# The European Biodiversity Observation Network, EBONE

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## 1. Introduction

EBONE (European Biodiversity Observation Network) is a project developing a system of biodiversity observation at regional, national and European levels as a contribution to European reporting on biodiversity. The project focuses on GEO (Group of Earth Observations) task BI 07-01 to unify many of the disparate biodiversity observing systems and creates a platform to integrate biodiversity data with other types of information. The system will make use of existing networks of site observations, wider countryside mapping and Earth observation (EO). The project addresses issues important for development of biodiversity monitoring system such as concept of monitoring; indicator species and habitats, in-situ and EO methods of biodiversity; database management and IT tools; protocols and harmonisation of available in-situ data. Special attention is paid to intercalibration of in-situ and EO monitoring. The system, methods and protocols developed in the project will be tested and validated in the field. Based on the validation we will propose refinements to the system (sites, protocols). The project aims to contribute to a world-wide monitoring system by developing a prototype system for monitoring Mediterranean ecosystems outside Europe.

## 2. Project description

The objectives of the EBONE project are:

1. The provision of a sound scientific basis for the production of statistical estimates of stock and change of key indicators that can then be interpreted by policy makers responding to EU Directives regarding threatened ecosystems and species;
2. The development of a system for estimating past change but also for forecasting and testing policy options and designing mitigating management strategies for threatened ecosystems and species.

Moreover, it is essential to link the scientific basis of the project to a sound institutional framework. This ensures continuity and long term collaboration between partners in the project. The end product will therefore be *„a biodiversity observation network that is spatially and topically prioritized and a structure for an institutional framework allowing European and monitoring and a possible extension worldwide including projections on trends based on reliable data and indicators"* (Halada et al 2009).

The framework developed in this project is being tested outside Europe as it is based on plant life forms which are also used in biogeography to define world biomes. In the period February-March field work has been carried out in Israel. The experiences from Israel are being integrated in the field handbook. These results will allow extending the approach to the development of a world monitoring system by adding habitats and life forms.

A major part of the work is examining available data, both in terms of its representativeness but also in terms of its statistical reliability. This process involves not only the assessment of in situ data but also the availability of EO data and especially the potential for inter-calibration. Statistics are being designed to measure the added value of integration in order to make recommendations for a sound and cost effective observation system.

The first phase of the project a conceptual framework for monitoring has been developed utilising the existing institutional context of European monitoring, databases, observation points and observing organizations agencies, and NGOs. The criteria for identifying indicators have been defined using existing experience and the framework of the CBD and SEBI and going beyond if needed. The design of requirements, protocols and procedures for a cost-effective monitoring system for Europe requires bringing together existing knowledge on monitoring protocols and a concept that is able to upscale and downscale data and observations from point locations to a general European level. It also needs a concept of the sampling design that can be used to test the existing data, observation points and databases. The conceptual framework will be used to consider how monitoring of biodiversity trends can be linked with the ecosystem research on underlying processes, drivers and pressures at multiple scales.

The statistically robust framework for monitoring is under development and it will form the basis for a system for Europe-wide statistically reliable, geographically referenced and comparable data collection of species and habitats of conservation interest. The General Habitat Categories that already have been developed in the BioHab project are elaborated as a common denominator to link existing data sets (Bunce et al 2008). The special attention will be paid to intercalibration of Earth observation (EO) and in-situ monitoring data. The monitoring system will be validated and the cost aspects in time and budget will be monitored in representative test sites. The sample sites in the project will be dispersed in strata defined in the project of the European Environmental Stratification (Jongman et al 2006).

The degree in which a relationship can be established between electromagnetic signals and the thematic classes (e.g. physiognomic, floristic or ecological) required by the biodiversity monitoring community, will determine the usefulness of the EO derived thematic maps. The work of Paradella et al. (1994) suggested that physiognomy may be the most important attribute which influences the EO response of vegetation. Whilst Jakubauskas et al. (2002), Moody and Johnson (2001) have reported successful crop, vegetation and species classifications when using time series of EO to exploit differences in phenology. Many have shown that when working regionally or locally, and using EO data types and classification approaches appropriate for the local scenario, accurate and reliable and therefore useful results can be achieved [Hill and Thomson 2005, Thomson et al 2003),

However, when continental and global biodiversity monitoring requires consistency in methodology, the variety of EO data types and approaches available is greatly reduced. As a result, the global land cover maps produced from EO have been limited to reporting the extent of major vegetation types (total number of vegetation classes ranges between 7 and 18 at pixel sizes ranging from 1km to 300m). Class, type and spatial detail of these products make them inadequate for detailed biodiversity or habitat monitoring.

In addition to thematic maps, EO can deliver quantitative information that is related to site conditions, physiological processes, stress conditions or vegetation damage, and is relevant to biodiversity. For example, the leaf phenological cycle and its changes over time have been measured with EO [Delbart et al. 2006, Heumann et al. 2007], the SEBI indicator 'fragmentation' is an obvious candidate for EO retrieval [Estreguil et al., submitted], and EO vegetation indices have been related to NPP and linked to species richness [Oindo and Skidmore 2002].

'Going in situ' is the only way to collect detailed information on the flora and fauna present. Also in situ land cover or habitat observations, when benefiting from a well designed field survey approach and protocol, have the advantage of providing high thematic and spatial detail. Many trials have already been carried out, and although much discussed, full integration between in situ and EO has not been achieved, as emphasised in the recent GMES summary produced by Wyatt et al [2004]. The PEENHAB project (Mücher et al, 2004) shows that all the available data bases have limitations and restrictions because of lack of validation. EBONE is planning to provide clear statements on the added value of data integration by testing if integration delivers improved estimates of biodiversity measures, in particular the SEBI indicators: (i) Trends in extent of selected ecosystems and habitats and (ii) Trends in abundance and distribution of selected species.

The EBONE hypothesis is that better estimates of habitat extent can be achieved through inter-calibration when combined with a well designed environmental stratification (Jongman et al. 2006) and a habitat classification system such as the BioHab General Habitat Categories (GHC) system which is based on 'EO friendly' physiognomic characteristics. EBONE will investigate the success of inter-calibration applied on existing EO land cover maps which provide full coverage but also look at the inter-calibration of EO habitat maps of sample sites produced to increase the in situ samples in space and/or time. The advantage of the second approach is that it could allow for the introduction of strata specific EO mapping methods. In this context EBONE will look at the role of LIDAR and EO time-series analysis.

## 3. Case-studies and applications

EBONE contributes directly to GEO BON, a Social benefit Area of GEO, the Group on Earth Observations (www.earthobservations.org) that is a partnership of 80 member nations (among which the Russian Federation) and more than 50 NGOs, working to benefit society by improving the coordination of existing Earth observation data sets and implementing new observations and related products. It is designing a Global Earth Observing System of Systems (GEOSS) as the mechanism to achieve these goals. Biodiversity is one of the nine Societal Benefit Areas set forth by GEO as foci for its work. Thus, a Biodiversity Observation Network (GEO BON) is one of the first systems GEO is proposing for the GEOSS.

By facilitating and linking efforts of countries, international organizations, and individuals, GEO BON will contribute to the collection, management, sharing, and analysis of data on the status and trends of the world's biodiversity. It will also identify gaps in existing observation systems and promote mechanisms to fill them. The role of EBONE in this context is to act as a pilot for Europe that can be used by comparable initiatives in other continents.

The main users of GEO BON will likely be national governments (especially in relation to their obligations under biodiversity-related conventions) and their natural resource and biodiversity conservation agencies at national and regional levels, international organisations and the biodiversity-relevant treaty bodies, non-governmental organisations (both national and international) in the fields of biodiversity protection and natural resources management, and environmental and scientific research organisations both in and out of academia.

The EBONE project is the European contribution to GEO BON. It is developing a system of biodiversity observation at regional, national and European levels as a contribution to European reporting on biodiversity as well as to the GEOSS tasks on biodiversity and ecosystems. EBONE assesses existing approaches on validity and applicability starting in Europe, expanding to regions in Africa and seeking cooperation with projects in other continents.

The EBONE approach for Europe will need to be compatible with approaches at the world-wide level. Through a pilot for global Mediterranean systems EBONE will adapt the system that will be developed for Europe for Mediterranean and desert systems in test areas in Israel and South Africa as representative countries for this biogeographical zone. This allows linking European approaches to Mediterranean and desert environment elsewhere in the world and allows testing of the methodology. A fundamental feature of the common approach to habitats is that it is based on life forms that form a biogeographical basis for defining world biomes.

## 4. Potential EU-Russia collaboration

Many biodiversity protection organisations have adopted "the ecosystem approach". For this to be effective, consistent and accurate information on ecosystem location, composition and status must be readily available. GEO BON's goal is to harmonise the mapping and monitoring of ecosystems worldwide, including terrestrial, freshwater and marine ecosystems. The key metrics of ecosystem change are extent (including the size and connectivity of fragments), condition, and change in functional parameters.

A global network of in situ field stations ("GEO BON Observation Nodes") is needed for ecosystem condition and function monitoring, and the development of harmonised field protocols is an important element of that endeavour. Some regional examples are extant or under development (e.g., ILTER, NEON and BIOTA), and can serve as prototypes. GEO BON will integrate key ecosystem functional parameters, many monitored from space with in situ calibration, into a Terrestrial Ecosystem Function Index (TEFI). TEFI will be based on a data assimilation model of measurements of the energy, carbon and nutrient balance, and will require research and development by partner groups. The following deliverables will be produced.

Because there are many approaches for defining habitats, ecosystems and RS data, continental and global data tend to be coarse or incomparable. This deliverable will provide common definitions, derived from the existing definitions and formulated by conventions and national and international data standardisation committees. A related product will be a set of guidelines for global data harmonisation for data relating to ecosystem change. This is a set of guidelines for sharing data between data owners and clients, including national data owners, institutes, university research groups and NGOs. Covering both in situ and RS data, it will focus on standardised protocols for handling intellectual property rights, including provision of intellectual and/or financial recognition and taking into account the restrictions of different GEO partners.

Ecosystem monitoring is carried out in Europe as habitat monitoring, but different countries apply it in different ways. The reporting on the Habitats and Species Directive showed that within Europe data are collected in such variable ways that comparison was not yet possible beyond the national level.

The most often used proxy for ecosystem data is land cover, but this can only be used for the main ecosystem types such as "tropical forest" because it does not distinguish between, for example, primary and secondary forest, and it combines evergreen and deciduous forest into a single category. Land cover definitions depend on the agencies that interpret the reflectance data. New hyperspectral and LiDAR tools will provide improved performance in the near future, but the results will need to be well-coordinated.

Ecosystem data are essential for data integration among GEOSS Societal Benefit Areas. Such data are at the basis of species diversity as well as ecosystem health, ecosystem services and climate modelling impacts. The present situation of poor data availability calls for an effort to set up a globally accepted system of ecosystem monitoring data in a harmonised way as described above in the deliverables.

It is already proposed to expand the EBONE project in the near future to those biomes that are most vulnerable to global change, land use change and climate change. These Biomes are the Arctic, high mountain systems and the tropical rain forest.

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