1. LONG-TERM MANAGEMENT OF NATURAL RESOURCES

2. EXPERTS

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4. INTRODUCTION

4.1. Thematic context

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

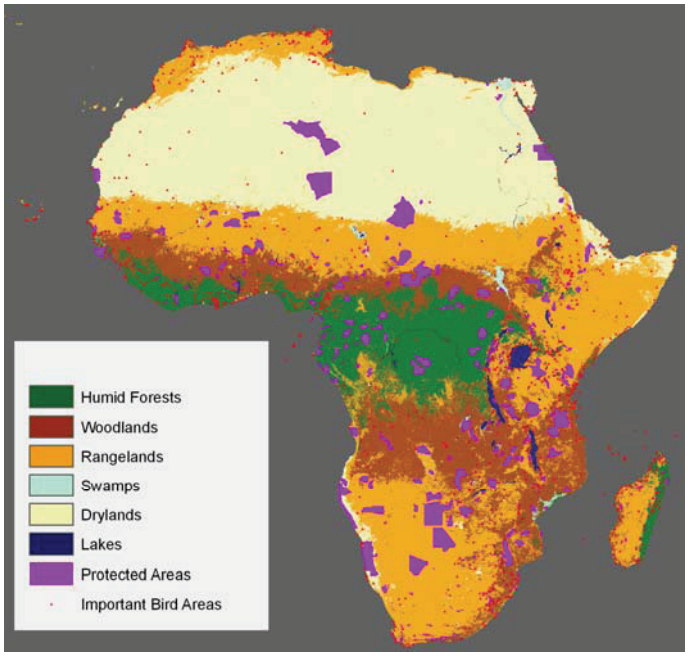

Figure 1: Main ecosystems of Africa (derived from GLC2000) with Protected Areas and Important Bird Areas

Continental and global services provided by the African ecosystems are also of first importance. The Congo Basin forests constitute the second largest area of contiguous moist tropical forest left in the world and play a major role in the carbon cycle; the biodiversity present in African landscapes in unique in terms of quantity and quality; fresh water resources represent an enormous potential for irrigated land and hydropower. In this chapter, we will concentrate on the following categories of natural resources for avoiding overlap with other parts of the GMES Africa action plan: forests, woodlands and rangelands, biodiversity.

While for forests, woodlands and rangelands, the status and the dynamics of the land-cover are the 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…).

African environment is subject to rapid evolution under the influence of changing climatic conditions (e.g. recent droughts) and socio-economic pressure (e.g. rapid population growth, globalisation…). To satisfy the growing needs for food, several natural areas were cleared for agriculture production, mainly in the circum-Sahara zone. In other African regions, demand for timber also increased the pressure on natural areas. These changes have serious implications on the state of the environment, as well as on long-term ecosystem services for the population.

4.2. Pressure on the natural resources

The African natural resources are currently subject to many degradation phenomena:

Table 1: Main pressures existing on the Natural Resources in Africa

Resources	***Phenomenon***
Land resources	Land degradation Soil salination Loss of chemical 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 Species extinction Increase of invasive species Pressure around protected areas

Although there are many evidences of the changes above-listed, we are currently unable to answer in a quantitative way to several fundamental questions. For example, where and with which intensity demographic pressures generate more extensive utilization of lands? How the deforested areas are used? What is the magnitude and the speed of the land degradation and desertification processes? What is the pressure in and around protected areas? One does not have nowadays an exhaustive and precise knowledge on the nature and the magnitude of all these changes. The long term trend of land cover and land

use would give important key-answers for ensuring the sustainable exploitation of natural resources, i.e. guarantying needed services for the local population, increasing the economic growth of the countries, and maintaining the ecological value of the ecosystems. More importantly, these answers 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 ongoing global changes.

5. POLICY DRIVERS AND NEED ANALYSIS

5.1. Policy drivers

Environmental resources management and monitoring are very complex depending on the number of actors, factors, disciplines and the levels of spatial organization 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 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) in discussion can allow African countries to convert their forest covers into “carbon credits” which can be traded with developed countries.

However, it is worth mentioning that operational mechanism such as National Action Plan on Environment still lack full consideration in the national development agenda. Also, one can note the lack of synergy between these systems, since the action plan of a given convention barely refers to the program of another convention. And yet, the multiplicity of the sources and factors of environmental degradation require a strong synergy between theses plans in order to set up coordinated and relevant solutions. With the ongoing decentralization 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 this environmental agreements have components that explicitly reference the need for Earth observations, to help achieve their goals. In particular, the third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), held in 1999, in its resolution 54/68, 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, constituencies 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 has issued a Strategy on Disaster Risk Reduction, calling for a coordinated, comprehensive and sustained global Earth observations, data analysis and information generation. In January 2007, the Meeting of the African Heads of State Summit has made the a decision and a declaration on Climate Change and endorsed the Climate for Development in Africa (CLIMDEV Africa) programme for Climate Change in Africa. The AU Executive Council decision EX.CL/Dec.254 (VIII) of January 2006 adopted the Science and Technology Consolidated Plan of Action (CPA) which introduce space science and its applications as flagship research and development area. 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.

5.2. Needs analysis

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

- 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 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 in African ecosystems induces an urgent need for a 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. These include the strengthening of local, national and regional capacities for creating, updating and keeping on providing coherent spatial and statistical information on environmental variations and change towards improved management and decision-making. The table below summarize 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. – Climat & Water: Seasonal characteristics, spatial patterns
Global	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 Changes intensity

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

6. IDENTIFICATION OF COMMUNITIES

The GMES Africa Programme envisions to develop applications and provide products and service at local, national and regional level. In this regard, the programme needs strong coordination mechanism involving all 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.

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 – 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 Carbon Potential The information should be global through an Early Warning System
Technical Decision-Makers	– Relevant National Ministries (Forests, Environment, Land planning, Agriculture, – Regional and national development agencies (COMIFAC, RAPAC…)	All aspects of environment, such as vegetation status, vegetation change, surface water, fire, carbon stocks… The information should be in near real time

	– Managers of protected area – Development banks (WB, AfDB) – Technical services of development Agencies: EC, Member States, USAID, ACDI…	at subregional to national scales and combined with ancillary input such as socio-economic data
Scientific Community and Information Producers	– Networks : GOFC-GOLD, NESDA, EIS-AFRICA, AARSE, UICN, OSS, FARA, ASARECA, CORAF, OFAC – RICs : AGRHYMET, RSAU, RCMRD, RECTAS – Regional and National Research Institutions: CGIAR, JRC, ITC, WRI, IRD, USGS – National Centers : SAC, CRTS, CSE, CERGIS, etc.	Forest Cover status Land Use Land Cover Vegetation phenology (Biomass variation, foliar index, etc…) Biodiversity (change in the floristic composition), etc…
Ultimate Beneficiaries	– Producers of Goods : OIBT, OAB, National Forest Services, Private forest companies – International and local NGOs : WWF, BirdLife Africa, UICN, – Civil society : ROPPA –	Forest logging Deforestation

7. MAPPING EXERCISE

7.1. Existing capacities and programmes

Earth Observation in Africa must be “user-pull” and not “technology-push”. Therefore, research, Science and Capacity building must be regarded as fundamental issues. GMES Africa will help scientist and engineers from the continent to get a real expertise and scientific capabilities in Earth Observation to ensure that they can help meet the expanding needs of African. Partners in the project are expected to constitute a technical network of regional and national organizations and institutions able to operate continuous monitoring and assessment of natural resources in Africa. The operational features of continent-based institutions are shown in the table below.

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

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 (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 SAC SPAIF CENATEL	Field data	Payment of fees	No	Vegetation types	Biomass Biodiversity	No	Bulletin	Short term training Workshop
Research Institution Universities	Field data	No	No	No	Key environmental indicators	No	No	Diploma Courses
Regional Organizations Rivers Bassins 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					

7.2. Human capacities

The current capacities to produce geospatial information in this thematic domain are unequally distributed in Africa, geographically and by type of institution. As a general rule, the stakeholders in charge of the management of the resources (forest companies, conservation NGOs, regional development agencies…) have completely integrated the use of Earth Observation for helping them in the decisions. The governmental services in charge of these issues are less prepared to produce and use the 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 training "on-project" of technicians for a specific task. At the level of graduates, there is a lack of remote sensing and GIS matters in the thematic training activities, which lead to an insufficient number of graduates (forest engineers, conservationists, rural developers…) able to use the geospatial information in an optimal way.

On the other hand, when human capacities exist, it is often underused by lack of hosting institution and facilities. In this case, the main challenge is to retain and maintain existing capacities.

7.3. Methods

Automated processing chains for extracting thematic information in forestry, biodiversity and land-cover exist for medium and coarse resolution data, but nowadays, there is no standardised methods 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 deriving composite indicators.

8. IDENTIFICATION OF GAPS AND OF EXISTING OR PLANNED FUNDING PROGRAMMES

8.1. Identification of gaps

In Africa, the current low level of infrastructure capacities for the collection and assessment of data, for their transformation into useful information and for their dissemination does not allow for exloting at the optimal level the existing human capacities. GMES 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 the various elements necessary for decision-making

- Earth Observation data covering the continent at the right resolution and accessible for the users at the acceptable price

- In-situ data regularly collected, harmonised, standardised, structured in accessible and interoperable databases. A special focus should be given to carbon tracking, biodiversity and socio-economic parameters.
- Acquisition and processing physical infrastructure.

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)	
Medium Resolution (10-50m)	LANDSAT SPOT CBERS IRS ASTER	Complete coverage yearly	Maspalomas (Canary) Hartebeeshoek (South Africa) Aswan (Egypt) Jos (Nigeria) Malindi (Kenya)	Lack of receiving stations in large key regions (Central Africa, West Africa…)
High resolution (2-5m)	SPOT	Complete coverage 3-5 years	Murzuq (Lybia) Hartebeeshoek (South Africa) Maspalomas (Canary)	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 / Projet	ftp transfer rate is very low in many countries

In situ observation

The in-situ 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 georeferenced 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: 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…		
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 exist (Senegal, South Africa)	No consolidated network of land-cover 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 Efficiencency		

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. A detailed table of acquisition and processing infrastructure is proposed next page.

For the infrastructures 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 trough some projects funded by USA in the frame of GOFC-GOLD, but a real dynamics is still to build in many regions.

8.2. Future planned activities

Apart from the existing capacities already listed in section 7.1., new initiatives merit some attention.

- The Group on Earth Observations 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 panafrican 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.

9. BUILDING GMES-AFRICA SERVICE

9.1. 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 (carbon content, biodiversity, water balance…).
In specific regions of interest (subject to climate change debate, like the Congo Basin, or with high biodiversity patterns), 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
The land-cover and forest-cover change estimates are necessary at national level for reporting to international conventions and for analysing general trends, and at local scale 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 get an 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 concessions, climate projects…). In this case, the methods (sampling or the 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: carbon stock and flux, biodiversity value and change maps, land suitability for energy and agriculture…

9.2. Capacity-building

9.2a Necessary elements
As in other thematic areas, the issue of capacities is critical and should be solved in a holistic manner. Different levels of capacities should be reinforced:

- technicians involved in the day-to-day management of natural resources
- technicians for the production of geospatial information
- managers of natural resources involved in the planning and implementation of policies
- high profile scientists for adapting scientific tools and methods to the African context.
- Local communities for using earth observation service into management problems solving and sustainable use of natural resources.

9.2b Strategy of implementation
According to the category, the reinforcement of capacities should take place in existing schools (forestry, fauna, rural development…) or 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 Panafrican Universities.

9.3. 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 acquiring and processing EO data in Africa. It should be based on the existing facilities when available and the creation of new centres when 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.
For developing the regional processing centres, a massive effort of capacity-building must be put in the production of geo-spatial information, in specialised institutions and in thematic training institutions (agriculture, forestry, conservation).

In the mean time, the policy-makers should be trained to include geo-spatial information in their decisions by specific awareness-raising activities.

9.4. Organisational scheme

For the management of GMES Africa, a clear political vision is a pre-requesite. Thus, there is an important role to 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 all stakeholders (technicians, politics 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 scientist. 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 Centers of Excellence (RECTAS, RCMRD and AOCRS) : supervision of the technical activities on a daily basis
- National Agencies: CRTS, NASRDA, NARSS, SAC, CSE, 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: UNEP, 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: 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.

9.5. Timetable

This long-term strategy should be articulated in 3 phases:
Phase 1 (2yrs): Exploratory phase with installation of the governance model and the political dialogue Europe-Africa, identification of pilot-products in selected areas, identification of the candidate training institutions, gap filling in HR data acquisition, identification of the model for in-situ data collection.
Phase 2 (4yrs): Pilot phase with test of exploratory products over large areas, training activities in specialised and thematic centres, awareness-raising of policy-makers, installation of national-regional processing facilities for satellite data and collection of in-situ data.
Phase 3 (4 yrs): Operational phase with provision of complete GMES services based on the pilot-products, full deployment of national and regional facilities, maintenance of a complete network of data acquisition (in-situ and satellite).

2010	Action plan adopted by Heads of State
2011	Installation of the political dialogue Installation of satellite data acquisition in missing regions
2012	Identification of regional processing and training centres Development of exploratory products
2013	Setting-up or strengthening of regional/national processing facilities
2014	Strengthening on training institutions for production of geo-spatial information
2015	Awareness-raising of policy-makers
2016	Test over large areas of exploratory products
2017	Development of operational services
2018	Full deployment of regional/national processing facilities
2019	Maintenance of acquisition infrastructure and processing facilities
2020	Amplification of the capacity-building activities

9.6. Indicative development plan and budget estimate

Taking into consideration the current state of capacities and the existing cost for existing regional centres, the first estimates for this component are
Phase 1: 10 M EUR
Phase 2: 15 M EUR
Phase 3: 20 M EUR

10. RECOMMENDATIONS

A sound management of natural resources, in particular forest and biodiversity, is necessary for guaranteeing the livelihood of huge populations on Africa and for maintaining the long-term ecosystem services. The recommendations for the GMES Africa programme related to the long term management of natural resources, with respect to data, products and capacities, are the following:

Data acquisition and processing

- 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;
- 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, 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: technician, manager and high-level scientist

Institutional dialogue

- The regional information centres are the best level 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 and implementation centres) and users (political institutions). GMES Europe can provide some lessons in that respect for the system architecture and the implementation mechanisms.
- Targeted applications and institutions must be privileged in a first time (community of users well identified) with a further broadening of the spectrum of activities.
- 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 Panafrican scope of the monitoring systems could be ensured by a specific bureau, in liaison with the AUC.
- The financial and technical partners of GMES Africa should also envisage the permanent dialog with other programs involved in the long-term management of natural resources (SERVIR-Africa, CARPE, CBERS…)

11. SUMMARY

Ecosystem services provided by natural resources in Africa allow for the subsistence of nearly 90% of the population. On the other hand, African environment is essential for maintaining a stable climate and a biodiversity reservoir for the entire planet. For these local needs and the payment of the global services, a permanent monitoring of forests, rangelands and protected areas is required. When information systems are missing, reliable information to support management decisions is not readily available and accessible as it could be, 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 the right scale (5-10 m for forest monitoring) and the right delivery time for long-term management of natural ecosystems (annual complete coverage at minimum);
- Develop processing facilities at national and regional level, able to produce updated information for the new challenges and opportunities (climate, forest management, biodiversity). The regional centres should be linked to political institutions.
- Build on existing human capacities in specialised schools of forestry and conservation 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 Africa can give a general framework for the cooperation between Europe and Africa, but the concrete dialog between the different stakeholders is still missing. On the other hand, other stakeholders (USA, Brazil, Asia) are also involved in this process and should be consulted.
A 10-year three phase implementation strategy is proposed including an exploratory phase (2 years) followed by a scaling up period of 4 years and a final operational phase of 4 years. The budget proposed for each phase is 10 m, 15 m and 20 million Euro respectively.

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
AOCRS	African Organization of Cartography and Remote Sensing
ASAR	Advanced Synthetic Aperture Radar
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
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)
NDVI	Normalised Differential Vegetation Index
NESDA	Network for Environment and Sustainable Development in Africa
NGOs	Non-governmental Organizations
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
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
WB	World Bank
WRI	World Resources Institute
WSSD	World Summit on Sustainable Development
WWF	World Wildlife Fund

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