Earth Observation Initiative in former homeland of South Africa in support to EU activities on land degradation and integrated catchment management.

SIXTH FRAMEWORK PROGRAMME

Cooperation (INCO)

PRIORITY A.2.1 A.2.3

PRIORITY TITLE: Rational use of natural resources

SPECIFIC SUPPORT ACTION

Publishable Final Activity Report

Council for Geoscience

brgm Géosciences pour une Terre durable

GRS

Contents

List of figures

List of tables

1. Project Objectives

1.1. Strategic objectives

EO-LANDEG is a FP6 Specific Support Action (SSA) which aim is to develop a pilot initiative to promote, at international level, an attractive study area in the former bantustan of Transkei, South Africa, with the perspective to monitor and propose conservation measures to combat land degradation, soil erosion, stress on ecosystem and water resources, and their integration to technical assessments, economic productivity and poverty alleviation. Transkei is one of the poorest and most disadvantaged former homelands in South Africa where natural resources (vegetation, wetland, water, soil and vulnerable spring ecosystems) are being depleted, due in particular to natural changes (climate variation straddling over semi-humid to semi-arid in places and rapid geomorphologic changes) but also to inadequate agricultural practices and techniques of water utilisation, overgrazing, and mismatching between resource and population spatial distribution.

1. 2. Technical objectives

Objective 1: Setting up the pilot site. Relevance of existing data and on-going research: The first objective of EO-LANDEG is to consolidate local expertise, monitor on-going research and facilitate accessibility to spatial data and exploitation of the results. This consolidated set-up will represent the core of the Earth Observation Initiative around which strategy workshops, need analyses, decision making, information and dissemination activities will take place.

Objective 2: Assessing Earth Observation and monitoring tools: Remote sensing simultaneously covers several monitoring parameters and allows measuring changes and speed of changes of the natural environment. This activity is dedicated to setting up of a working group on land-use remote sensing and its application on assessment and monitoring of land and ecosystem degradation, desertification, erosion, utilisation and protection of natural resources in Transkei. The relevance of different techniques of assessment using several remote sensing approaches and types of images are to be discussed. Of special interest is the analysis of newly developed innovative observation tools that are still in needs of application in the estimation of reserves of natural resources: radar, radar interferometry (INSAR), imaging spectroscopy, very high spatial resolution…

Objective 3: Dissemination and promotion of the EO-LANDEG initiative: The objectives here are to demonstrate the exploitation of the results of the Transkei Pilot Earth Observation Initiative to the international scientific community, local stakeholders and policy makers, to test EO-LANDEG as an educational tool at school and university level as well as at local community level, to promote the team and to position itself as a partner in a future EU consortium. EO-LANDEG will be able to provide a site-based model as a research platform and information management system to be compared with, or applied to, regions in Europe and Africa.

2. Contractors

2.1. Co-ordinator

BRGM is the French Geological Survey. The support activity team possesses a solid expertise in Earth Observation techniques applied to environmental problems: land degradation, soil erosion, risk and natural disaster monitoring, water, and development planning.

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2.2. Contractors

Council for Geoscience (CGS) is the Geological Survey of South Africa. The project team has a wide experience in Transkei and the Mzimvubu Water Management area where they have completed and are still carrying out several projects on water reserves, ecosystems and Earth Observation at catchment scale. CGS works in close co-operation with the stakeholders, the policy makers and the scientific community and has built a large spatial data set.

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Geospatial and Remote sensing Services (GRS) is a South African SME. GRS teaches and trains students in GIS and Earth Observation at Fort Hare University in the former Transkei. GRS has large experience in remote sensing applied to land use, agriculture, ecosystems and works in collaboration with other departments specialised in ecology and sociology. GRS has started a unique educational initiative by which it demonstrates how GIS can be used at school level to teach geography, social science and natural resource protection.

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3. Official project logo and web site

EO LANDEG www.eolandeg.com

4. The pilot initiative area

The pilot site area covers the Water Management Area 12 (WMA12) of the Republic of South Africa. It includes the Mzimvubu, Mtata, Mbashe, Buffalo, Nahoon, Groot Kei and Keiskamma major rivers.

It corresponds to the former homeland of Transkei and is one of the areas most severely affected by land degradation in the country

5. Work performed during the reporting period

Apart from Consortium management activities (Consortium Agreement, project handbook and Quality Assurance Plan, see section 3) the main “technical and promotional” activities carried out during the project are reported below.

5.1. Meetings with national and local stakeholders

- The Department of Science and Technology (DST), through its Department of International Partnership, is in charge of FP6 for South Africa and they have started a European – South African Science and Technology Advancement Programme (ESASTAP) which is running for 2 years and will be helping the research teams to partnership with Europe and participate to FP7.
- The Department of Water and Forestry (DWAF) can release data on surface and groundwater abstraction, river gauge monitoring as well as on forestry potential.
- The Department of Agriculture is in charge of the implementation of the national Land Care Project at local scale.
- The Weather Bureau holds data on climate and rainfalls
- The Institute for Soil, Water and Climates (ISCW) carries out soil inventories.
- The Department of Environment and Tourism
- ESKOM (Electricity Board) and TELKON (Telecommunications)
- The Survey and Mapping holds ancient and recent aerial photographs

5.2. Field investigations and meetings with local stakeholders

A field visit by the project team and meetings with the main stakeholders were organised during the first term of 2006. Land degradation forms were assessed by the project team in the field. The major stakeholders involved in national and local programmes were met in view of informing them of the EO-LANDEG initiative and to discuss data availability and on-going relevant activities.

The Mzimvubu catchment was historically divided into two territories, before the abolition of the apartheid regime, i.e. the Transkei (homeland) and the former Republic of South Africa.

This led to two different farming practices (Figure 1), the result of which can still be seen on the Landsat satellite image (Figure 2). The image clearly distinguishes the region north-east of Queenstown where the Bonkola basin is occupied by commercial farming with grassy grazing grounds from the Qoqodala – Ku Zingqutu – Vaalbank area which is characterized by communal settlement practicing subsistence farming. Deep erosion and land degradation is mostly reported in the former homeland areas.


Figure 1: commercial extensive farming (left) and subsistence farming (right)

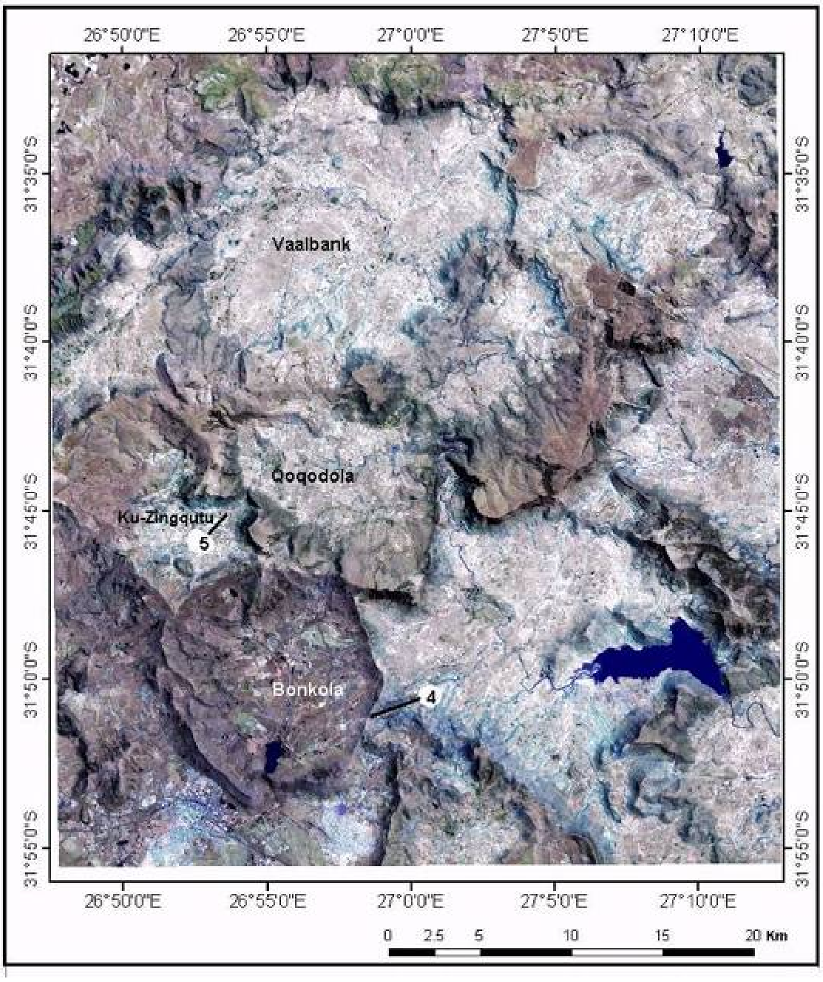

Figure 2: Landsat image of the Qoqodala area

The field investigations have clearly enhanced the difference between commercial farming which consists of large farms with grassy plains for cattle and sheep grazing and subsistence farming in the former homeland which consists mostly of shrubs and maize plots (Figure 1).

The field investigations have shown that land degradation concerns are of several types:

- Strong erosion often starting upstream in a spring-fed wetland which leads to the formation of badlands (locally called "donga") and the silting of rivers and dams ;
- Invasive plants as a result of clearing of natural vegetation and destruction of the ecosystem (shrub and trees) for firewood ;
- Barren soil as a result of extensive cultivation and uncontrolled cattle grazing.

5.3. Data collection and cataloguing metadata

During meetings and interviews, an extensive review of existing data and on-going projects relevant to the pilot initiative area was carried out locally by the South African team. Efforts were carried out to collate as much data as possible in view of creating a catchment database easily accessible. This made possible inventorying significant metadata on form of a metadata catalogue using the ArcCatalog software, compatible with the European INSPIRE format.

Access to data has been described in a "Data Use Agreement" that provides potential users with access rights and fares where applicable.

Resource title		WMA12 Enpat Existing Forestry
Date-publication		20010501
Date- temporal extent		
Geographic extent	**X min**	26.7639965948484
	X max	29.9463405609103
	Y min	-29.8722709991975
	Y max	-32.9732894894677
Resource language		English
Resource topic category		Forestry
Keyword		land use, forestry
Geographic service		
Constraints	**Access constraints**	Copyright DWAF Not to be sold
	Use limitations	Not to be sold
Resource responsible party	**Organisation**	Coastal & Environmental Services
	Role	
Abstract		Coastal and Environmental Services Joint Venture. 20 February 2006. Draft Report prepared for DWAF. The development of a Strategic Environmental Assessment (SEA) for the Zone of Afforestation Potential in the Eastern Cape. This data set delineates existing forestry plantation areas within WMA12. It was derived from the ENPAT/TOURPAT 2001 database by extracting areas of land use of type Forestry.
Purpose		In terms of the WMA12 SEA this layer represents exclusionary areas where forestry is not allowed, since it represents areas of land under commercial forestry plantation.
Deliverable format	**Name**	Shape file
	Version	
Representation type		
Resource spatial reference system	**Code**	Gauss conform, central meridian 19°E

Figure 3: extract of the metadata catalogue

5.4. Review of existing projects

Several large scale projects are currently undertaken in the pilot site area. They include:

- Assessment and monitoring of land degradation using remote sensing and geographic information systems (by CGS).
- Development of methodologies for land degradation mapping using a combination of radar and optical remote sensing (CGS and Reunion University)
- Land erosion and degradation modelling on the Macubeni rehabilitation pilot project (GTZ, Rhodes University, ATS)
- Agricultural strategies, soil conservation and land care (Department of Water Affairs and Forestry)
- The development of a Strategic Environmental Assessment for the Zone of Afforestation Potential (DWAF and Coastal & Environment Services)
- Research needs in water stress areas and water development strategy at National, Provincial and Local levels (Water Research Commission)
- Aquifer conceptualisation of catchment scale (Water Research Commission)

5.5. Role of Earth Observation in land and ecosystem degradation monitoring

A desk study of Earth Observation tools and methods relevant of land degradation parameters and processes has been performed. This took the form of an extensive compilation of the existing appropriate literature.

A review of different types of land degradation (erosion, salinisation, organic matter loss, soil compaction, landslide, soil contamination, loss of biodiversity, soil sealing, mining) and relevant indicators was performed.

In parallel, a review of the main existing EO sensors and their characteristics was carried out, including: sensor type (optical, radar), spectral range and number of bands, spectral resolution, stereo capabilities, revisit capabilities, ground resolution, etc.

An extensive compilation of relevant scientific literature was undertaken to highlight the different EO and image processing techniques that can be used, or have the potential to be used, in monitoring surface parameters relevant of land degradation processes.

These include:

- Parameters accessible through digital image processing, e.g. :vegetation monitoring (various parameters on nature and status of vegetation), soil monitoring (moisture content, roughness, soil composition and mineral abundance), soil contamination, salinisation, soil protection monitoring (crop residues), population density monitoring;
- Quantitative morphology parameters accessible through digital processing of DEMs: slopes (angle, curvature, length, aspect…), drainage (drainage network, density, hierarchy, drained area, flow accumulation…);
- Parameters accessible through image interpretation and/or processing: tillage direction, gully and channel erosion features, river and dam sediment load, irrigated areas, sealed soils, parcel map.

The study in particular highlights that newly developed techniques, i.e. high spectral resolution (imaging spectroscopy) and very high spatial resolution can bring an invaluable contribution to land degradation assessment and monitoring, giving (quantitative) access to parameters previously out of reach through EO.

Regarding land degradation processes, all these parameters can be grouped in different categories according to their evolution in time:

- Permanent factors include nature, composition and mechanical properties of soils, slopes angle, aspect and curvature and all geomorphologic parameters, nature and density of the drainage pattern, geological and structural context;
- Semi-permanent or progressive factors are represented by factors evolving in time and include vegetation, land use and land cover, deforestation, agricultural practices, hydro-climatic conditions, anthropogenic factors (population distribution density and pressure on its environment…), soil moisture content, etc;
- Triggering or aggravating factors correspond to sudden events, the occurrence of which may destabilize natural equilibrium and trigger or aggravate the degradation process. These include exceptional climatic event, floods, earthquakes and other natural disasters together with man-induced impacts.

Most of land degradation parameters accessible on a spatialised form through Earth Observation data processing have been summarized in the table below

Type of land degradation	Main controlling parameter	Accessible or measurable parameters	Sensor(s)	Processing technique
Water erosion	Soil erodibility	- soil composition - particle size – surface roughness	Hyperspectral SAR	- Mineral classification, spectral indices - Signal inversion
	Vegetative cover	- vegetation density - species - health status	Multispectral Hyperspectral Hyperspectral	- NDVI, LAI, FPAR, various spectral indices… - Indices, classification - Indices, classification
	Slopes	- angle, length, curvature, aspect	DEMs : Radar (SRTM…), Optical (stereoscopy)	- Quantitative morphology analysis

	Rain drop erosion	- Soil compaction	Multispectral, hyperspectral	- Spectral indices
	Rills, gullies, channels		Very high spatial resolution (optical)	- Visual interpretation - Pattern recognition?
Tillage erosion	Tillage direction		Very high spatial resolution (optical)	- Visual interpretation - Pattern recognition?
Soil salinisation	Salt content at surface	- Soil reflectance - Soil composition	Multispectral, hyperspectral	- Albedo - Mineral classification
Organic Matter loss	Organic matter content	- Organic matter content	Multispectral, hyperspectral	- Spectral analysis
Contamination	Nature and quantity	- Nature and extension of contaminants - Effects on vegetation	Hyperspectral Multispectral, hyperspectral	- Spectral analysis, possibly quantitative
Biodiversity	Veld degradation	- Veld mapping - Vegetation species	Multispectral, hyperspectral	- Indices, classification
Soil sealing	Concrete, asphalt, crusting	Mapping impervious soils	multispectral	- Image classification

Table 1: parameters accessible on a spatialised form through Earth Observation data processing

Through the study of Earth Observation sensors and tools and parameters to be monitored through EO, a monitoring strategy can be proposed that takes into account the ground resolution, the spectral characteristics and the revisit capabilities of the different sensors.

Low resolution sensors present a very high revisit capability (one to several images a day), a very low cost per square kilometer and thanks to their multispectral characteristics, they can be used for small scale monitoring of very large areas, including:

- Accurate seasonal vegetation status and biomass parameters monitoring;
- Overall land use changes over various period of time;
- Desertification monitoring;
- Indirect monitoring of climate related parameters (transpiration, ETP, soil holding capacity, …

Medium resolution sensors cover large areas into a single image (60 x 60 Km up 180 x 180 Km). They have low revisit capabilities (generally 3 weeks) but this can be improved to few days thanks to the off-nadir viewing capabilities of several sensors. Apart from their relatively low cost per square kilometer (less than 2 €), one of their major advantage lies in at least twenty years of worldwide archives which enables medium scale (1:100,000 to 1:50,000) monitoring of parameters like:

- Regional land use - land cover mapping and monitoring and changes over the last twenty to thirty years;
- Few soil parameters mapping (Fe-oxides);
- Soil wetness;
- Soil brightness
- Soil organic matter content

Very high spatial resolution sensors cover small areas in a single image (less than 20 x 20 Km) and their cost per square kilometer remains very high (more than 20 €). Thanks to off-nadir viewing capabilities, their revisit capabilities remain less than 5 – 7 days. Through either image interpretation or digital image classification techniques, they enable monitoring parameters at large scales (up to 1:2;500) like:

- Local land use – land cover
- Few soil content parameters
- Erosion and land degradation features
- Population distribution and density
- Agricultural practices identification and mapping
- Soil sealing mapping

Figure 4: potential of very high resolution images in land degradation assessemnt and monitoring

Very high spectral resolution sensors or hyperspectral sensors are currently mostly airborne as no reliable spaceborne sensor is available today. Data acquisition hence is complex and costly and revisit capabilities are limited by the frequency of airborne data acquisition campaigns. Nevertheless, through dedicated image processing techniques, they can be used for monitoring invaluable parameters such as:

- Soil mineral composition mapping
- Clay mineralogy
- Soil contamination mapping
- Vegetation species and health
- Fractional abundance of green vegetation, dry vegetation and bare soil mapping
- Soil roughness
- Soil humification
- Soil crusting (biological soil crusts)
- Soil salinity

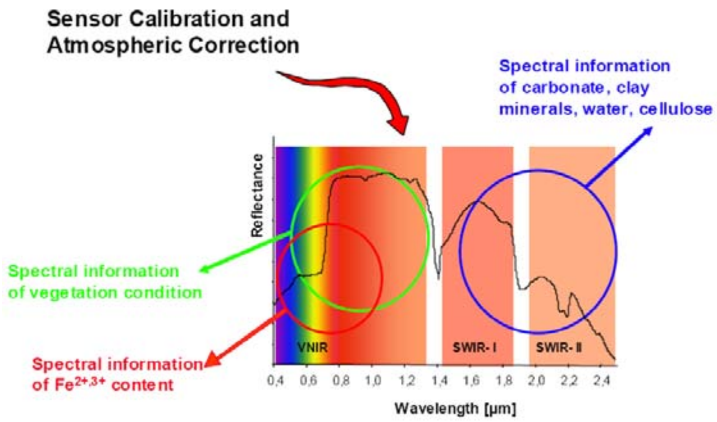

Figure 5: Spectral Extraction of Bio-, Geochemical Parameters through imaging spectroscopy

The future of hyperspectral for land degradation lies in the forthcoming launch of spaceborne sensors, like EnMAP and the future MSMi south African satellite

It is hence proposed to follow a multi-scale, multi-date, multi-sensor monitoring strategy.

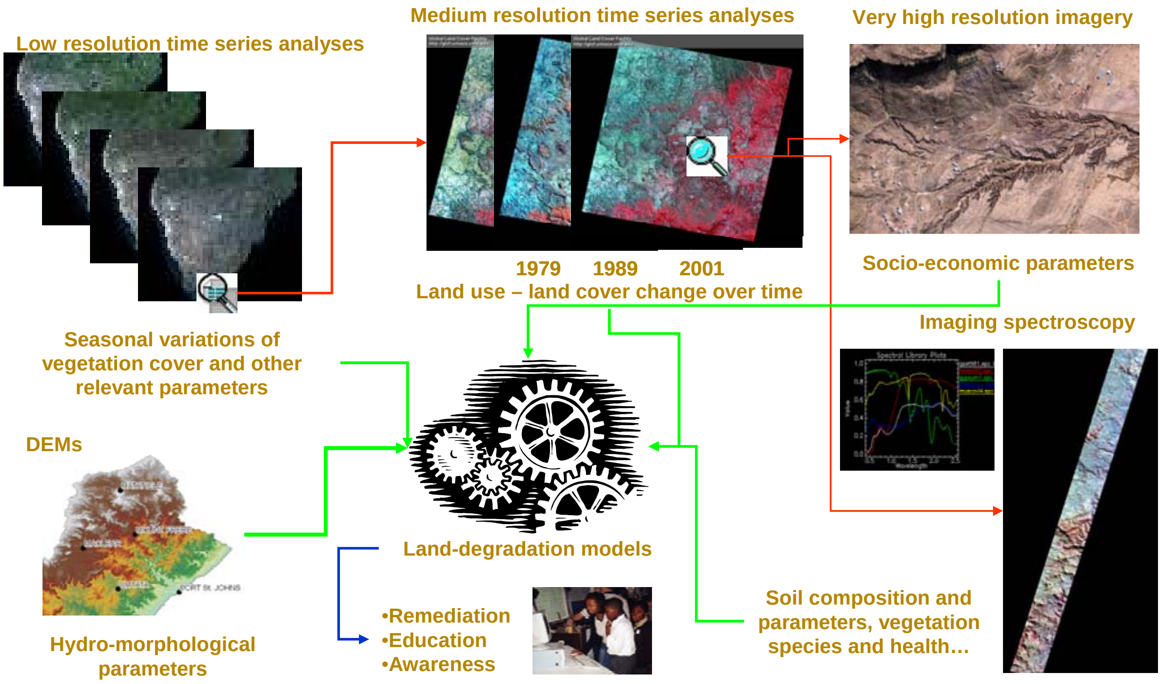

Figure 6: proposal for a monitoring strategy

Low resolution multispectral sensors (NOAA, SPOT Vegetation, MODIS) can be used to monitor seasonal variations of biomass at country scale and possible deviations from the normal seasonal variations. Using archives can enable monitoring changes over the last decade(s) and a rough estimation of areas affected by land degradation. Development of improved specific algorithms can be foreseen to better fit these needs.

Medium resolution sensors will enable zooming at basin or Water Management Area scale. Using thirty (Landsat) to twenty (SPOT) years archives will make possible a monitoring of land degradation parameters, in particular the land cover and land use evolution, that may have taken role in land degradation. Time series will also highlight extension and worsening of land degradation over time.

Most affected areas can be monitored at a single catchment scale (for instance the Macubeni basin, see deliverables 3, 6 and 8) using very high spatial resolution sensors, to identify land degradation features and access to socio-economic parameters (like population density and distribution, farming practices…). Progress monitoring, in particular those relevant of remediation or conservation measures, can further be monitored acquiring new images at regular time spacing. Probable developments are needed to better exploit very high resolution imagery.

Meanwhile, acquiring hyperspectral imagery over the same area would enable the access to local invaluable parameters on soil composition and vegetation species and status. Imaging spectroscopy still needs scientific developments to be routinely used in this domain.

Digital Elevation Models will be used to extract quantitative morphology parameters of relevance in land degradation. Where needed, high resolution DEMs can be produced from very high spatial resolution stereoscopic imagery (SPOT 5, Quickbird, IKONOS…)

Such an approach will provide a batch of information layers that, together with other relevant data, will feed land degradation models. The input of local scientific expertise will be essential to develop models that fit at best with the local conditions.

It is anticipated that the application of this strategy will allow a better understanding of the land degradation processes at regional to local catchment level as well a better knowledge of the key parameters that control these processes. Proposal for conservation and remediation measures can then be derived from such models.

5.6. Education and awareness

The sketch of Figure 7 shows how the project interfaces, through Earth Observation and GIS, with stakeholders in charge of land degradation management as well as in education at University and school level and local community awareness.

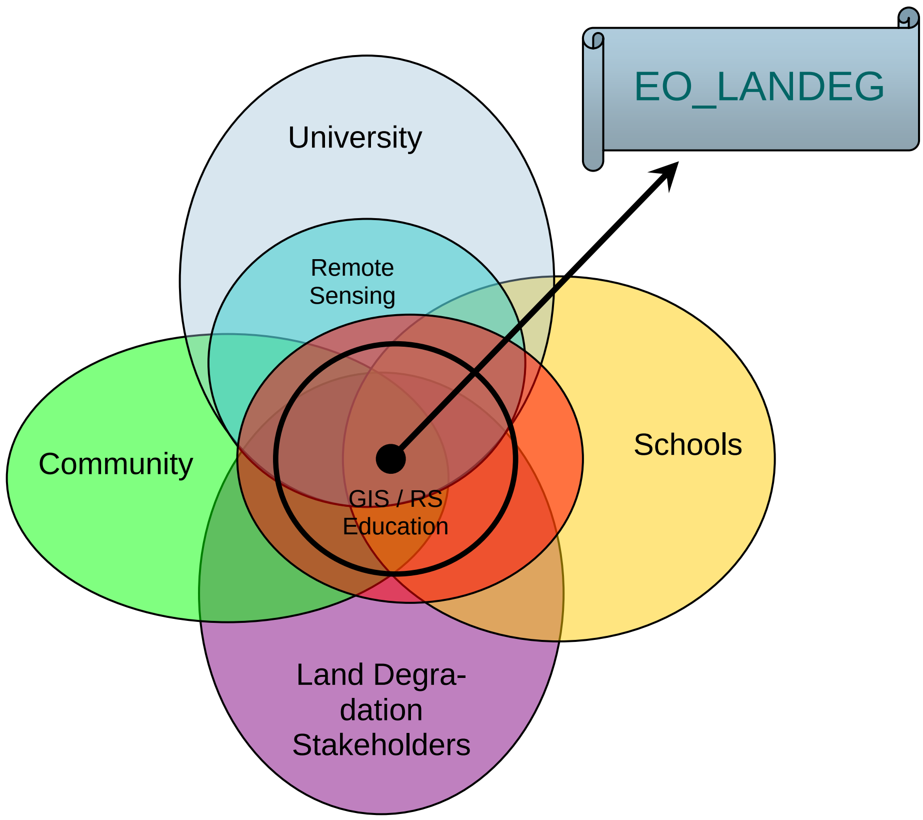

Figure 7: EO-LANDEG in education and awareness

Preparation of a demonstration set for the University

All the digital data collected was collated and structured into a digital spatial atlas for dissemination to any interested parties (mainly Universities, appropriate schools and those involved in the soil erosion project in Macubeni).

The data was compiled using TNTMips software to create an interactive archive of all the data available for the study area, including the intermediary and final stages of the soil erosion models. TNTAtlas software enables any interested user to run the Atlas (no software purchase is necessary), and provides a range of tools from simple viewing and querying of data (requiring a minimum amount of skill) to complex analysis procedures (only for those with a GIS or remote sensing background). It must be noted that this a data dissemination tool not a fully fledged image processing system, but is one that has proved to be a huge value in assisting decision makers and has worked very well in education at both university and school level. Hyperlinks are embedded in the Atlas to allow the viewing of field photographs and related documents.

Data incorporated into the Atlas is includes the following:

- Elevation Data:
  - DEM (30 m, 50m, & 90m)
  - Slopes, Aspect & Sun shaded DEM
  - Contours & Spot Heights
- Satellite Imagery:
  - Aster 2002: composite & classification
  - Landsat ETM (February 2001); Landsat TM (April 1989) & Landsat MSS (November 1972): colour composites, Normalised Vegetation Index; Principal Components composite (PC1,2,3); classifications
  - SPOT 5 (2006): colour composites
- Rainfall, Geology and Soils
- Drainage data: raster & vector, including the results of watershed analyses
- Toposheets: 1:50 000 raster scans
- Topo-vectors: vector data digitized from the 1: 50 000 Toposheets; including:
  - Roads, railways, air transport
  - River & water features (natural & man made)
  - Settlement features: buildings, built-up areas, Landuse, line structures (power lines etc.) and others
- Boundary information: historic boundaries, municipalities, local study area information (e.g. settlement names)
- Ward level 2001 census data: examples include population density, access to services (water, energy, sanitation), employment, income and transport
- Field data: sample sites and photographs
- Soil Models: All steps and results of the two different soil models run on the data

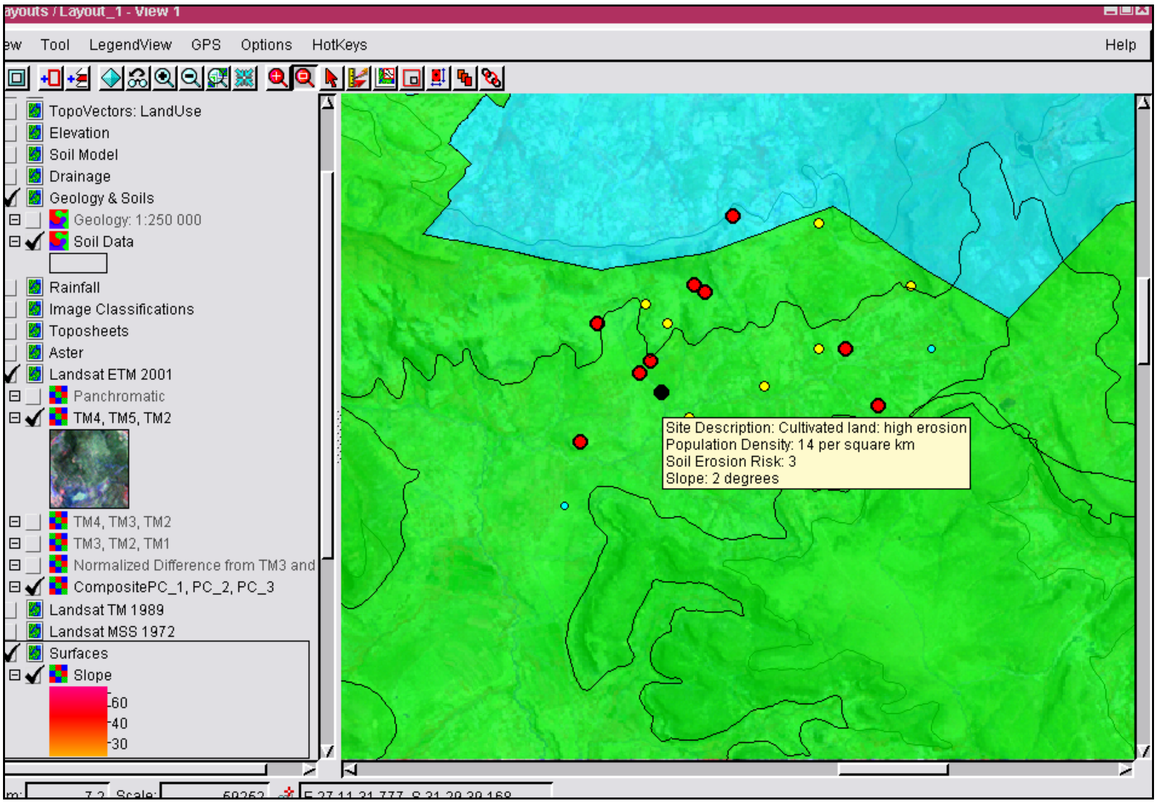

Figure 8: Exploring relationships between soil erosion and possible contributing factors.

Practical demonstration at University

The educational tool developed will be implemented at the University of Fort Hare, Alice. This University not only is the closest university to Macubeni, but, being a historically disadvantaged university, draws many of its' students from the Eastern Cape including villages and towns near the study site. In addition to this, the University runs the only dedicated Honours degree in Applied Remote Sensing and GIS in the country. The modules comprising this course are:

- GIS 501: Introduction to Remote sensing (7 weeks)
- GIS 502: Remote Sensing of the Environment (6 weeks)
- GIS 503: GIS for Decision Support (6 weeks)
- GIS 504: Applied Project Work (9 weeks)

The data and knowledge provided by this project has led to a restructuring of the Applied Remote Sensing module to incorporate a greater emphasis on land degradation and soil erosion remote sensing and modelling. The demonstration set and soil modelling procedures have formed the basis for the development of a three week Applied Project as part of the Applied Project Work (GIS 504) and the inclusion of a new course component (Land Degradation Monitoring and Soil Erosion Modelling) into module 502 (Remote Sensing of the Environment). Materials have been developed using the soil modelling techniques used in the study site and the data collected have been developed into a project, whereby students will utilise newly acquired SPOT imagery of the study area to implement the soil models and prepare comparisons between the different imagery and assessment of the model results.

A field trip has been organised from August 14th to August 16th 2007 to the study area – Macubeni. Planned activities include the collection of ground data for use in land cover mapping (from the existing satellite imagery), modelling of erosion and verification of soil erosion model results. The participants of the trip will be the Honours students, M. Thompson (land cover mapping expert), L. Ngcofe (CGS), C. Tyson (GRS), B. Dube (GRS) and S. Vuso (Masters Student).

A **school and community response** to awareness and education events was carried out in the middle of the study area.

School response

Several schools were visited during the course of the project in 2006. One of them, the Khanya School was selected for the demonstration and information campaign with response from the learners. The main objective of this initiative was to introduce the learners and educators to the topography and geology of their proximal environment via demonstration of Earth Observation techniques and ground truthing in the vicinity of the school. The purpose was also to show the pupils that the area has developing tourism potential while pristine ecology can be protected. The Khanya school is in the middle of a stressed area characterised by shortage of water and natural resources. Dongas and erosion gullies and scares have developed in the low land areas.

The demonstration was done over two days and was attended by 1750 learners from 11 different schools in the region. The EO-LANDEG team made several demonstrations of geological and Earth Observation techniques. Because of several logistical problems encountered at the beginning, like electricity cuts, the large number of attendants compared to what it was expected, the need for a sound system, projection facilities etc... the demonstrations were done outdoor and the crowd was eventually split into various working groups. This is the first type of visit and development program that was ever encountered into the region of Whittlesea and the District Director from Department of Education in Whittlesea conveyed his appreciation for the information and program that were presented. He requests that our participation as a research organisation in collaboration with the European Community to continue in such initiative for prosperous relationships and partnerships between the communities, schools and various sectors.

Community response

Another vital component of the response to information and awareness was the involvement of the community in order to gather their perspectives on land degradation and its effects.

In order to understand the overall environmental and socio-economic problems, interviews were conducted to establish perceptions about land degradation history and its current status. Field survey and house hold interviews were conducted in Qoqodala, (in the Great Kei catchment) in order to gain a holistic nature of the problem within the study area. The questionnaire was designed to stimulate conversation rather than elicit precise response. The respondents recognised that the have been a decrease in natural vegetation and grassland while euryops increase. Awareness of such factor came from 56.3% of interviewed local community while 34% of interviewees did not recognise shrubs as an encroaching species depleting vegetation and grassland, with 9.4% of the interviewees not aware of changes happening to their environment. The general perception amongst the members of the community is that land degradation led to the loss of fertility and production of the land which means less food for them and their families.

5.7. Promotional and networking activities

The promotional activities carried out during the project course consisted in:

- Presentation of the EO-LANDEG initiative to the South African Department of Science and Technology and its representative in Brussels (June 2006);
- Presentation of the project at the GFZ-Potsdam in Germany and the Royal Museum for Central Africa, Tervuren, Belgium;
- Presentation of the metadata catalogue to the stakeholders;

- Organisation of a technical workshop in the Eastern Cape, including a field visit. The technical workshop, organised in November 2006, gathered scientists and stakeholders and favoured the definition of a South African partnership in view of FP7;
- Participation in the information day on “Earth Observation under theme 6 Environment (including climate change)” organised by DG RTD and held on 15th January 2007, in Brussels where the EO-LANDEG project and the team views for FP7 were presented;
- Organisation of a workshop in EU on land and ecosystems degradation and Earth Observation monitoring, held on June 11th, 2007, in South African Embassy premises in Brussels.

6. Dissemination and use

Exploitable knowledge and its Use

As a Specific Support Action, EO-LANDEG did not produce specific knowledge commonly understood as “exploitable”. However, several results of the project activity might be used by scientists, educators and stakeholders.

Exploitable Knowledge (description)	Exploitable product(s) or measure(s)	Sector(s) of application	Timetable for commercial use	Patents or other IPR protection	Owner & Other Partner(s) involved
Geographical information	Metadata catalogue over the WMA12.	Scientific research, education, land degradation assessment and monitoring, conservation measures…	From 2007 onwards	Described in the “Data Use Agreement” (access rights and fees)	CGS
Educational material	Digital Atlas over the Macubeni catchment	Education at University and school level	From 2007 onwards	Free of access	GRS

Table 2: overview of knowledge exploitation

The geographical information covering the Water Management Area 12 (WMA 12) come from various data providers and/or stakeholders or project sources. They include satellite imagery and DEMs, aerial photographs, geology, hydrogeology and geophysics, land use, soil maps, land degradation maps, average rainfall and temperature. Access right and fees, where applicable, are indicated for each data provider or owner. CGS is responsible for the metadata catalogue maintenance and consultation.

The educational material has been developed by GRS, with the help of BRGM, using the TNTMips software to create a TNTAtlas. The material is primary designed for the Fort Hare University Honours course, but can be used in other Universities as well as an educational tool in schools. GRS is responsible for the material maintenance and distribution to interested parties.

Dissemination of knowledge

Planned /actual Dates	Type	Type of audience	Countries addressed	Size of audience	Partner responsible /involved
September 2006	Presentation of metadata catalogue	Stakeholders	South Africa	11 attendants	CGS
June and September 2006	Press release(press/radio/TV)	General public	South Africa, Transkei	Large public	CGS
07/2007	Project web-site	General public	worldwide	unknown	CGS
June 2006	Flyer 1	Scientists	South Africa, EU	unknown	BRGM
June 2006	Flyer 2	Scientists	South Africa, EU	unknown	BRGM
August 2007 ownwards	University of Fort Hare, Honours degree in Applied Remote Sensing and GIS	Students	South Africa	12 students: 10 honours and 2 masters	GRS

Table 3: overview of knowledge dissemination