Section III – Thematic Issues

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5.0 Long-Term Management of Natural Resources

EXPERTS[1]

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5.1 INTRODUCTION

5.1.1 Thematic context

The African continent contains a wide variety of ecosystems, from deserts to tropical rain forests (Fig. 1), providing important ecosystem services to the local population and to the entire planet. In the continent, nearly 90% of the population draws its subsistence from the exploitation of natural resources.

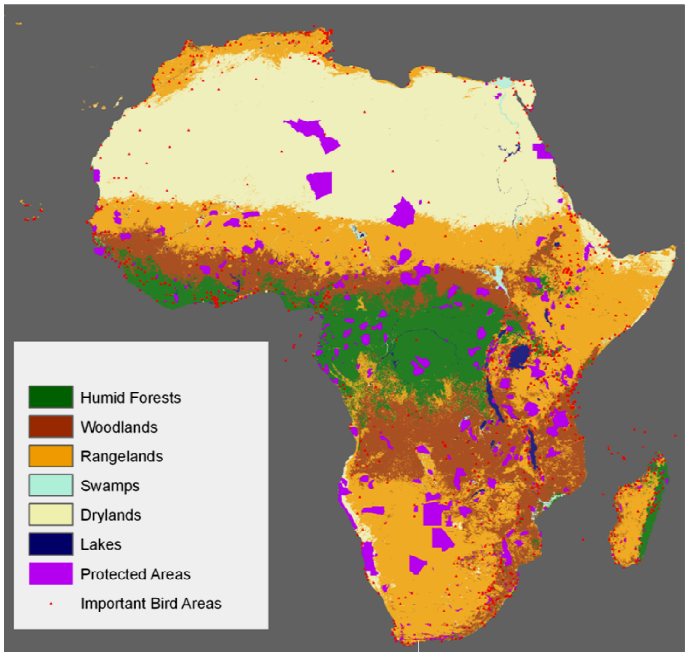

Figure 1: Main ecosystems of Africa with Protected Areas and Important Bird Areas. Source: GLC, 2000.

Continental and global services provided by the African ecosystems are also of high importance. For example, the Congo Basin forests constitute the second largest area of moist tropical forest left in the world and play a major role in the global carbon cycle; the biodiversity present in African landscapes are unique in terms of quantity and quality; fresh water resources represent an enormous potential for irrigated land and hydropower. To avoid overlap with other thematic issues of GMES and Africa, this chapter will focus on the following categories of natural resources: forests, woodlands and rangelands, mineral resources and biodiversity.

While for forests, woodlands and rangelands the status and the dynamics of the land-cover are important parameters to measure over the entire continent, the monitoring of biological resources is essentially concentrated in territorial units (protected areas, important bird areas, RAMSAR sites, etc.).

The African environment is undergoing rapid changes under the influence of changing climatic conditions (e.g., leading to more frequent droughts) and socio-economic pressure (e.g., rapid population growth). To satisfy the growing needs for food and other resources, many natural areas have been cleared for agricultural production, and increasing demand for timber and minerals also increases the pressure on valuable natural areas. The main pressures on the African natural resources are presented in Table 1 below. These changes have serious implications on the state of the environment, as well as on long-term ecosystem services for the population.

Table 1: Main pressures on the Natural Resources in Africa

Resources	***Phenomenon***
Land resources	Land degradation Pollution (e.g. with heavy metals, pesticide residues) Soil salinization Loss of chemical & biological fertility Water and wind erosion
Forest and rangeland resources	Deforestation Impoverishment of commercial species Forest fragmentation Illegal logging Conversion to croplands Overgrazing Increase of uncontrolled fires
Biological resources	Habitat degradation and loss Species extinction Increase of invasive species Pressure around protected areas
Mineral resources	Increasing oil prices Increasing population-induced economic pressures Declining reserves Internal and regional armed conflicts Poverty

Although there is clear evidence for the above-listed changes, we are currently unable to answer several fundamental questions in a quantitative way. For example, where and with which intensity are demographic

pressures generating more extensive utilization of lands? How are the deforested areas used? What is the magnitude and the speed of land degradation and desertification processes? What is the pressure in and around protected areas? What is the state of the mineral resources left on the continent? Exhaustive and precise knowledge on the nature and the magnitude of all these changes does not exist. Knowledge about the long term trends of land cover and land use would give important answers for ensuring the sustainable exploitation of natural resources, i.e. guarantying necessary services for the local population, increasing the economic growth of the countries, and maintaining the ecological value of the ecosystems. More importantly, these answers would make it possible to forecast the future states of land cover and land use, which is a requirement for predicting other environmental, social and economic dimensions of on-going continental and global changes.

5.2 POLICY DRIVERS AND NEED ANALYSIS

5.2.1 Policy drivers

Environmental resources management and monitoring are very complex processes which depend ona number of actors, factors, disciplines and the levels of spatial organizations involved. Awareness in environmental degradation among decision makers is a reality today, as many countries have ratified several international conventions on environment. These conventions could be seen as a constraint to development by several governments, but they now represent unique funding opportunities for the African environment. For example, mechanisms like the Clean Development Mechanisms (CDM) and the REDD mechanism (Reduction of Emissions by Deforestation and forest Degradation) can allow African countries to convert their forest covers into “carbon credits” which can be traded with developed countries.

However, operational mechanisms such as National Environmental Action Plans (NEAP) still lack full consideration in the development agendas of many countries. Also, one can note lack of synergy between these systems, since the action plan of a given convention barely refers to the program of another convention. However, the multiplicity of the sources and factors of environmental degradation require a strong synergy between these plans in order to set up coordinated and relevant solutions. With the on-going fragmentation processes in Africa, more synergistic systems are required for adequate local and regional environmental governance.

The 2002 World Summit on Sustainable Development (WSSD) identified priority areas that place emphasis on water and sanitation, energy, health and environment, agriculture, biodiversity and ecosystem management. The implementation plan of WSSD was built on the outcomes of landmark environmental Summits, especially the 1972 United Nations Conference on the Human Environment (Stockholm), the 1992 United Nations Conference on Environment and Development (Earth Summit), the UN Convention to Combat Desertification (UNCCD), the UN Framework Conventions on Climate Change (UNFCCC) and Convention on Biodiversity (CBD) and other multilateral environmental conventions at global or regional level.

All these environmental agreements have components that explicitly refer to the need for Earth observations, to help achieve their goals. In particular, through Resolution 54/68 adopted during the third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III) held in 1999, the United Nations General Assembly endorsed the Vienna Declaration: Space Millennium for Human Development, which called for action, among other matters, i) to protect the Earth’s environment and manage its resources and ii) to use space applications for human security, development and welfare. In line with these recommendations, there are several international agreements, conventions and regulatory bodies in Africa that can benefit for long term monitoring of environment trends in Africa.

The Heads of State and Government of the African Union assembled in Abuja, Nigeria in December 2006, recalling the decision to adopt the Comprehensive Africa Agriculture Development Programme (CAADP) at the Maputo Summit in July 2003 as a framework for accelerating agriculture development and Food Security on the continent, declared their commitment to develop continental and regional market information systems and support the development of the same at national level by 2008.

In 2006, the African Union issued a Strategy on Disaster Risk Reduction, calling for coordinated, comprehensive and sustained global Earth observations, data analysis and information generation. The AU Executive Council decision EX.CL/Dec.254 (VIII) of January 2006 adopted the Science and Technology Consolidated Plan of Action (CPA) which introduces space science and its applications as flagship research and development area. At its January 2007 meeting, the African Heads of State Summit made a declaration on Climate Change by endorsing the Climate for Development in Africa (CLIMDEV Africa) programme for Climate Change in Africa. The AU has also provided various mandates in environmental issues by the African Ministerial Council Conference on Environment (AMCEN) and the African Ministers’ Council on Water (AMCOW).

At regional level, long-term strategies have also been put in place by specialized agencies like the COMIFAC (Commission Ministérielle des Forêts d'Afrique Centrale) for exploiting the forest resources in a sustainable way. The "Plan de Convergence" insists on the need for knowing in detail the resources as a prerequisite for any sound management and exploitation of forests and biological resources.

Although the mining industry, seen from countries' perspectives in Africa is an individual business at the discretion of each government, efforts have been deployed since the beginning of the Millennium in trying to harmonize policies in this domain. The RECs have developed initiatives to harmonize their sub-regional mineral policies (Protocol on Mining adopted by the SADC region in 2000, Directive on the Harmonization of Guiding Principles and Policies in the Mining Sector adopted in 2009 by the ECOWAS, WAEMU's Common Mining Policy adopted in 2000).

The first AU Conference of Ministers responsible for Mineral resources development adopted an African Mining Vision (AMV) in 2008 with the goal to use Africa's mineral resources to meet the Millennium Development Goals. Subsequently, an Action Plan was adopted in December 2011 with a view to implementing the vision.

5.2.2 Needs analysis

The purpose of regional monitoring and assessment for long term management of natural resource is to:

- Understand and assess opportunities of the existing natural resource base.
- Facilitate the development of a common information system through the improvement of the generation, organization and use of information for priority areas identified at local, regional and global level.
- Inform and influence national and regional policies and decision-making processes
- Expand national and local constituencies for sustainable development
- Develop national and local capacities and effort and to identify and fill major gaps in sustainable management of natural resources
- Strengthen field programmes and projects
- Facilitate and increase the cost-effectiveness of thematic or sectoral system recurrent assessment.

The observed fragility of African ecosystems induces an urgent need for continuous environmental monitoring. Any action should have the view to promoting mechanisms for diagnosing, continuously monitoring and managing the African environment on a global to local scale, particularly the long term trends and effects. Actions include the strengthening of local, national and regional capacities for creating, updating and maintaining coherent spatial and statistical information on environmental variations and change towards improved management and decision-making. Table 2 below summarizes the rationale for long term assessment of environment at desired scales:

Table 2: Rationale for long term assessment of natural resources at different scales.

Scale	***Type of action***
Local	To set up multi-scale information systems enabling any user or decision maker to know what information resource is available locally – Seasonal trends and dynamic in rural area – Quantification of available resources : water, soil, vegetation – Vulnerability Analysis and Identification of risk area – Assessment of land tenure
Regional	To set up a regional reference system for assessing and characterizing the state of natural resources and the environment (stocktaking of the situation, basic mapping) – Vegetation: Cover, Biomass, Deforestation rate – Land: Degradation rate, available arable lands, etc. – Climate& Water: Seasonal characteristics, spatial patterns
Continental	To assess and forecast environmental phenomena and set up operational early warning systems – Land use and Land Cover: Change and trends – Vegetation: Resilience, Carbon sequestration – Climate Change effects and impact – Ecosystems: dynamics monitoring and assessment
Global	To assess and forecast environmental phenomena and contribute to global early warning systems – Climate Change effects and impact – Global Changes intensity

It must be underlined that the land-cover and land-use dynamics have profound synergies in many other areas discussed in the GMES Africa Action Plan: Food Security and Rural Development (e.g., land availability), Water resources (e.g., protection of watersheds), Land Degradation and Desertification (e.g., erosion), Coastal Areas (e.g., coastal erosion, eutrophication).

5.3 IDENTIFICATION OF COMMUNITIES

The GMES Africa Programme envisions to develop applications and provide products and services at local, national and regional levels. In this regard, the programme needs a strong coordination mechanism involving key stakeholders at all levels. Indeed, GMES Africa should assist in strengthening the existing political, institutional, technical and operational mechanisms and networks which will be in support of a synergetic action for diagnosing, continuously monitoring and managing the African environment.

There is a large spectrum of producers/users' community base in Africa for long term monitoring products as depicted in Table 3 below.

Table 3: Communities of producers and users of geospatial information related to natural resources in Africa.

Level	***Constituencies***	***Information needs***
High Political	– Head of State Conferences – African Ministerial Conferences : AMCEN, AMCOW, AMCOST, Conference of African Ministers responsible for Mineral resources development – AUC, AfDB – RECs: ECOWAS, SADC, IGAD, ECCAS, AMU – UN (ECA, FAO, UNEP, UNDP…) – EU Aid Agencies – Conventions' Secretariats	Global trends in the status, quality and nature of the environment, extension of mineral reserves Carbon Potential The information should be global through an Early Warning System
Technical Decision-Makers	– Relevant National Ministries (Forests, Environment, Land planning, Agriculture, Livestock, mineral resources – Regional and national development agencies (COMIFAC, RAPAC, NMAs, NEAs…) – Managers of protected areas, Resources planners – Development banks (WB, AfDB) – Technical services of development Agencies: EC, Member States, USAID, ACDI…	All aspects of environment, such as vegetation status, vegetation change, surface water, fire, carbon stocks… geographic extension of mineral resources, limits of mineral exploration concessions, environmental impact of the mining industries. The information should be in near real time at sub-regional to national scales and combined with ancillary input such as socio-economic data
Scientific Community and Information Producers	– Networks: GOFC-GOLD, NESDA, EIS-AFRICA, GLCN, AARSE, UICN, OSS, FARA, ASARECA, CORAF, OFAC – RICs: AGRHYMET, RSAU, RCMRD, RECTAS, ARCSTEE – Regional/International and National Research Institutions: CGIAR, JRC, ITC, WRI, IRD, USGS – Space Agencies: NASRDA, ALSA, SANSA – National Centers: SAC, CRTS, CSE, CERSGIS, NMHSs, etc.	Forest Cover status Land Use Land Cover Vegetation phenology (Biomass variation, foliar index, etc…) Biodiversity (change in the floristic composition), etc… Meteorological services
Ultimate Beneficiaries	– Producers of Goods: OIBT, OAB, National Forest Services, Private forest companies, agro-météo – International and local NGOs: WWF, BirdLife Africa, IUCN, – Civil society: ROPPA – Human Rights, UNICEF – NEAs	Forest logging Deforestation Location of mining sites with intensive manpower demand Geographic extent and efficiency of Environmental Impact mitigation measures

5.4 MAPPING EXERCISE

5.4.1 Existing Capacities and Programmes

The Earth Observation agenda in Africa must be "user-pull" and not "technology-push". Therefore, research, science and capacity building must be regarded as fundamental issues. GMES and Africa will help scientists and engineers from the continent to expand the expertise and scientific capabilities in Earth Observation to ensure that they can contribute to meet the expanding needs of Africa. The partners in the project are expected to constitute a technical network of regional and national organizations and institutions able to provide continuous monitoring and assessment of natural resources in Africa. The operational features of continent-based institutions are shown in Table 4 below.

In the domain of the mining industry, high resolution images are required over the various sites before the opening of the exploitation. They will be used to derive DEM and other information products to serve as reference for guiding and checking the restoration effort after the exploitation phase.

Table 4: Major institutional capacities existing in assessment of African natural resources.

	Data collection, accessibility and	***Monitoring and Assessment***	***Information Diffusion &***

Institutions Organizations	***integration***						***Capacity Building***	
	Data Collection	***Data Access***	***Data Integration***	***Assessment***	***Monitoring***	***Forecast/ Early Warning***	***Information Diffusion***	***Capacity Building***
Regional Implementation Centres: RECTAS RCMRD AGRHYMET OFAC RSAU	Base Datasets (Vegetation type) Earth Observation data (NDVI, DMP, …)	Accessibility for processed data Access to Base data through technical services	Data are integrated through clearinghouse nodes	Agriculture domains Biomass	Land Use Land Cover Changes	SISEI SERVIR,	Bulletin Web sites	Short terms training Diploma courses Workshops
National Centres CRTS CSE CSIR SPAIF CENATEL SP/CONEDD Mining cadastre agencies Space agencies	Field data AMESD data Satellite EO data	Payment of fees	SISA AMESD data products	Vegetation types Mining sites restoration assessment	Biomass Biodiversity Mining sites planning and overall follow up	GTP	Bulletin	Short term training Workshop
Research Institutions Universities	Field data	No	No	No	Key environmental indicators	No	No	Diploma Courses Tertiary Education
Regional Organizations River Basins OSS								

Table 5: Projects, programmes and networks involved in the assessment of African natural resources.

Programmes & Projects	***Data collection, accessibility and integration***			***Monitoring and Assessment***			***Information Diffusion & Capacity Building***	
	Data Collection	***Data Access***	***Data Integration***	***Assessment***	***Monitoring***	***Forecast/ Early Warning***	***Information Diffusion***	***Capacity Building***
Africover	Field Data EO data	Accessibility for value-added data	Processed data	Land Cover Land Use	No	No	Thematic databases	Workshops
GOFC-GOLD	EO Data							
Global Land Cover Network	No	No	No	Land Cover Land Use	No	No	No	Workshops
GLC2000	Field Data EO Data							
Globcover	EO Data	Thematic data	No	Land Cover Land Use	No	No	No	No
FAO/JRC - FRA								
AMESD	Field Data EO Data	Thematic data	No	Environmental Status	No	No	No	Short-term training Workshops
TIGER	EO Data	Yes		Water resources	Water Spatial Patterns	Flooding	DDS Stations	Short-terms training Workshops
CarboAfrica	Field Data	No	No	Carbon stock	No	No	Bulletin	Workshops
BIOTA-Africa	Field Data	No	No					

5.4.1.1 Human capacities

The current capacities to produce geospatial information in the NRM domain are unequally distributed in Africa, both geographically and by type of institution. As a general rule, stakeholders in charge of the management of natural resources (e.g., forest and mining companies, conservation NGOs, regional development agencies) have integrated the use of Earth Observation for decision making. On the other hand, governmental services in charge of these issues are far less prepared to produce and use geospatial

information in the definition and implementation of their policies, due to a lack of qualified human capacities and adapted infrastructure.

In the domain of forestry and biodiversity, training activities consist mainly of professional "on-the-job" training of technicians for a specific task. At the level of graduates, a lack of remote sensing and GIS matters in the thematic training activities leading to an insufficient number of graduates (e.g., forest engineers, conservationists, rural developers) that are able to use the geospatial information in an optimal way.

Another issue is that, where human capacities exist, they are often underused by a lack of appropriate hosting institutions and facilities within the African continent. In this case, the main challenge is to retain and maintain existing capacities.

In general, there is a low level of organizational capacity in the African countries in order to make the best use of EO data at national level, within efficient national EO networks where the collaborative work and the shared resources principles are applied. In the area of mining, very little use is made of radar data and spectrometry techniques by national agencies because of a shortage in the respective human capacity.

5.4.2 Methods

Automated processing chains for extracting thematic information in forestry, biodiversity and mining exist for medium and coarse resolution data, but nowadays, there is no standardised method for processing high resolution data for land-cover, land-use, and change detection.

Close to the decision-making process, there is still a need for developing expert systems for a better integration of *in situ* information (including socio-economic data) with satellite-derived parameters for developing composite indicators.

Conflicts and disputes also arise in the area of mining exploration due to poor capacity to manage the exploration permits (physical limits of the concessions are generally not managed in spatial data bases).

5.5 IDENTIFICATION OF GAPS IN EXISTING OR PLANNED FUNDING PROGRAMMES

5.5.1 Identification of gaps

In Africa, the current low level of infrastructure capacities for the collection and assessment of EO data, for their transformation into useful information and for their dissemination does not allow full exploitation of the existing human capacities. GMES and Africa should develop and deploy the necessary infrastructure in order to address the various sectoral thematic areas and cross-cutting issues. In order to complete regular monitoring operations, the strategy of data acquisition and collection must be comprehensive and include various elements necessary for decision-making:

- Earth Observation data covering the continent at the right resolution and accessible for the users through agreed data sharing principles for GMES.
- In-situ data regularly collected, harmonised, standardised, structured in accessible and interoperable databases. A special focus should be given to carbon tracking, biodiversity, mineral resources and socio-economic parameters.
- Acquisition and processing of physical infrastructure.

5.5.1.1 Space-based Observation

The following table details the spatial resolution, the acquisition strategy, the existing and planned capacities, and the gaps of the main EO data categories.

Table 6: Needs and gaps in terms of Earth Observation data useful for the long-term assessment of African natural resources.

Category of Data	***Sensor / product***	***Acquisition strategy***	***Operational Environment (Ground Stations)***	***Identification of gaps***
Low Resolution (300m-1km)	MSG NOAA SPOT-VGT MERIS MODIS ASAR	daily	53 African Countries AGRHYMET (Niger) RSAU (Botswana) ICPAC (Kenya) RCMRD (Kenya) CSE (Senegal) UCTC (South Africa)	
Medium Resolution (10-50m)	LANDSAT SPOT CBERS	Complete coverage yearly	Maspalomas (Canary) Hartebeesthoek (South Africa)	Lack of receiving stations in large key regions (Central Africa, West Africa…)

	IRS ASTER NigeriaSat-1 & X		Aswan (Egypt) Abuja &Jos (Nigeria) Malindi (Kenya)	
High resolution (2-5m)	SPOT Nigeriasat-2	Complete coverage 3-5 years Coverage on-going	Murzuq (Lybia) Hartebeesthoek (South Africa) Maspalomas (Canary) Abuja (Nigeria)	Few sensors are acquiring information but rarely on the African continent; lack of receiving stations or on-board recording
Very High resolution (<1m)		Sampling for statistical applications and validation		Few sensors are acquiring information but rarely on the African continent (low economic demand)
Radar high resolution (1-50m)		Complete coverage yearly		Lack of receiving stations in large key regions (Central Africa, West Africa…) Lack of fully validated procedures
Geodetic Measurement	GNSS GPS CORS		Hartebeesthoek EMA (Ethiopia) ECA-SROWA (Niger) CICOS (DRC) Kilimanjaro (Tanzania)	
Data Dissemination	EUMETCAST VGT4Africa ftp		53 African Countries RICs Programme / Project	ftp transfer rate is very low in many countries

5.5.1.2 *In situ* observation

The *in situ* data component is at least as important as the Earth Observation component, since there is currently in Africa no sustained effort for systematically collecting and harmonising ground-based information on the natural resources. This category of information will serve two main uses: the calibration of EO data and validation of space-based products on the one hand, and the combination with geospatial information for providing real decision-tools on the other hand. The ultimate goal of the *in situ* component would be a network of geo-referenced field observations, representative of the different biophysical and human situations, statistically valid for reporting obligations and scientific models, collected according to harmonised and internationally recognised protocols and accessible to managers in simple and understandable formats. The long list of field parameters can be structured into three main categories: biophysical information, socio-economic information and management data. Table 7 is a summary of the needs and gaps in the availability of *in situ* data useful for long-term assessment of the continent's natural resources.

Table 7: Needs and gaps in the availability of in-situ data useful for long-term assessment of African natural resources.

Biophysical parameters		**Existing and planned capacities**	**Gaps**
Soil	Carbon, Erosion, Moisture…		
Mineral resources	Geology, hydro-geology, fractures	Artisanal and Small-scale Mining (ASM) widespread in Africa. Government-controlled Mining industry mainly based on partnership with external companies. Planned capacity includes Comprehensive knowledge of Africa's mineral endowment for the implementation of the AMV Action Plan	No harmonized exploration approach with regard to in-situ data collection economies of scale No harmonized regulation rule frameworks for the mining permits, especially concerning how to manage potential conflicts with protected area, land uses management or other resources (water, forest,…) managements Locally, poor mapping networks due to inaccurate (or sometimes lacking) geodesic frameworks Poor accessibility to potential mineral resources partly due to a lack of running network of inventories for those resources
Vegetation and forest	DBH, height Biomass Phenology Carbon flux	Basic forest parameters are collected in timber concessions; a network of carbon flux towers is starting under the CarboAfrica program	No network of forest inventories measurements Missing elements for biomass (allometric equations, dead wood, litter..) No network of phenology measurements
Biodiversity	Species inventories Habitat description	Excellent inventories exist in many protected areas Continental distribution (GBIF, IUCN)	No consolidation at national and African level for many species No systematic inclusion to GBIF or IUCN databases
Hydrology	River discharge River gauge		No recent observation in many critical basins (Congo)
Land-cover	LC attributes	Some national or regional initiatives	No consolidated network of land-cover

		exist (Senegal, South Africa)	attributes No standardised protocol of data collection
Socio-economic parameters		**Existing and planned capacities**	**Gaps**
Population	Density, structure… Poverty		
Land tenure	Ownership		Nearly inexistent
Development	Energy Infrastructure		No information on status of transport infrastructure
Management parameters		**Existing and planned capacities**	**Gaps**
Territorial units	Protected areas, Logging concessions Mining concessions Climate projects	World Database of Protected Areas National databases for logging and mining	Global databases often obsolete Lack of accessibility of validated information
Management	Institutional capacities Efficiency		

5.5.1.3 Acquisition and processing Infrastructure

In terms of infrastructure, the access to data is still a weak point for the main users in forestry and biodiversity. In particular, the lack of receiving stations at high and medium resolution is considered as a major constraint for Central Africa and West Africa. Recent facilities installed in South Africa have drastically improved the situation in this part of the continent.

The access to coarse resolution data is facilitated by the Geonetcast system and the PUMA/AMESD receiving stations that give access to MSG, SPOT VEGETATION data and products. Other CR data (MERIS, MODIS…), freely accessible by internet, are less accessible because of the low performance of internet in many African countries.

For the infrastructure dedicated to the production of added-value products for biodiversity and forestry, there is a lack of processing centres and storage of data and products, except in South Africa. Substitution solutions are found through some projects funded by the USA in the frame of GOFC-GOLD, but a real dynamics is still to be built in many regions.

No consolidated spatial databases on mineral resources of the continent have been developed. Geophysical prospection facilities are usually provided by external companies and the data are not reused as mineral data management capacity is weak.

5.5.2 Future planned activities

Apart from the existing capacities already listed in Section 5.4.1.1., new initiatives merit some attention.

- The Group on Earth Observations (GEO) has put in place a specific working group on Biodiversity Observations, including space and field data;
- the model of OFAC is now under institutionalisation in a perennial structure funded by several donors;
- under the intra-ACP budget line of EDF, a specific component is reserved for setting up a facility on biodiversity observations at the pan African level;
- many programmes dealing with REDD are now trying to set up a reliable system for carbon accounting at national level, to strengthen the local capacities for monitoring, reporting and verifying the carbon fluxes, and to create the mechanisms of redistribution to the local population.

5.6 BUILDING GMES-AFRICA SERVICE

5.6.1 Service Definition and Provision

The generation of standard products can be envisaged in function of the current policies. However, the political context and the requirements can change in a close future due to external drivers (financial crisis, REDD, biofuels). In consequence, we will explain the main principles guiding the definition of products and concentrate on key generic multi-user proposed products. Three thematic categories of products must be realised with different coverage, spatial and temporal resolution.

(i) Near-real time monitoring systems

The systematic wall-to-wall information on seasonal trends in vegetation conditions (i.e. phenology, productivity, surface water availability and fires) is essential for characterising land-cover classes, detecting anomalies and drastic changes, and for evaluating ecosystem productivity, all components necessary for biodiversity management and carbon estimates. The biophysical parameters can have huge impact on the livelihood of local population, and on the payment of ecosystem services. This component should deliver

daily measurements of biophysical parameters, composed by periods of 10 days, and automatic detection of anomalies.

(ii) Land-cover characterisation
Two land-cover maps are recommended at continental scale following the international standards in terms of legend (LCCS-compliant), validation, and metadata:

- the regular land-cover characterisation at coarse resolution (300m) updated every 3 years locating the main land-cover types,
- the baseline map at medium resolution (20-50m) updated every 10 years, providing the baseline for land-cover change assessment.

Both products should adopt a compatible legend, with a focus on essential classes (forest resources, agricultural domain that can be related to specific ecosystem services (e.g., carbon content, biodiversity, water balance).

In specific regions of interest (subject to climate change debate or with high biodiversity), the update frequency and the thematic content can be adapted in order to meet the reporting and management requirements. A specific product on the agricultural domain will be produced every 10 years at high resolution (2-5m spatial resolution).

(iii) Land-cover change estimates
Land-cover and forest-cover change estimates at national level are required by international conventions. They are important for analysing general trends and for managing the territorial units. Two different products are therefore necessary:

- National estimates based on a sampling design, with an intensity depending on the country size (from 1 degree to ¼ degree in order to obtain the accuracy required by UNFCCC) analysing extracts of medium resolution images every 5 years.
- Local estimates with a finer spatial detail (2-5m) on specific regions of interest (i.e. protected areas, around urban settlements, logging/mining concessions, climate projects). In this case, the methods (sampling or wall-to-wall, frequency, legend) will be selected according to the final objective of the estimates. For verification of forest management plans (national and FLEGT) and of reported afforestation and reforestation activities in the context of CDM and JI projects, annual mapping of forest cover disturbance at individual tree canopy level is needed on clearly identified sites.

Built upon these generic products, specific deliverables must be adapted to particular users, integrating field observation into added-value information, for example, carbon stock and flux, biodiversity value and change maps, land suitability for energy and agriculture.

(iv) Consolidated spatial databases on mineral resources
From a strategic point of view, Africa as a continent cannot ignore the need to follow up on the evolution of her mineral reserves. Based on the AMV Action Plan

- Systematic EO-based explorations should be carried out and countries should strengthen collaboration in the area of mineral-related data collection, both with EO-based data and in-situ measurements, particularly in cross-country resources areas, similarly to the cooperation in road infrastructure development across countries.
- Consolidated spatial databases on mineral resources exploitation should be developed to support and strengthen a wide application of the Extractive Industries Transparency Initiative (EITI)

5.6.2 Capacity-building

5.6.2.1 Necessary elements

As in other thematic areas, the issue of human capacity is critical and should be solved in a holistic manner. Different levels should be strengthened:

- at technical level, e.g., technicians involved in the day-to-day management of natural resources or for the production of geospatial information;
- at managerial level, e.g., managers of natural resources involved in the planning and implementation of policies;
- at scientific level, e.g., high profile scientists for adapting scientific tools and methods to the African context;
- at local level, e.g., local communities for using earth observation service into management problems solving and sustainable use of natural resources, including mineral resources.

5.6.2.2 Strategy of implementation

Capacity strengthening for natural resource management and EO should take place in existing schools (forestry, fauna, rural development, geology and mining) as well as in specific schools with a focus on space-based technologies. An important aspect for maintaining the African capacity to develop adapted solutions is the increase of research in these specific issues, in the frame of the pan-African universities.

5.6.3 Prioritisation of Requirement and Actions

The first priority for deriving reliable added-value products for the long-term management of natural resources is the installation of infrastructure for the acquisition and processing of EO data in Africa. It should be based on the existing facilities when available and the creation of new centres where needed. In a second step, regional processing centres should be developed in each region of Africa, in order to adapt the generic GMES Africa products to each particular context. For example, the deforestation estimates should be available at national level for countries interested in the REDD process (essentially in Central Africa) and be compliant with the UNFCCC requirements. Similarly the mineral resources sector should move from being highly confidential to a subject of shared information in order to build a common knowledge of the changes occurring in the status of this resource base so important for Africa's future.

For developing the regional processing centres, a massive effort of capacity building must be put into the production of geo-spatial information, in specialised institutions and in thematic training institutions (agriculture, forestry, conservation, mining). In the meantime, awareness should be raised amongst policymakers to appreciate the value of geo-spatial information in their decision making processes.

5.6.3.1 Organisational scheme

For the management of GMES and Africa, a clear political vision is a pre-requisite. Whilst this is already being taken up by AfriGEOSS and the pan African WG on Space, an important role can be played by the African Union and the African Regional Economic Communities (RECs). A participative approach for designing the project is needed to ensure that stakeholders at all levels (technicians, researchers, politicians and managers of various sectors) can express their view and concerns in the project.

The approach to be adopted is that of continental coordination and national implementation. For practical effectiveness, an intermediate coordinating structure should be set up in a form of a joint expert group UN-AU expanded to include key partners and scientists. During the operational phase, each partner of the network will have a role to play as part of the project implementation. Each directly involved stakeholder (technical core) should set up a project unit serving as a focal point for implementing the project's activities.

- Regional Institutions (EU, AUC, UNECA): in charge of the administrative and financial coordination and strategic orientation in conformity with the Programme's objectives.
- Sub-regional Institutions (RECs, RICs, Regional Centres of Excellence (RECTAS, RCMRD and AOCRS)): supervision of the technical activities on a daily basis
- National Agencies (CRTS, NASRDA, NARSS, CSIR, CSE, NMHS etc.): running the technical services in order to implement the project's activities at country level.
- Scientific partners and bilateral and multilateral co-operation partners (AARSE, UNEP, UNESCO FAO, CGIAR, WRI, EIS-Africa, OSS): play a role, which consists of providing support-advice, in the implementation of the project's activities as part of the already existing collaboration agreements with the institutions.
- Users (e.g., UNCCD, CBD, NGOs, CSOs): Users of the project's products include at least the technical services of the participating countries, and grassroots level users such as NGOs and local organizations.

5.7 RECOMMENDATIONS

A sound management of Africa's natural resources, including mineral resources, is necessary for safeguarding the livelihood of huge parts of the population in Africa and beyond. The recommendations for the GMES and Africa programme related to the long term management of natural resources, with respect to data, products and capacities, are the following:

<u>Data acquisition and processing</u>

- An effort must be put in place for acquiring yearly cloud-free medium resolution images over the entire continent. Receiving stations must be installed in critical regions. Radar data acquisition, improvement of geodesic networks (both at the continental and regional scales) and geophysical

prospection facilities are also part of the required infrastructure supporting a strategically efficient management of Africa's mineral resources[2].
- The flow of coarse resolution images and products must be maintained by the current processing facilities (CTIV, LandSAF) and dissemination infrastructure (Geonetcast).
- A structured network of *in situ* observations must be put in place on carbon, biodiversity, land use and tenure, mineral commodities, taking profit on the starting initiatives.

Products
- Information produced should combine near-real time monitoring systems, land-cover characterisation and land-cover change estimates.
- Two scales should be targeted; the regional and national scales by coarse resolution maps and statistical estimates based on sample of medium resolution images, while the local information will be produced at medium and high resolution on selected areas.

Capacity-building
- The capacities should be reinforced at all steps of the decision chain, from the production of information to the integration of the information in the decision process.
- The different levels should be targeted: technical, managerial, scientific and local.
- Particular emphasis is needed to establish/support thematic research networks between African universities and European research centres; supported by the EC Research Framework Programme Horizon2020.

Institutional dialogue
- Regional information centres should be strengthened as they provide the optimal platforms for developing the appropriate information and to discuss it with the decision-makers.

To reach these different objectives, several implementation steps should be envisaged by the donor community:
- Consolidation of existing regional and national institutions by projects and programs funded by EU (EDF or budget) in the most appropriate mechanism. Examples like the Pan African AMESD or OFAC in Central Africa (Observatoire des Forêts d'Afrique Centrale) can provide first models to consider and learn from. In all cases, a solid link of technical implementation centres with the political institutions in charge of the management of natural resources is a key element of success.
- The above-mentioned projects and programs must strengthen the co-operation between European and African information producers (scientific community, universities, implementation centres and companies) and users (political institutions). GMES Europe can provide some lessons in that respect for the system architecture and the implementation mechanisms.
- As the main issues are common at regional level, it should be preferable to develop strong regional centres, with a good link with national services.
- The financial and technical partners of GMES Africa should also envisage the permanent dialogue with other programs involved in the long-term management of natural resources (e.g., SERVIR-Africa, CARPE, CBERS)

5.8 SUMMARY

The exploitation of natural resources in Africa provides for the subsistence of nearly 90% of the population. Among these, mineral resources are the basis of economic growth in many countries. On the other hand, the African environment is essential for maintaining a stable climate and a biodiversity reservoir for the entire planet. To support these local needs and global services, and to provide the basis on which to calculate payments for environmental services, a permanent monitoring of forests, woodlands, rangelands, protected areas and mineral reserves is required. Because coordinated information systems are missing, reliable information to support management decisions is not readily available and accessible, and paradoxically donor institutions tend to privilege more immediate activities, maintaining the information gap for future decisions.

In this context, GMES and Africa represents a unique opportunity to:
- Ensure data acquisition at an appropriate scale (5-10 m for forest monitoring, radar high resolution 1-50m for mineral resources exploration) and the appropriate delivery time for long-term management of natural ecosystems (annual complete coverage at minimum).

[2] This is the task of national geological survey institutions. A continental harmonized data set is available – AMMP (African Magnetic Mapping Project); each country has a harmonized data set available over their territory.

- Develop processing facilities at national and regional level, able to produce updated information for the new challenges and opportunities (climate, forest management, biodiversity, mineral resources monitoring). The regional centres should be linked to political institutions.
- Build on existing human capacities in specialised schools of forestry and conservation, geology and mining, and in training centres dedicated to geospatial information.
- Develop operational services for improving the decision making processes in the long-term management of natural resources in Africa.

The programme can build upon existing regional initiatives, like OFAC in Central Africa, or national institutions, like the CSIR in South Africa or the CSE in Senegal.

The general policy-drivers are clear in this domain, starting from the international conventions to the local management of resources. GMES and Africa can provide a general framework for the cooperation between Europe and Africa, but the concrete dialogue between different stakeholders is still missing. On the other hand, other stakeholders (e.g., in USA, Brazil, Asia) are also involved in this process and should be consulted.

LIST OF ACRONYMS

AARSE	African Association of Remote Sensing for the Environment
ACDI	Agence Canadienne de Développement International
AfDB	African Development Bank
AGRHYMET	Centre Régional de Formation et d'Application en Agrométéorologie et en Hydrologie Opérationnelle
AMCEN	African Ministerial Council Conference on Environment
AMCOST	African Ministers' Council on Science and Technology
AMCOW	African Ministers' Council on Water
AMU	Arab Maghreb Union
AMESD	African Monitoring of Environment for Sustainable Development
AMV	Africa Mining Vision
AOCRS	African Organization of Cartography and Remote Sensing
ASAR	Advanced Synthetic Aperture Radar
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
ASM	Artisanal and Small-scale Mining
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
AU	African Union
AUC	African Union Commission
AVHRR	Advanced Very High Resolution Radiometer
CAADP	Comprehensive Africa Agriculture Development Programme
CARPE	Central African Regional Program for the Environment
CBD	Convention on Biological Diversity
CBERS	China-Brazil Earth Resources Satellite
CENATEL	Centre National de Télédetection (Benin)
CERGIS	Centre for Remote Sensing and Geographical Information Systems (Ghana)
CGIAR	Consultative Group on International Agricultural Research
CICOS	Commission Internationale du Bassin Congo-Oubangui-Sanga
CORAF	Conseil Ouest et Centre africain pour la recherche et le développement agricoles
CR	Coarse Resolution
CRTS	Centre Royal de Télédétection Spatiale (Maroc)
CSE	Centre de Suivi Ecologique (Sénégal)
CSIR	Council for Scientific and Industrial Research (South Africa)
CSO	Civil Society Organisations
CTIV	Centre de Traitement des Images Vegetation
DBH	Diameter Breast Height
DDS	Data Dissemination System (ESA satellite-based Earth Observation)
DMP	Dry Matter Productivity
ECA	Economic Commission for Africa (United Nations)
ECA-SROWA	Economic Commission for Africa – Sub-Regional Office for West Africa
ECCAS	Economic Community of Central African States
ECOWAS	Economic Community of West African States
EDF	European development Fund
EIS-AFRICA	Environmental Information Systems in Africa
EMA	Ethiopian Mapping Agency
EO	Earth Observation
EU	European Union
EUMETCAST	EUMETSAT's Broadcast Service for Environmental Data
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FAO FRA	UN Food and Agriculture Organisation - Global Forest Resources Assessment
FARA	Forum for Agricultural Research in Africa
FLEGT	Forest Law Enforcement Governance and Trade
GBIF	Global Biodiversity Information Facility
GEO	Global Earth Observation
GLC2000	Global Land Cover 2000
GMES	Global Monitoring for Environment and Security
GNSS	Global Navigation Satellite Systems
GOFC-GOLD	Global Observation of Forest Cover – Global Observation of Land Dynamics
GPS / CORS	Global Positioning System / Continuously Operating Reference Stations

ICPAC	IGAD Climate Prediction and Applications Centre
IGAD	Intergovernmental Authority on Development
IRD	Institut de Recherche pour le Développement (France)
IRS	Indian Remote Sensing satellites
ITC	International Institute for Geo-Information Science and Earth Observation
IUCN	International Union for Conservation of Nature
JRC	Joint Research Centre
LANDSAT	Land Satellite
MERIS	Medium Resolution Imaging Spectrometer
MODIS	Moderate Resolution Imaging Spectroradiometer
MSG	Metoesat Second Generation
NARSS	National Authority for Remote Sensing And Space Sciences (Egypt)
NASRDA	National Space Research & Development Agency (Nigeria)
NEAP	National Environmental Action Plan
NDVI	Normalised Differential Vegetation Index
NESDA	Network for Environment and Sustainable Development in Africa
NGOs	Non-governmental Organizations
NMHS	National Meteorological and Hydrological Service
NOAA	National Oceanic and Atmospheric Administration
OAB	Organisation Africaine du Bois
OFAC	Observatoire des Forêts d'Afrique Centrale
OIBT	Organisation Internationale des Bois Tropicaux
OSS	Observatoire du Sahara et du Sahel
PUMA	Préparation à l'Utilisation de Metoesat en Afrique
RAPAC	Réseau des Aires Protégées d'Afrique Centrale
RCMRD	Regional Center for Mapping of Resources for Development
RECs	Regional Economic Communities
RECTAS	Regional Centre for Training in Aerospace Surveys
REDD	Reducing Emissions due to Deforestation and forest Degradation
RICs	Regional Implementation Centres
ROPPA	Réseau des Organisations Paysannes et des Producteurs de l'Afrique de l'Ouest
RSAU	Remote Sensing Applications Unit (SADC)
SAC	Satellite Application Centre (South Africa)
SADC	Southern Africa Development Community
SAF	Satellite Application Facilities
SERVIR	Regional Visualisation and Monitoring System
SISEI	Système d'Information et de Suivi de l'Environnement sur Internet
SP/CONEDD	Secretariat Permanent du Conseil National pour l'Environnement et le Développement Durable
SPIAF	Service Permanent d'Inventaire et d'Aménagement Forestier (Dem. Rep. Congo)
SPOT	Satellite pour l'Observation de la Terre
UN	United Nations
UICN	Union Internationale pour la Conservation de la Nature
UNDP	United Nations Development Programme
UNECA	United Nations Economic Commission for Africa
UNEP	United Nations Environment Programme
UNCCD	United Nations Convention to Combat Desertification
UNFCCC	United Nations Framework Convention on Climate Change
UNISPACE III	United Nations Conference on the Exploration and Peaceful Uses of Outer Space
USA	United States of America
USAID	United States Agency for International Development
USGS	United States Geological Survey
WAEMU	West African Economic and Monetary Union
WB	World Bank
WRI	World Resources Institute
WSSD	World Summit on Sustainable Development
WWF	World Wildlife Fund

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Annex 1: Additional text on non-renewable resources for consideration by Workshop participants

I – NON-RENEWABLE NATURAL RESOURCES

The state and use of Africa's non-renewable natural resources - fossil fuels (coal, gas, and oil) and minerals - is characterized by a surprising contradiction: "Although Africa ranks high in terms of resources, its share of world base metal and mineral fuel consumption is very modest, a consequence of the continent's low level of industrialization, economic status, and per capita consumption patterns" [6].

Fig 2: map of Non-Renewable resources location in Africa
Source: Council for Geoscience and Mintek (2007)

Coal

In the domain of fossil fuels, Africa's coal resources are mainly found in Southern and Western Africa, with major deposits in Botswana, the Democratic Republic of Congo, Mozambique, Nigeria, South Africa and Zimbabwe, and minor deposits in Senegal, Benin, Niger, Somalia, Ethiopia, Tanzania, Zambia, Malawi, Madagascar, Egypt and Morocco. South Africa, with some 34 billion tons (2005 estimation) holds the majority of the continent's estimated recoverable coal reserves, and is ranked the sixth-largest holder of coal reserves in the world. In terms of consumption, South Africa is an exception, with 91,6% of the continent's total coal consumption (Year 2006). Africa's Coal export – mainly shipped through the Richards Bay Port in South Africa - is affected by infrastructure constraints, resulting in a decrease in export figures between 2005 and 2006 [6].

Projects related to coal production in Africa include Moatize project in Mozambique, Mchuchuma in Tanzania, 3 Main Mine project in Zimbabwe, Morupule Colliery production increase in Botswana.

Oil

Crude oil deposits are located in the north of the African continent, in Algeria, Chad, Egypt, Libya, Morocco and Tunisia. Other locations include Nigeria and Angola.

In 2005, the continent's production of crude oil was 9.8 million barrels per day representing 11,6 % of the world crude petroleum production. Nigeria accounts for more than a quarter of the total oil production in Africa. Libya, Chad, Sudan, Angola, Algeria and Equatorial Guinea are countries in Africa where oil production increased also, mainly as the result of starting new extraction fields. The 1.01 billion barrels consumed in 2005 by the continent represents only 3.2 % of the world consumption of petroleum products.

Natural Gas

The largest deposits of natural gas can be found in Algeria and Mozambique, but Libya, Niger, Morocco, Nigeria, Rwanda, Ghana, Egypt, Tunisia, off the costs of South Africa, Tanzania and Namibia are other locations of significant natural gas deposits in Africa. The total production of dry natural gas for the continent was 163 billion cubic meters in 2005, and Algeria alone accounted for 54% of the figure.[7]. Nearly 3% of the world natural gas was consumed on the African continent in 2005, which is the equivalent of 71.2 billion cubic meters. Algeria is also the largest exporter of Liquified Natural Gas (LNG) in Africa.

The production of natural gas was at the time expected to increase globally in Africa, due to individual countries' plans to produce more, such as the new field of Gassi Touil in Algeria, The West African Gas Pipeline project of Nigeria, increase at the Temne field in Mozambiqu, and Songo Songo in Tanzania.

Minerals (metals and non-metals)

Africa is known to be endowed with several of the world's most important minerals and metals. Some twenty five (25) different types of mineral commodities have been associated with Africa's natural endowment, including gold, diamonds, uranium, manganese, chromium, nickel, bauxite, cobalt, etc. Africa dominates some of the world's mineral resources supply, with South Africa standing out as the world's leader producer of Chromite and ferrochromium, gold, palladium, platinum and vanadium. South Africa is the second ranked

producer of manganese and ferromanganese, rutile, and zircon. However, the production of several minerals is comparatively small on the continent, and for some minerals, the production trend has been declining. The mine production of bauxite, copper and led decreased from 1990 to 2005. [6]

- Uranium: Namibia and Niger share the largest deposits of uranium in Africa. Algeria, the Central African Republic, Gabon and South Africa also shelter significant occurrence of uranium some of which are not still unexploited (Namibia and South Africa). Niger was the first producer of uranium in Africa in 2004 (46%), followed by Namibia (45%) and South Africa (9%). Despite these figures, Africa accounted in 2005 for only 0.47 percent of the global supply of nuclear power electricity. However, plans at national level to increase the production of uranium were as follows in 2005: opening of the Dominion mine in South Africa and starting of the Kayelekera project in Malawi;
- Gold: South Africa, Ghana and Tanzania share the largest gold deposits in Africa, with other significant occurrence in Mozambique, Zimbabwe, the Democratic Republic of Congo, Algeria, Mali, Sierra Leone, Senegal, Côte 'Ivoire, Guinea, Burkia Faso, Niger and Ethiopia. The mine production of gold decreased globally in Africa in 2006 with 552 tons equivalent to a 14% decline with reference to the level of production in 1996. This is the consequence of the long term decline of gold production in South Africa, resulting globally in a downward movement of Africa's share of world gold production that fell from 32 percent in 1990 to about 21 percent in 2006. [6]. Gold mines were to open in Africa, for example in Mauritania with the Tasiast Gold Mine, Taparko, Essakane, in Burkina Faso, Bisha in Eritrea, Kilo Moo Mine in the Democratic Republic of Congo, and some more in Madagascar and Uganda.
- Diamonds: The most important continent for diamond-mining and the richest is Africa. Africa accounts for more than half of the world's diamond production. In 2005, Botswana was the top producer in Africa, followed with a slight margin by the Democratic Republic of Congo. The West Africa accounts for about 2.5 percent of Africa's total diamond production. Despite its production of more than a half of the world's gem-quality diamonds, Africa's rough diamonds are exported without any value addition, due to the lack of beneficiation facilities. [6] The major diamond trading hubs of Belgium, Israel and India are the places where the majority of beneficiation occurs. The Kimberley Process Certification Scheme (KPCS) on illegal diamond trade seems to be an efficient framework, as over 99 percent of all diamonds are certified through this process, as being from conflict-free sites.

  Projects announced in 2005 included the Kamachia-Kamachia, the Luarica, and the Rio Lapi Garimpo mines in Angola, increased production considered in the Murowa area in Zimbabwe, and expansion of production in other countries such as Democratic Republic of Congo, Lesotho, Botswana, Namibia, South Africa.
- Ferrous Metals: The demand for crude steel supply, a continuing double-digit economic growth in China and the acceleration experienced in worldwide economy in the beginning of the New Millennium resulted in a surge of world ferrous minerals consumption. Between 2004 and 2005, the increase in world steel production reached 6.6 percent. China alone increased the steel production over the same period by 26.3 percent to reach 349 million tons, which represented a 31 percent share of the world production. India also witnessed an increase in steel production, together with a few other Asian countries. Attempts to control the increase in metal prices resulted in a considerable drop of manganese ore and alloys prices in 2005, while chrome ore, silicon metal and vanadium prices increased significantly on the world market. But the trend is that metal prices move in parallel with a world-wide growing economy.

  In Africa, chrome deposits are found in South Africa, Madagascar, and Zimbabwe. Other significant deposits are located in Egypt, Sierra Leone, and Sudan. More than 80 percent of the chromite produced in Africa is consumed locally, which is a good sign for the local industry. However the majority of the the ferrochrome production in Africa is exported. [6].

  Iron ore deposits are well spread out over the continent, but most of the known reserves are located in South Africa. But Africa consumes very little of the continent's iron production, which is exported to China and the Pacific Rim countries.

  Manganese deposits are also well spread out over Africa, with deposits larger than 10 million tons located in Burkina Faso. Gabon, Ghana, Namibia, South Africa and Togo. The outlook is growth in world crude steel output, major driver of demand for manganese, continuing to secure a strong demand for African manganese resources. [6]
- Industrial minerals: Phosphate rock deposits are well spread out over the continent, with more than 10 million tons resources located in the north and the south. Morocco is endowed with the largest resource of phosphate rock deposit in the world. Africa globally has considerable phosphate resources. And yet, with a population representing 12 percent of the total world population, the use of fertilizer in Africa was only 2 percent of the world consumption in 2005.

- Non-Ferrous Metals and Minerals: the aluminium resources of the continent are located in the west Africa (Burkina Faso, Cameroon, Côte d'Ivoire, Ghana, Guinea and Sierra Leone. However , 11 other countries are endowed with deposits of more than 1 million tons.
- Copper resources are located In the southern part of the continent, and in the copper belt area of Central Africa. Major deposits are in Botswana, Burkina Faso, the Democratic Republic of Congo, Namibia, South Africa and Zambia. Seventeen other countries, with deposits of more than 50 000 tons are also part of the copper-endowed parts of the continent. The copper belt is a curved area measuring around 600 km long and 50 kms wide in central Africa, with one of the world's greatest concentrations of copper and cobalt deposits. Modern exploration practices are still to be applied to explore largely the copperbelt where new ore bodies are likely to be discovered.

All these facts show that the African continent is a region where natural economic resources are abundant in average. The way these resources are managed is determinant for the economic future of the continent and that of the populations living there. Then the basic question is: how do EO applications help achieve the sustainable management of these non-renewable resources, with a visible impact on the well-being of the concerned populations ? How do EO applications influence the level of industrialization, the economic status, and the per capita consumption patterns in Africa ?

5.1.2 Policy Drivers and need analysis

5.1.2.1 Policy Drivers

Although the mining industry, seen from countries' perspectives in Africa is an individual business at the discretion of each government, efforts have been deployed since the beginning of the Millennium in trying to harmonize policies in this domain. The RECs have developed initiatives to harmonize their sub-regional mineral policies (Protocol on Mining adopted by the SADC region in 2000, Directive on the Harmonization of Guiding Principles and Policies in the Mining Sector adopted in 2009 by the ECOWAS, WAEMU's Common Mining Policy adopted in 2000).

The first AU Conference of Ministers responsible for Mineral resources development adopted an African Mining Vision (AMV) in 2008 with the goal to use Africa's mineral resources to meet the Millennium Development Goals. Subsequently, an Action Plan was adopted in December 2011 with a view to implementing the vision.

5.1.2.2 Needs Analysis

The long term management of non-renewable natural resources aim at planning the use of these resource in a way that

- supports economic growth
- ensures that a certain level of deposit reserves are kept untouched for the future
- warrants reinvestment in the social sector for the local communities
- generates employment, stimulates the local economies and struggles against poverty
- encourages internal consumption of the related commodities

This translates into the following broad information needs:

- Accurate knowledge of the location and volume of the deposits by nature of resource (fossil fuels, minerals)
- Internal (domestic) consumption needs and opportunities to use substitutes for the non-renewable resource
- behavior of the related commodity on the world market and medium / long term trends
- present state of each type of non-renewable resource

This calls for robust Information systems integrating the various types of data, levels of information needs, source of input data, in order to deliver the appropriate information products and information services required for decision making over time. The table below contains a summary of the type of data needs related to information needs.

Table 1: Information needs for non-renewable natural resources management and stakeholders involved

Scale	***Information need/ data type***		***Stakeholders involved***
National local	Location /volume of deposits	EO data for prospection In situ measurements for detailed knowledge of deposit characteristics	• Mining Authority • EO application experts
Continental	Aggregate data from national	EO data for integration	• African Ministerial body

	level	Aggregated in situ data	• Continental level coordination institution
National local	National consumption needs, NR resource substitute opportunities	Population distribution and growth data EO for Agricultural / pastoral land areas (eg for phosphate consumption pattern) Transportation/transformation Industries and their respective consumption pattern	• National statistics office • Inter-ministerial experts committee (mining, economics, statistics, planning, environment, agric, livestock, transportation, industry, trade) • Cabinet
Continental	Aggregate figures from national level	Data compiled and classified from the national sources	• African Ministerial body • Continental level coordination institution
National	fossil fuel / mineral items' behavior on world markets and regional markets	World market /regional market prices statistics	• Mining Authority • National statistics office
Continental	Same as above + trends	Same as above	• African Ministerial body • Continental level coordination institution
National Local	Information on mine and artisanal production	In situ data on production and reserve depletion	• Mining Authority • National statistics office
Continental	Aggregate figures from national level	compiled from national extraction data	• African Ministerial body • Continental level coordination institution

5.1.2.3 Existing capacity and programmes

Institutions Organizations	***Data collection, accessibility and integration***			***Monitoring and Assessment***			***Information Diffusion & Capacity Building***	
	Data Collection	***Data Access***	***Data Integration***	***Assessment***	***Monitoring***	***Forecast/ Early Warning***	***Information Diffusion***	***Capacity Building***
Regional Implementation Centres: RECTAS RCMRD AGRHYMET OFAC RSAU	Base Datasets (geological data) Earth Observation data (radar, high res data)	Accessibility for processed data Access to Base data through technical services	Country data are highly confidential and difficult to access	Fossil fuels deposits Mineral deposits	Land Use Land Cover Changes	SISEI SERVIR,	Bulletin Web sites	Short terms training Diploma courses Workshops
National Centres CRTS CSE SAC SPAIF CENATEL SP/CONEDD Mining Cadastre agencies SPACE AGENCIES	Field data AMESD data Satellite EO data	Payment of fees	SISA AMESD data products	Vegetation types Mining sites restoration assessment	Biomass Biodiversity Mining sites planning and overall follow up	GTP	Bulletin	Short term training Workshop
Research Institutions Universities	Field data	No	No	No	Key environmental indicators	No	No	Diploma Courses Tertiary Education
Regional Organizations River Basins OSS								