are of prime interest not only to identify habitats and high-risk areas, but also to gain detailed information about the behaviour of these animals. Using satellite EO data jointly with hammerhead shark tracking data allowed a study of how shark movements, and in particular the timing and route of their migrations, are linked to ocean conditions. The wildlife migration service developed in DIVERSITY relies on near-real-time satellite-derived maps of oceanographic conditions (sea surface temperature, water quality, surface currents) in the Tropical East Pacific Corridor (TEPC) area. The different EO products are derived using results from the current ESA's Medspiration and GlobColour projects. The relations between the observed animal movements and EO data of oceanic conditions are analysed to determine the oceanic conditions that trigger, constrain or facilitate the sharks' migrations.



⇒ left: Tracks of hammerhead shark, with error ellipses for the estimated underwater positions (95% and 50% confidence intervals) overlaid on sea surface temperature (MESPIRATION: Microwave + Infrared composite on March 10th, 2006).  
 ⇒ bottom: Hammerhead shark equipped with a pop-up tag for tracking the shark's movements. In this case, tagging is performed by a free-diver using a special speargun.

