

OSS - USING INTERDISCIPLINARY RESEARCH AND MODERN MONITORING TECHNOLOGIES TO ASSESS ECOSYSTEMS IN AFRICAN DRY AREAS

C. Fezzani^a, W. Essahli^a, H. Ravenel^a, G. Begni^{b,*}, J.M. D'Herbes^c

^a Sahara and Sahel Observatory (OSS), Boulevard de l'Environnement BP 31, 1080 Tunis Cedex, Tunisia, { boc, wafa.essahli, hugues.ravenel }@oss.org.tn and oss@gnet.tn

^b MEDIAS-France, CNES-Bpi 2102, 18 Avenue Edouard Belin, 31401 Toulouse Cedex 4, France, begni@medias.cnes.fr

^c Research Institute for Development (IRD), Maison de la Télédétection, 500 rue J.F. Breton, 34093 Montpellier, France dherbes@teledetection.fr

KEY WORDS: Developing countries, Ecosystem, Monitoring, Satellite, Decision support, Network, Observations

ABSTRACT:

The Sahara and Sahel Observatory (OSS) aims at building up an African arena for co-operation and exchange to combat desertification and poverty through a North-South-South mutually profitable partnership. More specifically, OSS supports the implementation of the Convention to Combat Desertification in Africa. OSS has launched the *DOSE* programme to develop a management tool for desertification processes that decision-makers and stakeholders could use to better understand as a phenomenon, and, working together, better curb its adverse effects (Agenda 21). This program includes three major parts: *ROSELT*, *IMAGES* and *SISEI* (an environmental information and monitoring system on the Internet). *ROSELT* and *IMAGES* are described here. The *ROSELT* research programme aims at promoting and supporting long term programmes for environment monitoring in arid zones affected by land degradation, taking into account biodiversity management and the role of arid zones in relation to the global climate change and the combat against desertification. The *IMAGES* programme aims at defining an OSS approach for the development of a desertification monitoring mechanism that can serve the countries and sub-regions in the OSS zone of action. This approach is based on the use of satellite data together with ground and socio-economic data in order to produce indicators that describe the extent and pace of evolution of the related processes. It offers technical support in developing operational applications to help local decision-makers and technical staff addressing critical issues such as food security, natural resources management, and environmental monitoring. The three components of the *DOSE* programme have been designed as mechanisms for environmental information management to serve legal instruments on the African environment (e.g. on desertification, biodiversity, climate change, wetlands, etc.). They will provide decision-makers with sound scientific and technological tools to combat desertification within a sustainable development perspective.

1. THE OSS (« OBSERVATOIRE DU SAHARA ET DU SAHEL ») INSTITUTION, ITS MISSION AND ITS PROGRAMMES

The Sahara and Sahel Observatory (OSS – “Observatoire du Sahara et du Sahel”), an independent international organisation based in Tunisia, is composed of African and European countries, regional and international organisations, and representatives of civil society. Its mission is to strive to build up an African arena for co-operation and exchange to combat desertification and poverty.

The OSS guideline is to promote a North-South-South mutually profitable partnership, through experts and institutions networking. Its Executive Secretariat is made of multidisciplinary and multicultural professionals working for and with Africa. Thanks to its flexible and simple structure designed to ensure maximum efficiency, it may work with member states and organisations, and strengthen their actions but never acts in their stead. The OSS overall objective is to harness, disseminate and share information to encourage and develop sustainable natural resource management.

More specifically, OSS supports the implementation of the Convention to Combat Desertification, the CCD in Africa using a decentralised approach that commits the states just as completely as the civil society.

By developing inter-regional co-operation in monitoring and evaluation among African countries, OSS has supported some African countries in including the System for the circulation of information on desertification (*SID/SISEI*) and the *CCD impact monitoring-evaluation indicators* in their National Action Programmes (PAN).

Chap. 12 of Agenda 21 and Art. 16 of the CCD recommended developing a management tool for desertification processes that decision-makers and stakeholders could use to better understand as a phenomenon, and, working together, better curb its adverse effects. To respond to this need, OSS has launched the *DOSE* programme (Mechanism for desertification observation, monitoring and evaluation). *DOSE* aims at ensuring access to the considerable mass of information that exists in Africa, exploiting it, organising its dissemination and promoting the development of a mechanism for observing, monitoring and evaluating desertification in Africa. This programme produces data at various scales - from field studies to low and high resolution satellite images using well co-ordinated methods.

The *DOSE* programme includes three components. *ROSELT* (long-term ecological observatories monitoring network - www.roselt-oss.teledetection.fr) and *IMAGES* (satellite images for meteorology, agrometeorology and environment management in the Saharan-Saharan zone -

* Corresponding author.

www.unesco.org/oss/v_fr/programmes), serve to improve regional-level knowledge on the desertification process. They plan to enable African and European scientific institutions to develop methodologies for co-observation of environmental inter-observatory measurements either on the ground or using satellite images. *SISEI* is an environmental information and monitoring system on the Internet, aiming at helping to circulate information scattered in many centres of expertise (www.sisei.net). The two first components, ROSELT and DOSE, are described hereunder.

The objective of the Network for Long Term Ecological Monitoring Observatories (*ROSELT*) Programme is to promote and support long term programmes for environment monitoring in arid zones affected by land degradation.

The *IMAGES* programme objective is to provide the various African data processing centres in the OSS area with standardised tools and methods for exploiting low resolution satellite images acquired using instruments such as NOAA/AVHRR and Spot 4-5/VEGETATION.

ROSELT and *IMAGES* aim at providing the OSS partners with a sound scientific and technological basis to address ecosystem assessment in dry areas using advanced interdisciplinary research and modern monitoring tools.

2. THE ROSELT PROGRAMME

As stated above, the Network for Long Term Ecological Monitoring Observatories (*ROSELT*) Programme is to promote and support long term programmes for environment monitoring in arid zones affected by land degradation. Biodiversity management and the role of arid zones in relation to the global climate change and the combat against desertification are taken into proper account. ROSELT is developed by IRD ("Institut de Recherche pour le Développement"), a French institute, and INSAH, an African regional institute linked to CILSS (« Centre Inter-Etats pour la Lutte contre la Sècheresse au Sahel »).

After an initial stage of design and start-up, involving the countries concerned and a group of North and South experts, ROSELT is currently implementing a quadrennial programme on a group of pilot observatories where data collection and processing protocols are being applied and tested. These protocols were produced using harmonised methods, and defined and validated products such as biophysical and socio-economic indicators. The participating observatories constitute a network of territories representing the main ecological situations in the area where research programmes in line with sustainable development are being carried out. Up to now, ROSELT has been considered as the tool and the scientific framework for desertification surveillance and monitoring-evaluation mechanisms needed for the Action Programmes defined by the CCD.

The ROSELT network was designed to:

- provide reliable, harmonised data bases for the preparation of "states of the environment" at different levels;
- better understand ill functioning of the ecological systems and the mechanics of desertification;
- assess the impact of developmental actions and actions to combat desertification;

- identify methods and techniques for environmental rehabilitation and rational management of natural resources;
- provide reliable information on the scope of desertification and its ecological, agro-ecological and socio-economic consequences.

A unique feature for ROSELT is that, for first time, African countries have committed themselves to joining forces to develop a common cross-border monitoring tool for the circum-Saharan area as a whole (OSS region) by merging their national, sub-regional and regional interests.

3. THE IMAGES PROGRAMME

The main objective of the *IMAGES* programme is to provide the various African data processing centres in the OSS area with standardised tools and methods for exploiting low resolution satellite images acquired using instruments such as NOAA/AVHRR and Spot 4-5/VEGETATION. This programme offers technical support in developing operational applications that involve products derived from low resolution images to help local decision-makers and technical staff with critical issues such as food security, natural resources management, and environmental monitoring.

The *IMAGES* programme has three main components:

- component A: consolidation, monitoring and evolution of SPACE II/OSS software;
- component B: study of a desertification monitoring mechanism;
- component C: pilot project of AVHRR data process by SPACE II/OSS

3.1 Component A: SPACE II/OSS software

In order to strengthen exchange relations in the OSS zone, the SPACE II/OSS software was developed to provide for standard operational processing of AVHRR images acquired by NOAA/HRPT receiving stations. It has been adapted for production purposes and is tailored to rapidly generate optimally corrected mosaics by incorporating calibration, atmospheric correction, navigation, automated correlation using ground control points, and restitution of given cartographic projection.

The core of the software was developed and validated by JRC/SAI (Joint Research Centre/Space Applications Institute) of the European Commission. It is run on Unix workstation under Solaris 2.5 and offers user-friendly interface with multiple windows, pull-down menus and click-and-point tasks. Several African centres are equipped with SPACE II/OSS, and OSS will consider requests for it from all African centres in the OSS zone. Furthermore, a PC version and an adaptation to process data from the VEGETATION instrument are available

3.2 Component B: study of a desertification monitoring mechanism

Thought and discussion by OSS and its partners are part of the implementation of environmental planning instruments provided for in the CCD (NAP, SRAP, RAP). The aim is to define an OSS approach for the development of a desertification monitoring mechanism that can serve the countries and sub-regions in the OSS zone of action. This approach is based on the

use of satellite data together with ground and socio-economic data in order to produce indicators that describe the extent and pace of evolution of the processes in question.

The Desertification Monitoring Mechanism thus defined forms an integrated set of information systems connected to the existing territorial level of activity and responsibility. It abides by the principle of subsidiarity with each level carrying out actions for which it is best-equipped, bearing in mind the requirements of sustainable development. Each of the systems produces indicators and information products based on both biophysical and socio-economic multi-scale, multi-source and multi-date geographical data and strives to satisfy the needs of the main categories of users, viz. scientists, experts, decision-makers, representatives of the civil society.

In more tangible terms, the mechanism will depend on the establishment of "situation centres" and "analytical centres", probably at the state level, and "co-ordination centres" at the sub-regional level, and "information centres" at the regional or international level. This work will be organised in three stages:

- establishment of a preliminary desertification monitoring mechanism to produce simplified but immediately useable indicators (institutional and technical stage);
- consolidation of simplified indicators and preparation of more sophisticated indicators (essentially scientific stage);
- gradual transformation of preliminary mechanism into a stronger mechanism that uses the upgraded indicators prepared in phase 2 (technical stage).

The creation of this mechanism will require the development of a strong, balanced partnership between the African and non-African organisations working on food security or environmental warning systems in order to strengthen the African capacity for analyses and decision-making.

These technical and scientific stages of the project will require substantial funding to which OSS will contribute. This mechanism fits in completely with the conclusions of a workshop on desertification warning systems convened by the CCD Secretariat in Niamey in October 1999. The workshop conclusions were approved by the Conference of Parties in Recife that same year. Much thought has been given internationally to this theme and several initiatives are being considered to materialise mechanisms of this sort. By actively participating in this work, OSS contributes to harmonising various approaches and calling appropriate attention to the achievements of its member states and organisations.

In a first step and at the national level, the mechanism will be developed in Algeria, Morocco and Tunisia under EC funding (LIFE-Third Countries).

3.3 Component C: Applications of SPACE II/OSS

Thanks to the products provided by SPACE II/OSS software, the following applications can be investigated from the local to the regional level using well-controlled technical and scientific bases. They have been tested together with the "Centre de Suivi Ecologique" (CSE, Dakar, Senegal), and AGRHYMET (a CILSS centre, West Africa) and as part of a capacity-building programme on early warning and food security for the IGAD region:

- **Monitoring natural vegetation and crops:** Improved vegetation indexes derived from SPACE II/OSS software

can be used for a more accurate analysis and a better description of the spatio-temporal evolution of vegetation. These indexes also provide information on biomass and main crop yield.

- **Bush fires:** Reflectance measurements from bands 3, 4 and 5 of the AVHRR sensor allow for quite good detection of active fires both in daytime and at night. This information can be delivered quickly to local users.
- **Water balance:** Surface temperature (computed from AVHRR bands 4 and 5) is a good pointer for vegetation cover evapotranspiration, which has bearing on water balance estimation. Comparing surface temperature with albedo (calculated from AVHRR bands 1 and 2) makes it possible to produce an indicator of vegetation desiccation. This information can be used in early warning systems for agrometeorology, agroforestry and plant physiology.

4. CONCLUSIONS

The DOSE programme brings together ROSELT, a scientific component aiming at better understanding what are the leading desertification processes and monitoring them through available information, and IMAGES, an application-oriented programme aiming at setting up operational monitoring systems. An active synergy between these two aspects is quite mandatory to set up robust monitoring actions as defined in the UNCCD and in the related National Action Plans. Such an effort has been made possible through North-South scientific and technological co-operation, taking advantage of ground knowledge available at local, national and regional scales, modern observation systems and associated software developments, federative research in European and African laboratories. The SID/SISEI concept allows a better information circulation and a flexible access to widely spread sources. This should make the DOSE programme a success story for African countries in implementing the UNCCD, such combating the impacts of dryness and desertification and consolidating their way to a sustainable development in spite of the many natural and socio-economic challenges they have to face.

ADDITIONAL INFORMATION SOURCES

OSS, 1997. Stratégie 2000 de l'OSS. General Assembly, Niamey, February.

OSS, 2002. <http://www2.unesco.org/oss1/> (accessed 4th March 2002).

OSS, SCOT, 1999. Etude d'un système global de suivi de la désertification intégrant données satellitaires et mesures terrain. December.

OSS, UNITAR, 2000. Guide SISEI, Systèmes de Circulation de l'Information et de Suivi de l'Environnement sur Internet. Edited by OSS, UNITAR, GTZ and Ministère Français des Affaires Etrangères, January.

ROSELT/OSS, 1997. Présentation générale de ROSELT, ROSELT leaflet, April.

ROSELT/OSS, 2002. Organisation, Méthodologie et Fonctionnement du Réseau ROSELT/OSS, January. See also <http://www.roselt-oss.teledetection.fr/> (accessed 4th March 2002).