

ENVIRONMENTAL INDICATORS: REMOTE SENSING INDICATORS¹

Remote sensing and environmental assessment

Remote sensing is a unique instrument that can provide timely environmental information complementary to that from ground-based monitoring systems. It can be particularly useful for the cross-boundary synthesis and comparison of information. Remote sensing can make a significant contribution to assessments of large-scale and long-term environmental conditions on the regional to continental range and throughout the seasonal cycle and can also be used to gather information on local “hot spots”. Remote sensing can be used for retrospective trend analyses and diachronic detection, particularly of slow changes such as urban expansion, through the use of past satellite records. It can be applied in conjunction with dispersion modeling for the tracking of very dynamic phenomena, such as, transported air pollution. Remote sensing can also provide an independent means for the evaluation of the spatial distribution of important environmental events, including natural disasters. It can help gather information in areas that are not comprehensively covered by ground monitoring networks (in EECCA these include, for example, the Black and Caspian Seas and remote areas of the Russian Federation and Central Asia).

With geographic information systems, RS data can be overlaid, compared and integrated with other geo-referenced data, allowing an evaluation of the spatial distribution of important environmental events and their impact.

Indicators derived from RS data are powerful, if not unique, tools for studying and monitoring various processes on the planetary surface. One main problem to be solved is that RS produces large amounts of data that must undergo several levels of processing (requiring special facilities and expertise), in order to fully exploit capabilities and derive suitable formats and indicators for end-users. Moreover, remote sensing often provides a holistic rather than an analytical approach to monitoring environmental progress – here, it could help improve links between different components of the DPSIR framework.

Thus far, however, remote sensing from Earth observation has been little used for the development of national state-of-the-environment reports and other environmental assessments in any country. Nor has remote sensing been greatly used at international level. The provision of earth observation information is now becoming more oriented towards the immediate needs of potential end users, through, for example, the new EU initiative on Global Monitoring for Environment and Security (GMES).

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Using remote sensing information

In UNECE countries that currently use remote sensing for environmental assessment, most work focuses on a few topics, in particular those related to terrestrial (land) applications:

- land cover and use;
- state and trends in vegetation;
- biotope monitoring;
- urban environment, such as tracking spatial expansion (here in particular, historical satellite records can be used);
- oil spills, including their detection;
- flooding, for near real-time observation, impact assessment and, to a limited degree, risk analysis;
- sea and inland waters, for monitoring and mapping pollution indicators;
- forest fires, including risk analysis, detection and impact assessment of significant events;
- atmospheric air pollution transport, supporting dispersion modeling.

Several European Union projects now underway or recently completed illustrate potential applications of remote sensing:

- The Global Land Cover 2000 project, undertaken by an international partnership of about 30 research groups coordinated by the European Commission's Joint Research Centre, developed a harmonized land cover database for the whole globe, with special attention to forests, wetlands and desertification.
(See <http://www.gvm.sai.jrc.it/glc2000/defaultGLC2000.htm>).
- The Land Use/Cover Area Frame Statistical Survey (LUCAS) focuses on detailed measurement of land cover and land use, mainly in EU countries.
- The Monitoring Agriculture with Remote Sensing (MARS) Program provides information on crop yield prospects in areas of the world affected by food shortages, supporting EU development and emergency aid efforts, and also monitors EU farming to ensure that agricultural subsidies are being provided correctly.
- MOLAND (Monitoring Land Use /Cover Dynamics) measures urban and broader areas and in terms of their progress towards sustainable development, supporting indicators of urban and regional sustainable development, EIA and strategic environmental assessment, as well as the creation of networks of cities and regions (see <http://moland.jrc.it>).

- The Pecomines Project developed a regional inventory of toxic waste sites from mineral mining in Pre-Accession countries, tools for impact assessment, and contributed to assessment of recent mining accidents such as those in Aznacollar (Spain) and Baia Mare/Baia Borsa (Romania).

Opportunities and obstacles for the use of RS in EECCA countries

In EECCA countries, experience and capacity for using remote sensing varies significantly. At its first workshop in Ispra, Italy, the WGEMA Task Force on Remote Sensing Applications for Environmental Monitoring reviewed current opportunities, use and obstacles.

The list of priority environmental problems in EECCA countries where remote sensing could be used is extensive. Issues raised by country experts at Ispra range from the local to regional/basin scales to sub-continental scale. At local scale, the main focus was on the problems linked to anthropogenic pressure on the environment: for example, urban sprawl, transportation corridors, specially protected areas and heavily polluted “hot spots”. At regional or basin scales, attention shifted mainly to water issues: water resources (identified by experts from Georgia, Kazakhstan, Kyrgyzstan, and the Russian Federation); coastal and marine management (Georgia and Turkmenistan); and monitoring of lakes, snow cover and glaciers (Georgia, Kyrgyzstan and Tajikistan). At sub-continental scale, land use/cover and land degradation (in particular desertification) were by far the issues attracting the greatest interest, and were identified by nearly all participating EECCA countries.

In most EECCA countries, however, national technical means and expertise for using and applying RS data remain at a very basic level. There are a few exceptions, notably that of the Russian Federation, where both RS expertise and data are available and are in use. In Belarus and Kazakhstan as well, a system of institutions is in place. In many EECCA countries, however, little progress has been made in the past decade in the field of RS applications for environmental monitoring; indeed, in many there has been a sharp decline in the use of RS data since the collapse of Soviet Union.

Overall, a key concern for most EECCA countries is thus to improve domestic capacity to use remote sensing data for specific national and transboundary environmental problems: capacity building is a priority for attention. In a number of countries, in particular in the Caucasus and Central Asia, key obstacles relate to a lack of equipment and software or its obsolescence, a lack of skilled specialists and a lack of access to satellite images. Indeed, one common problem is that public institutions in EECCA have extremely limited funding, and thus face difficulties purchasing remote sensing information.

In its first workshop in Ispra, Italy, the Task Force concluded that satellite-based remote sensing data offers a great potential value and benefits to environmental protection efforts in Europe. Specifically, RS can:

- Enhance state of the environment reporting by complementing existing ground, and airborne-based data, providing unique time series information showing spatial and physical changes, data on transboundary issues, and, in selected cases, an affordable and timely alternative to *in situ* assessments;
- Support monitoring of legal compliance and progress in implementation of policy targets;

- Enhance the information base of the policy planning process and the quality of resulting decisions made for environmental protection.

The Task Force's second Workshop on Remote Sensing Applications for Environmental Monitoring (held in November 2003 in Baku, Azerbaijan) developed a proposal for a program to use remote sensing information on a pilot basis for environmental monitoring and indicator development in EECCA. The main objective will be to identify a key set of indicators derived from remote sensing and to map these indicators across the UNECE region. A series of complementary measures, including an opportunity awareness campaign for end-users, capacity building activities and an application demonstration exercise, will also form part of the activities. This program would:

- Help to develop environmental indicators on the basis of data from remote sensing;
- Build capacity of EECCA countries to use RS for environmental assessments;
- Contribute to the harmonization of environmental assessments in the UNECE region;
- Provide input to the fourth pan-European environmental assessment report for the 2007 "Environment for Europe" Ministerial Conference;
- Associate EECCA countries with the Global Monitoring for Environment and Security initiative;
- Prepare strategic and technical documents on methods to provide decision-makers with information based on remote sensing.