Section III – Thematic Issues

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5.0 Long-Term Management of Natural Resources

EXPERTS

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EXECUTIVE SUMMARY

Sustainable long-term management of Africa's natural resources is of eminent importance not only for the people of Africa but also for the entire globe. Nearly 90% of Africans draw their subsistence from the use of forests, woodlands, wetlands, rangelands and their flora and fauna biodiversity. The extraction of mineral resources is the basis of economic growth in many African countries. The African environment is also essential for maintaining a stable climate and a biodiversity reservoir for the entire planet. Yet, there are immense pressures on this fragile environment, such as land degradation, logging activities, intensified agriculture, illegal mining, urbanisation and poverty. To support the sustainable use of the resources towards meeting local needs and delivering global services, a permanent monitoring of Africa's natural resources is required at national, regional, continental and global scales.

Although there are several important global and African political initiatives, research programmes and projects, and despite the recognition and endorsement of the importance of Earth Observation by the African Ministerial Conference on the Environment (AMCEN) and other high-level bodies, coordinated information systems with reliable data that are presented in compatible formats for NRM are still missing. Also, reliable information to support management decisions for Africa's natural assets is not readily available. Local capacity in terms of human resources and EO / IT is patchy and insufficient in some countries.

In this context, GMES and Africa represents a unique opportunity to develop and deploy the necessary infrastructure in order to address the various sectoral thematic areas and cross-cutting issues. GMES and Africa is an opportunity

- to ensure provision of space-based observation as summarized in Table 3;
- to provide availability and access to *in situ* observation as a reliable source of ground-based information on natural resources as presented in Table 4;
- to develop an Africa-wide acquisition and processing infrastructure;
- to strengthen human and technological capacity in Africa at technical, managerial, scientific levels for the long term monitoring and assessment of natural resources.

In terms of priority of requirements and actions, the following strategy is suggested: first, installation of infrastructure for the acquisition and processing of EO data; second, development of a regional processing centre in each REC. In terms of organisational scheme, a clear political vision is a pre-requisite. It is partly being taken up by AfriGEOSS and the Pan-African Working Group on Space, with the AUC and the RECs as important driving forces.
The following recommendations are formulated for consideration by the African policy makers and decision takers:

1. **Support the availability of more compatible, accessible and interoperational information and data sets.** This includes, *inter alia*, data acquisition at the appropriate spatial, radiometric and temporal resolutions (e.g a yearly coverage of cloud-free medium resolution images over the entire continent) a structured network of *in situ* observations on carbon, biodiversity, land use and tenure, mineral commodities, making use of existing and new initiatives; the use of international standards to facilitate national and regional data integration, with a special effort on the standardisation of EO, *in situ* data, processes, added-value information products and services and their dissemination and delivery online over the entire NRM chain for Africa.

2. **Facilitate the development of information services for natural resources inventories and assessment, and the reinforcement of existing facilities at national and regional levels.** Receiving stations should be installed in critical regions, geodetic networks improved at the continental and regional scales, information produced should combine near-real time monitoring systems, land cover characterisation and land cover change estimates; methodologies need to be developed to improve the exploration, specifically of NRNR, including the development and updating of mining and forestry cadastres.

3. **Foster the development of a pool of experts to support natural resources management at a pan-African level**. From the production of information, the organisational capacity, to the integration of the information in the decision making process, African capacity must be reinforced. All NRM-related projects should place a strong emphasis on training and local skills capacity building, making use of AMESD/MESA as a useful starting point. Particular emphasis is needed to establish/support thematic research networks between African universities and European research centres, including opportunities provided by the new EC Research Framework Programme "Horizon 2020".

4. **Encourage institutional dialogue and the development of operational services for improving the decision making processes in the long-term management of natural resources in Africa**. This requires the strengthening of regional information centres. In addition, African policy makers

(various ministerial conferences and summits of Heads of State and Government) should instruct countries to build and strengthen synergies of action, with a view to developing a coordinated pan-African space programme with a high potential for NRM on the continent, in line with the plan to create an African Space Agency

To reach these different objectives, African policy makers and decision takers are requested to ensure that the necessary funding and infrastructure is provided, and that a conducive environment for collaboration and data exchange is fostered. African partners should also be ready to provide counterpart funding where necessary to make a success of the whole initiative. In addition, the following should be envisaged to encourage support by the donor community:

1. Support Africa's effort to consolidate existing regional and national institutions' capacity through collaborative projects and programmes on acquisition and processing of EO data. Besides existing institutions, the development of strong regional processing centres, with a strong link to national services should be a strategic target. EU and AfDB are amongst the most appropriate donors which could help to achieve this goal. Examples like AMESD or OFAC (Observatoire des Forêts d'Afrique Centrale) can provide first models to consider and learn from. In all cases, a solid link between technical implementation centres and the political institutions in charge of the management of natural resources is a key success factor.
2. In parallel with the above, areas identified as gaps should be covered by an inclusive capacity building effort. Among the crucial needs, the following have been highlighted: application of radar techniques for e.g. the extractive activities, organisational capacity to make the best use of EO data, calling for an extensive application of the GMES-and-Africa-oriented Horizontal Model, use of open standards and software as opposed to commercial products, training of a critical mass of graduates (forest engineers, conservationists, rural developers, mining experts, planners, etc.) in the optimal use of geospatial information. Financial offers from donor agencies should be sensitive to these topics as real user needs;
3. A strong and permanent dialogue is critical between the programmes involved in the long-term management of natural resources on one hand (e.g., SERVIR-Africa, CARPE), and between the NRM component itself and the other chapters of the GAAP on the other hand. Therefore, funders of projects and programmes should encourage the reuse of past (EU-funded and other donor-funded) projects' results as building blocks for the NRM edifice.
4. EO-based NRM initiatives must target the strengthening of co-operation between European and African projects and programmes, and between information producers (scientific community, universities, implementation centres and companies) and users (political institutions) on both sides. The European GMES Copernicus programme can provide some lessons in that respect for the system architecture and the implementation mechanisms.

5.1 INTRODUCTION

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, of whom nearly 90% draws its subsistence from the exploitation of natural resources.

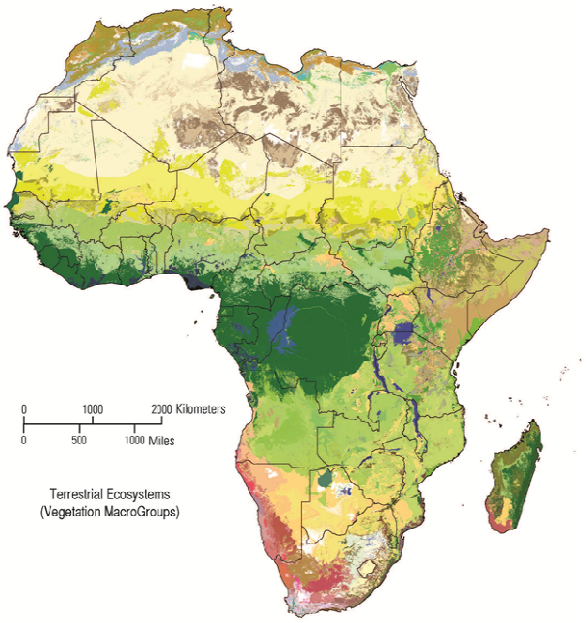

Figure 1:
Terrestrial ecosystems of Africa. Source and Legend: Sayre et al., 2013.

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 is unique in terms of quantity and quality; fresh water resources represent an enormous potential for irrigated land and hydropower. Significant economic growth at country level in Africa is generally due to Non-renewable Natural Resources (NRNR) exploitation, such as fossil fuels, and minerals (AfDB, 2007). In the present thematic context, NRNR encompass hydrocarbons, minerals and certain underground aquifers[1].

Examples of hydrocarbons include natural gas, gasoline, kerosene, fuel oil, lubricating oil, asphalt, etc., while minerals are naturally occurring inorganic solid matter such as gold, silver, copper, nickel, iron etc. extracted or obtained from the ground. 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, non-renewable natural 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 management of NRNR is driven, in the first place, by national policies, and their exploration and exploitation require the combination of space-born data, aerial surveys and *in situ* measurements.

The African environment is undergoing rapid changes under the influence of changing climatic conditions (e.g., leading to more frequent droughts and floods) and socio-economic pressure (e.g., rapid population growth, urbanisation). To satisfy the growing needs for food and energy, 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 loss of forest is particularly worrying because two-thirds of Africa's population depends on forest resources for income and food supplementation. An estimated 90 per cent of Africans use fuel wood and charcoal as energy sources. Despite, or perhaps because of this reliance on forest resources and non-timber forest products (NTFPs), deforestation in Africa has been estimated at 75 million hectares (10 per cent of the total area) between 1990 and 2010 (FAO, 2012). 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	Conversion to biofuel Logging for fuel wood Poaching Impoverishment of commercial species Forest fragmentation Illegal logging

[1] Water resources management in Africa, including groundwater resources, is covered by the Second GMES and Africa thematic chapter on Water Resources Management.

	Conversion to croplands Overgrazing Increase of uncontrolled fires
Biodiversity	Habitat degradation and loss Species extinction Increase of invasive species Poaching Pressure in and around protected areas
Non-renewable natural resources	Energy demand Increasing oil prices Increasing population-induced economic pressures Declining reserves Illegal mining 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 utilisation 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 and what is the impact of exploitation?

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 NEEDS ANALYSIS

5.2.1 Policy drivers

Environmental resources management and monitoring are very complex processes which depend on a number of actors, factors, disciplines and the levels of spatial organisations 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 opportunities to support the African environment, for example through the conversion of forest cover into “carbon credits” which can be traded with developed countries. Notable here are mechanisms like the **Clean Development Mechanism (CDM)** and the expanded **Reducing Emissions from Deforestation and Forest Degradation mechanism (REDD+)** which combines financial rewards including conservation measures, sustainable management of forests and enhancement of forest carbon stocks.

Other important policy drivers with particular relevance to natural resource management (NRM) are:

- The **UN Convention to Combat Desertification (UNCCD)** which is the sole legally binding international agreement linking environment and development to sustainable land management, addressing specifically the arid, semi-arid and dry sub-humid areas, where some of the most vulnerable ecosystems and peoples can be found.
- The **UN Convention on Biological Diversity (CBD)** aiming at the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources.
- The **UN Framework Convention on Climate Change (UNFCCC)**, which is intrinsically linked to the CBD and the UNCCD, being one of the three Rio Conventions, adopted at the Rio Earth Summit in 1992.
- The **Millennium Development Goals (MDG)**, specifically MDG 7: “Ensure environmental sustainability” which includes a call for sustainable management of natural resources and biodiversity for the benefit of the poor, who rely on these resources over proportionally.

- The **Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)** which aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival.
- The **Ramsar Convention on Wetlands**, which calls for the sustainable use of wetlands with a specific focus on the maintenance of designated Wetlands of International Importance.
- The **Payment for Environmental Services mechanism** whereby a land use model, beneficial for the land users, but bearing societal costs for other people can be substituted with another land use model with profit for the land users who pay for the environmental services and that avoids the societal cost or supports it financially.
- The **Extractive Industry Transparency Initiative (EITI)** which is a global standard that promotes revenue transparency and accountability in the extractive sector, by monitoring and reconciling company payments and government revenues from oil, gas and mining at the country level.
- The **African Convention on the Conservation of Nature and Natural Resources**, adopted by the OAU Summit of Heads of State and Government in Algiers in 1968, and revised at the AU Summit of Maputo in 2003.

All the Rio-related agreements and their implementation protocols have components that explicitly refer to the need for Earth Observation to help achieve their goals, for example through monitoring of endangered species, forest fragmentation or land cover changes. In addition, 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 calls for action, among other matters, to protect the Earth's environment and manage its resources and to use space applications for human security, development and welfare.

Despite these global frameworks, which have been ratified by most of the African nations and are endorsed by the **African Ministerial Council Conference on the Environment (AMCEN)** agenda for sustainable development in Africa, operational mechanisms such as National Environmental Action Plans (NEAP) still lack full consideration in the development agendas of many countries. There is a notable lack of synergy between these systems, since the action plan of a given legal framework barely refers to the programme of another convention, although a strong synergy between these plans would be desirable in order to set up coordinated and relevant solutions.

African engagement and ownership of these processes is very visible. Already in 1968 the **African Convention for the Conservation of Nature and Natural Resources** was adopted. More recently, the declaration on Climate Change was made by the African Heads of State Summit in 2007 which endorsed the **Climate for Development in Africa (CLIMDEV Africa)** programme for Climate Change Adaptation in Africa. The AU has also provided various mandates in environmental issues by AMCEN and the **African Ministers' Council on Water (AMCOW)**. 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 (AU, 2009). Subsequently, an Action Plan was adopted in December 2011 with a view to implementing the vision (AUC–AfDB–UNECA, 2011). The **Comprehensive Africa Agriculture Development Programme (CAADP)** calls for accelerating agricultural development; the development of continental and regional market information systems, agreed upon by the African Heads of State and Government are seen in support of this goal in a sustainable manner. The African Union also 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 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 managing 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.

Also at national level, a range of national agreements with direct relevance to NRM play an important role in determining the mandates, roles and functions of the institutional actors with respect to the spectrum of natural resources management requirements at large.

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 Regional Economic Communities (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, **Common Mining Policy** adopted by WAEMU in 2000 (ECA, 2011)

5.2.2 Needs analysis

The purpose of regional monitoring and assessment for long-term management of natural resources 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, organisation and use of information for priority areas identified at local, regional and global level and thus facilitate and increase the cost-effectiveness of thematic or sectoral system recurrent assessment.
- Develop early warning systems and assessment tools for long-term integrated NRM strategies.
- 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 to identify and fill major gaps in sustainable management of natural resources.
- Strengthen field programmes and projects and build synergies amongst them.
- Monitor illegal activities, namely logging, exploitation of minerals and trade of endangered species.
- Influence the exploitation of non-renewable natural resources in a way that supports national economies, profit the local communities, cares for future generations and preserves the local and global environment.

The observed fragility of African ecosystems induces an urgent need for continuous environmental monitoring. The generation, organisation and sharing of data needs to be transparent and any action needs to 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. Necessary 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. This highlights the importance of GMES and Africa needed for the development of continental Early Warning Systems and assessment tools for long-term Integrated Natural Resources Management strategies.

The **rationale** for long-term monitoring and assessment of natural resources at **local/national scale** is based upon the need for setting up multi-scale information systems enabling any user or decision maker to know what natural resource is available locally, how it is used and/or how uses change. This includes for example:

- Seasonal trends and dynamics in rural areas, including, for example, monitoring the extent of irrigated areas or areas under Genetically Modified (GM) crops.
- Quantification of available resources: water, soil, vegetation, forested lands, pasture lands, hydrocarbons and minerals.
- Vulnerability analysis and identification of risk areas, including overgrazing and areas prone to wild fires that endanger ecosystem potential.
- Assessment of land tenure (including mining cadastre, forest cadastre, conservation cadastre).
- Exploration, monitoring of the impact of the extractive industry on local/national environment and enforcement of EIA measures.
- Ecosystem services available for Pay for Environmental Services (PES) purposes.

At **regional scale** the requirement includes regional reference systems for assessing and characterizing the state of natural resources and the environment (baseline mapping, monitoring changes, hotspot / hopespot analysis), including:

- Vegetation: cover, biomass, deforestation rate, invasive species management.
- Land: degradation rate, available arable lands, etc.
- Water resources: seasonal characteristics, spatial patterns; watershed hydropower potential; identification of impacts (pollutants) on fresh water and marine ecosystem through the use of high resolution imagery and lab analysis (e.g. using Sentinel constellation and African resource management constellation (ARMC)).
- Information for climate change adaptation.
- Mining: harmonized data sets to support national policies.

At **continental scale** the needs include assessment and forecasting capacity of environmental phenomena and setting up operational early warning systems, including the following:

- Land use and land cover change and trends.
- Vegetation: resilience, carbon sequestration.
- Climate change effects and impact.

- Ecosystems dynamics monitoring and assessment; also habitat fragmentation due to the impact of extractive industry.
- Rangeland management: wild life migration and population dynamics.
- NRNR: hydrocarbons and mineral reserves evaluation.

At **global scale**, the rationale includes a need for the assessment and forecasting of environmental phenomena and making contributions to global early warning systems, as well as monitoring of NRNR based influence on the global economy:

- Climate Change effects and impact;
- Global Changes intensity;
- Global trends in NRNR distribution.

It must be underlined that the land cover and land use dynamics have profound synergies in many other areas discussed in the GMES and 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. land deterioration, drought, sand dunes migration, erosion), Coastal Areas (e.g., coastal erosion, eutrophication).

5.3 IDENTIFICATION OF COMMUNITIES

The GMES and 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 and Africa should assist in strengthening the existing political and technical institutions, 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 stakeholders in Africa for monitoring products. Some examples are depicted in Table 2 below.

Table 2: Some examples for communities of producers and users of geospatial information related to natural resources in Africa.

Level	*Example Constituencies*	*Example Information needs*
Policy makers	– Head of State Conferences – African Ministerial Conferences : AMCEN, AMCOW, AMCOST, Conference of African Ministers responsible for Mineral resources development, Conf of African Ministers of Finance, Planning and Economic Development – National Development Plans – 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 NRNR reserves – Carbon Potential – National geo-spatial and geophysical parameters that will be coherently interoperable with the regional scale The information should be global through a Early Warning Systems
Technical / operational Decision-Makers	– Relevant National Ministries lForests, environment, land planning, agriculture, Livestock, energy, and mineral resources/mines – Regional and national development agencies (COMIFAC, RAPAC, NMAs, NEAPs…) – Managers of protected areas, Resources planners – Development banks (WB, AfDB) – Technical services of development Agencies: EC, Member States, etc.	– All aspects of environment, such as vegetation status, vegetation change, , fire, carbon stocks… – geographic extent of NRNR, mining cadastre, forest cadastre, conservation cadastre environmental impact of the extractive industry . The information should be in near real time (e.g. fire early warning or emergency response) 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, ARCSSTEE – Regional/International Research Institutions collaborating with African institutions (eg: CGIAR, JRC, ITC, WRI, IRD, USGS, etc.) – Space Agencies: NASRDA, ALSA, SANSA, NARSS – National Centres: SAC, CRTS, CSE, CSIR, NEOSS, 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 – Geological, soil data, climate prediction models – DEM and topographic information as baseline data sets – Exploration and active extraction areas for environmental impact monitoring (e.g. risk of soil and water

		contamination with heavy metals and other chemical substances)
Private Sector	– Producers of Goods: OIBT, OAB, National Forest Services, Private forest companies – Mineral exploration companies	– Forest logging – Deforestation – Geology, lithology, soil data – national inventory of exploitation data
Civil Society	– International and local NGOs: WWF, BirdLife Africa, IUCN, – ROPPA – Human Rights, UNICEF – NEAPs – International Council of Mining and Metals (ICMM)	– Topographical maps – Climate (drought/flood) prediction – Migration data – Wildlife monitoring – Mining cadastre – Mining sites location

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 stakeholders from the continent, including policy makers, scientists and engineers, 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 initiative are expected to constitute a technical network of regional and national organisations and institutions able to provide continuous monitoring and assessment of natural resources in Africa. Examples for existing capacities include:

- **Regional Centres** (e.g., RECTAS, RCMRD, AGRHYMET, OFAC, RSAU, ICPAC, CILSS) which act as clearing houses for base data sets. Many regional centres provide short-term training, diploma courses and workshops.
- **National Centres** (e.g. CRTS, CSE, CSIR, SPIAF, CENATEL, SP/CONEDD, national mining cadastre agencies, national space agencies, or remote sensing centres, national environment agencies, national mapping agencies, NSDI networks). These centres acquire EO data or aerial survey data, collect and provide field data and AMESD products. Access to the information is often through fees or subscription. Technical training is provided through short-term courses or workshops.
- **Research Institutes** (e.g. African botanical and wildlife research institutes and networks, universities, museums, many biodiversity conservation and management institutions) which generate field data and provide data analysis at various scales. They provide both technical as well as academic training and short courses.
- **Private Sector** uses EO data, for example to monitor forest or mining concessions, but often does not have the capacity to interpret data in its raw form. Capacity development is required.
- **Civil Society Organisations** (e.g. producer associations, local, regional or international NGOs such as UNICEF, national park authorities, museums) require EO information for monitoring purposes, for example of environmental indicators. They usually do not have the capacity to access or interpret base data sets.

A non-exhaustive list of existing projects, programmes and networks involved in the assessment of African natural resources, including several collaborative projects between European and African partners, is provided in Annex 1.

5.4.1.1 Existing 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., research institutes, 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 appropriate 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 is 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 strong 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 all, African capacities and facilities need to be improved; in particular, quality of and accessibility to internet connectivity, upgrade in the mobile phone technology (3G/4G), IT maintenance of systems within organisations, capacity development to use open standards and software instead of commercial software, wide-spread application of data sharing and collaborative work principles, are some of the most pressing needs and key issues facing the African expertise and EO-related organisations at national, regional and continental levels.

In general, there is a low level of organisational capacity in the African countries preventing the best use of EO data at national level and within efficient national EO networks where principles of collaborative work and shared resources are applied. In the area of extractive industry, very little human capacity is available on radar data processing and spectro-radiometry techniques necessary for national agencies to test methodologies and supervise contractors' performance.

5.4.1.2 Existing methods

Automated processing chains for extracting thematic information in forestry, biodiversity and mining exist for medium and coarse resolution data. In the area of standardisation of methods for processing high resolution data for land cover, land use, and change detection, Land Cover Classification System (LCCS) continues to be promoted as a common standard in Africa. However, African expertise in the use of this standard should be built and strengthened on the basis of extended land cover / land use / change detection projects in all regions.

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. Of particular importance in this regard are Spatial Data Infrastructures (SDI) which provide the enabling environment to support documentation, access and utilisation of geographical data and meta-information, including organisational agreements (UNECA, 2005).

Conflicts and disputes also arise in the area of mining due to poor capacity to manage the exploration permits and licences (physical limits of the concessions are often not managed in spatial data bases) and illegal mining activities. Hence, the need to improve the mining cadastre as a source of efficient management of extractive industry-oriented land, respecting other land use options and realities, such as forest concessions, protected areas, agricultural and pasture land, etc. At the AU level, coordination is required for the identification and implementation of capacity building programmes in areas identified as gaps, within the Pan-African University and with the support of capacities from Europe.

5.4.1.3 Emerging initiatives

Apart from the existing capacities and methods, new initiatives, such as the examples listed below, merit attention:

- The Global Geospatial Information Management (GGIM), initiated by the United Nations has an African component that deserves full attention, as a cross cutting initiative of interest to all the chapters of the GMES and Africa Action Plan.
- The Tenth EUMETSAT Users Forum for Africa adopted in 2012 a recommendation for the implementation of the Global Framework for Climate Services (GFCS) in Africa. This recommendation with a direct impact on natural resources management in Africa needs to be followed up by the GMES and Africa Coordination organ.
- Of similar interest is the MESA (Monitoring of Environment and Security in Africa) programme which builds on the AMESD programme, using EO data and information products for environment and sustainable development, specifically designed for African users at continental, regional and national levels. It thus directly contributes to GMES and Africa.
- The Support Action for GMES and Africa on Earth Observation (SAGA-EO) developed a horizontal model for the emergence of national EO user networks in African countries for sharing geospatial data and Added-Value Information Products and Services (AVIPS) useful for all the GMES and Africa thematic areas. This validated model awaits a widespread implementation initiative for the benefit of Africa's NRM, among others.
- The African Space Agency, for which a feasibility study is underway, will enable cooperation among African states in space research and technology and their space applications.
- The Global Earth Observation System of Systems (GEOSS), is an emerging comprehensive public infrastructure, globally coordinated sustained System of Observing Systems for monitoring and forecasting changes in the global environment, with an African component – AfriGEOSS – to

coordinate and bring together relevant stakeholders, institutions and agencies across Africa, identify challenges, gaps and opportunities; assist in knowledge sharing and global collaborations in line with Goals 7 & 8 of the MDGs; and serves as opportunities for African contributions to GEO and GEOSS.

5.4.2 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;
- Airborne survey data (aerial photos, geophysical survey, radar) over gas, oil, mineral exploration areas and shared for other applications;
- *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.
- Funding for capacity building (at continental scale) to strengthen and develop expertise where needed in Africa and build EO organisational capacities.

5.4.2.1 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 3: 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***
Coarse 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 IRS ASTER NigeriaSat-1 & X EgyptSat-1	Complete coverage yearly	Maspalomas (Canary) SANSA (South Africa) NARSS, Cairo & Aswan (Egypt) Abuja & Jos (Nigeria) Malindi (Kenya)	Lack of receiving stations in large key regions (Central Africa, West Africa…)
High resolution (2-5m)	SPOT Nigeriasat-2	Complete coverage 3-5 years Coverage on-going	Murzuq (Lybia) SANSA (South Africa) Maspalomas (Canary) Abuja (Nigeria) NARSS, Aswan (Egypt)	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		Systems are operated by commercial companies and need to be purchased
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 Low level of expertise in radar imagery processing
Geodetic Measurement	GNSS GPS CORS		SANSA (South Africa) EMA (Ethiopia) ECA-SROWA (Niger) CICOS (DRC) Kilimanjaro (Tanzania)	Africa Reference Framework (AFREF) not operational, particularly inactive in West Africa
Data Dissemination	EUMETCAST VGT4Africa ftp		53 African Countries RICs Programme / Project	ftp transfer rate is very low in many countries lack of data policies resistance to data sharing and re-use lack of high-speed ICT

5.4.2.2 *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 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 input in decision-support 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 4 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 4: 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…	Africa Soil Information Service (AfSIS) ESA TIGER - Soil moisture dynamics from SAR for hydrometeorological applications in SADC	Data ownership by Africa not guaranteed
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 Forest litter Moisture	Basic forest parameters are collected in timber concessions; a network of carbon flux towers is starting under the CarboAfrica programme	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 Soil moisture Evapotranspiration	SERVIR – East Africa & Water ESA TIGER - Soil moisture dynamics from SAR for hydrometeorological applications in SADC	No recent observation in many critical basins (Congo)
Land cover / land use	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	Union for African Population Studies (UAPS) Poverty-Environment Initiative (UNEP and UNDP)	Insufficiently reliable and dynamic population statistics and distribution data in Africa Absence of poverty and environment linkage in development policies
Land tenure	Ownership	Land Network, West Africa	Nearly inexistent
Development	Transport Energy Infrastructure ICT	Africa Transport Policy programme (SSATP) Africa Renewable Energy and Access (AFREA) Program Programme for Infrastructure	Lack of transport policies that also address economic sustainability, environmental protection, and social equity. No coordinated Energy policy for Africa

		Development in Africa (PIDA) with 51 projects in 3 sectors: Energy (15) Transport (24) Transboundary Waters (9) and ICT (3)	No coordination agenda for EO application for PIDA implementation
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	Development of a model for the emergence of National EO user networks for data and added value info products sharing in Africa	Lack of support to generalize the SAGA-EO results to all countries in Africa

5.4.2.3 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 (e.g., MERIS, MODIS), freely accessible by internet, are less accessible because of the low performance of internet in many African countries.

Regarding the infrastructure dedicated to the delivery of added-value products and services 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 buy-in is still to be achieved in many regions.

Consolidated spatial databases on NRNR of the continent have not been developed. Geophysical prospection facilities are usually provided by external companies and the data are not reused because mining data management capacity, although efficient for the private sector's extractive industry, is weak in the national institutions of the sector. There is need for the acquisition and processing infrastructure for hyperspectral imaging of biodiversity and mining.

The use of hand-held mobile devices for local data collection (e.g. cyber tracker, Mobile Apps, GPS collars) is still suboptimal in Africa.

5.5 BUILDING GMES AND AFRICA SERVICE

5.5.1 Service Definition and Provision

It is important to note that services provided by GMES and Africa should be available publically for wide dissemination. The data should be presented to the users in an informative way and in the precision required by various stakeholders. While current policies determine the generation of standard products, the political context and the requirements can change rapidly if external drivers change. GMES and Africa needs to be prepared and flexible to react appropriately. For example, the level of detail for monitoring requirements may change with the adoption of new legal frameworks or the further development of ongoing processes, such as REDD+ which requires increasingly sophisticated monitoring, reporting and verification tools including RS and ground-based data collection. It is important that data generated through *in situ* data collection, satellite imagery and modelling are compatible and comparable. In the following, three key generic services delivery mechanisms will be presented.

(i) Near-real time monitoring systems

The systematic wall-to-wall information on seasonal trends in vegetation conditions (e.g., phenology, productivity, surface water availability, fires) is essential for characterising land cover classes, detecting anomalies and drastic changes, and for evaluating ecosystem productivity. These components are necessary for biodiversity management and carbon estimates and the monitoring of climate change and the effects of NRM processes. The biophysical parameters can have huge impact on the livelihood of the local population and on incentives such as payments for 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 and change estimates

Two land cover maps are recommended **at continental scale** (and sub-regional) following the international standards in terms of legend (LCCS-compliant), validation, and metadata to allow for land cover characterisation:

- Regular land cover characterisation at coarse resolution (300m) updated every 3 years locating the main land cover types.
- 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, biomass, 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).

These products will also be suitable for the monitoring of ecosystem services and health, and for agricultural land use parameters, such as land and soil quality.

Land cover and forest cover change estimates **at national level** are required by international conventions. They are also essential in national State of the Environment (SoE) reporting, as a basis for analysing general trends and for managing the territorial units such as protected areas, oversight and control of sub-national development plans' implementation. Two different products are therefore necessary:

- National estimates based on wall-to-wall mapping or a sampling design, with an intensity depending on the country size (e.g., 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 and of reported afforestation and reforestation activities, for example in the context of CDM 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 mining and agriculture. They are also useful to monitor illegal logging or mining activities and poaching.

(iii) Consolidated spatial databases on non-renewable natural resources

From a strategic point of view, Africa as a continent cannot ignore the need to follow up on the evolution of its non-renewable natural resource reserves. Based on the African Convention on the Conservation of Nature and Natural Resources, the African Mining Vision (AU, 2009) and its Action Plan, the following are required:

- Systematic EO-based reconnaissance information for mineral exploration combining different data sets are necessary. To this end countries need to strengthen collaboration in the area of NRNR data collection. Collaboration in EO-based data acquisition, aerial surveys and *in situ* measurements, particularly in cross-country resources areas need to become a common practice, similarly to the cooperation in road infrastructure development across countries;
- Consolidated spatial databases on oil, gas, and mineral resources exploitation data at geological survey organisations / ministries of mines are required to monitor mining operations (and their impact on the environment) and to support and strengthen a wide application of the Extractive Industries Transparency Initiative (EITI), as only 13 African states are currently on the list of EITI compliant countries.
- Vertical cross-scale interoperability is required for the best contribution of spatial databases to efficient NRNR management over the continent. To this end, national consolidated spatial databases must be designed in such a way that they provide relevant information services and feed regional inventories in the five RECs and the latter allow access to their data to build and maintain a continental level spatial database on NRNR under the AU coordination.

5.5.2 Capacity-building

5.5.2.1 Necessary elements

As in other thematic areas, the issue of human capacity is critical in the area of long-term monitoring and assessment of natural resources 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 for problem solving and sustainable use of natural resources, including mineral resources.

Capacity development should be seen under two complementary angles: training and infrastructure development.

- **Training**: Programmes taking into account the need to fill the gaps identified above are necessary. Fundamental research and Research and Development programmes need to be developed, and carried out by existing regional and national institutions. Respective curricula need to be developed for the planned Pan-African University. The Training of Trainers principle is required for the operational aspects of EO application capacity.
- **Infrastructure**: The requirements of the needed infrastructure for receiving, pre-processing and disseminating EO data should be carefully developed, taking into account the present configuration of Africa's own space programme capacity, (including the objectives of the AfriGEOSS initiative) and the plans for the future in European and international orientation of EO industry and the on-going Global Earth Observation System of Systems (GEOSS) infrastructure under development.

5.5.2.2 Strategy of implementation

Capacity strengthening should take place in existing schools (forestry, wildlife management, rural development, land management, 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 collaborative research in these specific issues, in the frame of the Pan-African Universities.

Funding should be structured around the following ideas:

Training: NRM-oriented R/D and high level training in EO applications for long-term monitoring and assessment of NR in Africa should be funded by a sustainable mechanism. An option could be to leverage funds, both internally in Africa and outside the continent, to finance these programmes in a form similar to elements of the EU FP7 Programme (e.g. collaborative research projects, Marie Curie programme) and the African Union Research Grant Programme. Such a programme should be broadened in scope to encompass the other thematic areas of the GMES and Africa initiative, and provide grants to existing centres on the basis of competitive R/D proposals in line with the gaps filling objective of the GMES and Africa Action Plan.

Operational training programmes for trainers should be decentralized to the national level, allowing local institutions with training capacities in EO applications to contribute to the gap filling programme. In this regard, bilateral and multilateral funding mechanisms could support such training programmes.

The private sector, such as the extractive industry, should be requested to invest in the GMES and Africa gap filling programme, both at regional level, but also internally in every country in Africa. Finally, existing training programmes in EO applications and national networks development should continue, with a close link to the GMES and Africa gap filling orientation.

Infrastructure: Developing the infrastructure to support the human capacity building in EO applications requires regional, national and international funding mechanisms. With a cross-cutting vision over the spectrum of GMES and Africa thematic areas, cooperation between countries engaged in space operations should support the emergence of a pan-African space programme. This would contribute to cost-effective use of the full potential of the resources individual countries can mobilise for their respective space programmes. An effort should be put in ensuring that a sustainable funding is made available for filling the gap in EO-related infrastructure.

5.5.3 Prioritisation of Requirements and Actions

Recognizing that not all urgent requirements can be addressed at once, it is suggested that the **first priority** for deriving reliable added-value products for the long-term management of natural resources be the **installation of infrastructure for the acquisition and processing of EO data** in Africa. It should be based on the existing facilities where 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 and 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 culture of shared information through national organisations in order to build a common knowledge of the changes occurring in the status of this resource base, which is 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). It is recognized that strong regional centres require strong national bodies to build upon. Capacity strengthening should therefore start at national level, and include organisational capacity, with the application of the Horizontal Model developed, tested and validated by the Support Action to GMES and Africa on Earth Observation (SAGA-EO) project. In the meantime, awareness should be raised amongst policymakers across Africa to appreciate the value of geo-spatial information in their decision making processes.

5.5.3.1 Organisational scheme

For the management of GMES and Africa, a clear political vision is a pre-requisite. Whilst this is partly being taken up by AfriGEOSS and the Pan-African working group on Space, important driving forces are the African Union Commission and the African Regional Economic Communities. A participative approach for designing the initiative is needed to ensure that stakeholders at all levels can express their views and concerns in the project. It is also required to ensure that synergies are identified and used. Establishing synergies and avoiding fragmentation of data will be one of the key benefits of GMES and Africa.

The approach to be adopted is that of continental/regional coordination and national implementation. For practical effectiveness, an intermediate coordinating structure should be set up in a form of a joint expert group EU-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 initiative'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, NEOSS, 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, JRC, etc.): 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 organisations.

5.6 RECOMMENDATIONS

A sound management of Africa's natural resources, including the non-renewable ones, is necessary for safeguarding the livelihood of huge parts of the population in Africa and beyond. The recommendations to **African policy makers and decision takers** for strengthening the long-term management of natural resources component of the GMES and Africa programme, are the following:

1. Support the availability of more compatible, accessible and interoperational information and data sets.

- An effort must be put in place for acquiring yearly cloud-free medium resolution images over the entire continent.
- 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, making use of existing and new initiatives.
- Inventories for natural resources – in particular non-renewable natural resources and forest resources – should be reinforced.
- The integration of different datasets needs to be improved to facilitate the use and exploration of different types of natural resources.

- The use of international standards should be promoted to facilitate national and regional data integration. A special effort should be dedicated to standardisation of EO and *in situ* data, processes, added-value information products and services and their dissemination and delivery online, over the entire NRM chain for Africa. The ongoing efforts by AMESD are a good starting point.

2. Facilitate the development of information services for natural resources inventories and the reinforcement of existing institutions at national and regional levels.

- Receiving stations must be installed in critical regions. Radar data acquisition, improvement of geodetic networks (both at the continental and regional scales), strengthening of national geological survey institutions with airborne survey analysis facilities, are all part of an essential requirement for Africa: to strengthen the infrastructure supporting a strategically efficient management of her natural resources.
- Two scales should be targeted; (1) the regional and national scales for which coarse resolution maps and statistical estimates, based on sampling of medium resolution images should be produced; (2) the local scale where information should be produced at medium and high resolution on selected areas.
- Information produced should combine near-real time monitoring systems, land cover characterisation and land cover change estimates.
- Methodologies need to be developed to improve the exploration specifically of NRNR, including the development and updating of mining and forestry cadastres.

3. Foster the development of a pool of experts to support natural resources management at a pan-African level.

- African capacity must be reinforced at all steps of the decision chain, from the production of information, the organisational capacity, to the integration of the information in the decision process. The different levels should be targeted: technical, managerial, scientific and policy.
- All NRM-related projects should place a strong emphasis on training and local skills capacity building. AMESD/MESA is providing a useful starting point.
- Particular emphasis is needed to establish/support thematic research networks between African universities and European research centres, including opportunities provided by the new EC Research Framework Programme "Horizon 2020" and the African Union Research Grant Programme.

4. Encourage institutional dialogue and the development of operational services for improving the decision making processes in the long-term management of natural resources in Africa.

- Regional information centres should be strengthened as they provide the optimal platforms for data dissemination, developing the appropriate information products and for influencing its use in the decision-making processes.
- African policy makers (various ministerial conferences and summits of Heads of State and Government) should instruct countries to build and strengthen synergies of action, with a view to developing a coordinated pan-African space programme with a high potential for NRM on the continent, in line with the plan to create an African Space Agency.

To reach these different objectives, African policy makers and decision takers are requested to ensure that the necessary funding and infrastructure is provided and that a conducive environment for collaboration and data exchange is fostered. African partners should also be ready to provide counterpart funding where necessary to make a success of the whole initiative. In addition, the following should be envisaged to encourage support by the donor community:

1. Support Africa's effort to consolidate existing regional and national institutions' capacity through collaborative projects and programmes on acquisition and processing of EO data. Besides existing institutions, the development of strong regional processing centres, with a strong link to national services should be a strategic target. EU and AfDB are amongst the most appropriate donors which could help to achieve this goal. Examples like AMESD or OFAC (Observatoire des Forêts d'Afrique Centrale) can provide first models to consider and learn from. In all cases, a solid link between technical implementation centres and the political institutions in charge of NRM policies is a key success factor.

2. In parallel with the above, areas identified as gaps should be covered by an inclusive capacity building effort. Among the crucial needs, the following have been highlighted: application of radar techniques for e.g. the extractive activities, organisational capacity to make the best use of EO data, calling for an extensive application of the GMES-and-Africa-oriented Horizontal Model, use of open standards and software as opposed to commercial products, training of a critical mass of

graduates (forest engineers, conservationists, rural developers, mining experts, planners, etc.) in the optimal use of geospatial information. Financial offers from donor agencies should be sensitive to these topics as real user needs;

3. A strong and permanent dialogue is critical between the programmes involved in the long-term management of natural resources on one hand (e.g., SERVIR-Africa, CARPE), and between the NRM component itself and the other chapters of the GAAP on the other hand. Therefore, funders of projects and programmes should encourage the reuse of past (EU-funded and other donor-funded) projects' results as building blocks for the NRM edifice.
4. EO-based NRM initiatives must target the strengthening of co-operation between European and African projects and programmes, and between information producers (scientific community, universities, implementation centres and companies) and users (political institutions) on both sides. The European GMES Copernicus programme can provide some lessons in that respect for the system architecture and the implementation mechanisms.

5.7 LIST OF ACRONYMS

AARSE	African Association of Remote Sensing for the Environment
ACP	Africa, the Caribbean and the Pacific
AfDB	African Development Bank
AFREA	Africa Renewable Energy and Access programme
AfSIS	Africa Soil Information Service
AGRHYMET	Centre Régional de Formation et d'Application en Agrométéorologie et en Hydrologie Opérationnelle
ALSA	Algerian Space Agency
AMCEN	African Ministerial Council Conference on Environment
AMCOST	African Ministers' Council on Science and Technology
AMCOW	African Ministers' Council on Water
AMESD	African Monitoring of the Environment for Sustainable Development
AMMP	African Magnetic Mapping Project
AMU	Arab Maghreb Union
AMV	Africa Mining Vision
AOCRS	African Organization of Cartography and Remote Sensing
ARCSSTEE	Africa Regional Centre for Space Science and Technology Education-English, Nigeria
ARMC	African resource management constellation
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
AVIPS	Added-Value Information Products and Services
BIOPAMA	Biodiversity and Protected Areas Management
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
CEMAC	Economic and Monetary Community of Central Africa
CENATEL	Centre National de Télédetection (Benin)
CERSGIS	Centre for Remote Sensing and Geographical Information Systems (Ghana)
CGIAR	Consultative Group on International Agricultural Research
CICOS	Commission Internationale du Bassin Congo-Oubangui-Sanga
CILSS	Comité permanent inter-État de lutte contre la sécheresse au Sahel (Permanent Interstate Committee for Drought Control in the Sahel)
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
COMIFAC	Commission Ministérielle des Forêts d'Afrique Centrale
CORAF	Conseil Ouest et Centre africain pour la recherche et le développement agricoles
CPA	Consolidated Plan of Action
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
DEM	Digital Elevation Model
DG	Directorate General
DOPA	Digital Observatory for Protected Areas
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
ECOFAC	Programme de Conservation et Utilisation Rationelle des Ecosystèmes Forestiers en Afrique Centrale
ECOWAS	Economic Community of West African States
EDF	European development Fund
EEA	European Environmental Agency

EIA	Environmental Impact Analysis
EIS-AFRICA	Environmental Information Systems in Africa
EITI	Extractive Industry Transparency Initiative
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	UN Food and Agriculture Organisation
FARA	Forum for Agricultural Research in Africa
FP7	Seventh EU Framework Programme
FTP	File Transfer Protocol
GAAP	GMES and Africa Action Plan
GBIF	Global Biodiversity Information Facility
GEO	Global Earth Observation
GEOBON	GEO-Biodiversity Observation Network
GFCS	Global Framework for Climate Services
GLC2000	Global Land Cover 2000
GLCN	Global Land Cover Network
GM	Genetically modified
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
GTOS	Global Terrestrial Observing System
ICMM	International Council of Mining and Metals
ICPAC	IGAD Climate Prediction and Applications Centre
IGAD	Intergovernmental Authority on Development
IOC	Indian Ocean Commission
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
IUCN	The World Conservation Union
JRC	EU-Joint Research Centre
LANDSAT	Land Satellite
MDG	Millennium Development Goal
MERIS	Medium Resolution Imaging Spectrometer
MESA	Monitoring for Environment and Security in Africa
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
NEOSS	National Earth Observation and Space Secretariat (South Africa)
NESDA	Network for Environment and Sustainable Development in Africa
NGOs	Non-governmental Organisations
NMA	National Mapping Agency
NMHS	National Meteorological and Hydrological Service
NOAA	National Oceanic and Atmospheric Administration
NRM	Natural Resource Management
NRNR	Non-Renewable Natural Resources
NTFP	Non-Timber Forest Product
OAB	Organisation Africaine du Bois
OAU	Organisation of African Unity
OFAC	Observatoire des Forêts d'Afrique Centrale
OIBT	Organisation Internationale des Bois Tropicaux
OSS	Observatoire du Sahara et du Sahel
PES	Payment for Environmental Services
PIDA	Programme for Infrastructure Development in Africa

PUMA	Préparation à l'Utilisation de Metoesat en Afrique
R/D	Research and Development
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 from 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
SAGA-EO	Support Action for GMES and Africa on Earth Observation
SANSA	South African National Space Agency
SDI	Spatial Data Infrastructure
SERVIR	Regional Visualisation and Monitoring System
SP/CONEDD	Secretariat Permanent du Conseil National pour l'Environnement et le Développement Durable (Burkina Faso)
SPIAF	Service Permanent d'Inventaire et d'Aménagement Forestier (Dem. Rep. Congo)
SPOT	Satellite pour l'Observation de la Terre
SSATP	Africa Transport Policy program
TIGER	ESA initiative for Water in Africa
UAPS	Union for African Population Studies
UICN	Union Internationale pour la Conservation de la Nature
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNECA	United Nations Economic Commission for Africa
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
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
VGT4Africa	Distribution of VEGETATION data in Africa through EUMETCast
WAEMU	West African Economic and Monetary Union
WB	World Bank
WRI	World Resources Institute
WWF	World Wildlife Fund

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ANNEX 1: NON-EXHAUSTIVE LIST OF EXISTING PROJECTS, PROGRAMMES AND NETWORKS INVOLVED IN THE ASSESSMENT OF AFRICAN NATURAL RESOURCES

- **AEGOS African-European Georesources Observation Network** (www.aegos-project.org) The AEGOS project aims at setting-up the preparatory phase for the building of an information system containing and making accessible data and knowledge on African geological resources including mineral resources, raw material, groundwater and energy (georesources). This information is/has been collected through numerous initiatives by both African countries, regional, international and European organisations collectively, and is a unique archive of Africa related geoscientific observation data which primarily need to be shared with African partners. Developing capacity building activities in the domain of Earth observation in developing countries is a priority. AEGOS is a Support Action of the European Union 7th Framework Programme (2008-2011)
- **African Magnetic Mapping Project AMMP** (www.pgw.on.ca/data_ammp.html) A project by Paterson, Grant & Watson Limited (PGW), a Canada-based consulting company, in collaboration with GETECH and ITC. It compiled all the available airborne and marine magnetic surveys for the continent of Africa and produced a set of maps and a data base covering about 80% of the land.
- **Africover** (www.africover.org) FAO project dealing with land cover assessment for the African continent, based on remote sensing and GIS techniques. The project gathers data on land use, climate conditions and natural resources. A major usage has been to provide flood warnings to governments and NGOs, who then pass the information onto farmers.
- **AfroMaison** (http:/www.afromaison.net) An EC FP7 project that aims to provide a holistic toolbox and operational framework for INRM. One set of tools that has a clear link with GMES are tools for spatial planning. Examples of tools are the AfroMaison Broker that allows users to search across various resources and lets them easily discover data that can fulfil their requirements, and the AfroMaison Spatial Data Infrastructure. Five case study sites, covering desserts, highlands, wetlands, grasslands, tropical humid forest and mountain forest, have thus been selected. Each case study has a specific focus as a response to specific pressures, policies and other local conditions.
- **Agricab** (http://www.agricab.info) An EC FP7 project that develops a framework for enhancing earth observation capacity to support agriculture and forestry management in Africa. The project aims at improving and sustaining capacity for data access, agrometeorological modeling, early warning, agricultural statistics, livestock monitoring and forest mapping. These components are developed through specific case studies in Senegal, Kenya, Tunisia, Mozambique, South Africa and Niger, leading to dedicated training actions capitalizing on the findings.
- **AMESD** (http://www.eumetsat.int/website/home/AboutUs/InternationalCooperation/Africa/AfricanMonitoringoftheEnvironmentforSustainableDevelopmentAMESD/index.html) Launched in 2007, AMESD is scheduled to run to mid-2013 and receive funding of 21 million Euro from the European Commission through the European Development Fund. The programme is managed by the African Union Commission in Addis Ababa, Ethiopia. A steering committee provides guidance to the programme, this is composed of the main AMESD stakeholders: the five Regional Economic Communities (RECs) (ECOWAS, SADC, CEMAC, IGAD, IOC) and the ACP secretariat. The AMESD initiative's objective is to provide all African nations with the resources they need to manage their environment more effectively and ensure long-term sustainable development in the region. Most importantly, AMESD aims to improve the lives and prospects of the 350 million disadvantaged people in Africa currently enduring poverty and hardship, whose livelihoods depend heavily on their environment. AMESD aims to provide decision-makers in the RECs, the African Union Commission and at national level with full access to the environmental data and products they need to improve national and regional policy and decision-making processes. AMESD is also paving the way for the GMES and Africa initiative.
- **BIOPAMA** (Biodiversity and Protected Areas Management) (http://www.iucn.org/about/work/programmes/gpap_home/gpap_capacity2/gpap_biopama) A programme of IUCN and JRC that aims to build capacity in ACP countries on how to protect and sustainably use local biodiversity resources.
- **BIOTA-Africa** (http://www.biota-africa.org) A project of African and German researchers studying sustainable use and conservation of biodiversity in Africa.

- **CarboAfrica** (http://www.carboafrica.net) An EC-FP6 funded network project of European and African partners that monitors GHG fluxes in order to quantify, understand and predict greenhouse gas emissions in Sub-Saharan Africa and its associated spatial and temporal variability.
- **DOPA** (http://dopa.jrc.ec.europa.eu/category/tags/biopama) The Digital Observatory for Protected Areas (DOPA) project is part of GEO's Biodiversity Observation Network (GEO-BON). It is composed of a set of distributed Critical Biodiversity Informatics Infrastructures (databases, web modelling services, broadcasting services, ...) combined with interoperable web services to provide a large variety of end users, including park managers, decision-makers and researchers with means to assess, monitor and possibly forecast the state and pressure of protected areas at the global scale.
- **ECOFAC** The Programme de Conservation et Utilisation Rationelle des Ecosystèmes Forestiers en Afrique Centrale (ECOFAC) operates in Congo (Brazzaville), Gabon, Equatorial Guinea, Cameroon, Sao Tome and Central African Republic. It aims to support the protection and rational utilisation of Central Africa's forest ecosystems. The EC programme started in 1992 and runs currently in its fifth phase (ECOFAC V 2011-2016)
- **GEO BON** (http://www.earthobservations.org/geobon.shtml) Group on Earth Observation Biodiversity Observation Network is a community of practice that coordinates activities relating to the Societal Benefit Area (SBA) on Biodiversity of the Global Earth Observation System of Systems (GEOSS). Some 100 governmental, inter-governmental and non-governmental organisations are collaborating through GEO BON to organize and improve terrestrial, freshwater and marine biodiversity observations globally and make their biodiversity data, information and forecasts more readily accessible to policymakers, managers, experts and other users. GEO BON has been recognized by the Parties to the Convention on Biological Diversity.
- The **Geoscience Information in Africa Network** (GIRAF, www.giraf-network.org) is a network gathering African Geological Surveys, universities and companies in order to support knowledge-based geoscience information and to contributes to improve the environmental and economic prosperity of the people in Africa.
- **GLC2000** (http://bioval.jrc.ec.europa.eu/products/glc2000/glc2000.php) A project by the European Union that developed a harmonized land cover database over the whole globe. GLC2000 used a dataset of 14 months of pre-processed daily global data acquired by the VEGETATION instrument on board the SPOT 4 satellite.
- **Global Biodiversity Information Facility** (http://www.gbif.org) GBIF was established by governments in 2001 to encourage free and open access to biodiversity data, via the Internet. Through a global network of countries and organisations, GBIF promotes and facilitates the mobilisation, access, discovery and use of information about the occurrence of organisms over time and across the planet. It currently (14 July 2013) contains 405,720,566 indexed records in 10,139 datasets by 493 publishers.
- **Global Forest Resources Assessment** (http://www.fao.org/forestry/fra) An assessment carried out by FAO every 5-10 years since 1946 in an attempt to provide a consistent approach to describing the world's forests and how they are changing. The Assessment is based on two primary sources of data: Country Reports prepared by National Correspondents and remote sensing that is conducted by FAO together with national focal points and regional partners.
- **Global Land Cover Network** (www.glcn.org) A multi-partner initiative under the auspices of FAO and UNEP to answer the need for a standardized global land cover database.
- **Globcover** (http://due.esrin.esa.int/globcover/) An ESA initiative in partnership with JRC, EEA, FAO, UNEP, GOFC-GOLD and IGBP aimed to develop a service capable of delivering global composites and land cover maps using as input observations from the 300m MERIS sensor on board the ENVISAT satellite mission. The land cover maps cover 2 periods: December 2004 - June 2006 and January - December 2009.
- **GOFC-GOLD** (www.gofcgold.wur.nl) This is a panel of GTOS with the overall objective to improve the quality and availability of observations of forests and land cover at regional and global scales and to produce useful, timely and validated information products from these data for a wide variety of users.
- **GTOS** (www.fao.org/gtos/index.html) A programme for observations, modelling, and analysis of terrestrial ecosystems to support sustainable development. GTOS facilitates access to information on terrestrial ecosystems so that researchers and policy makers can detect and manage global and regional environmental change.

- **ImpactMin** Impact Monitoring of Mineral Resources Exploitation (www.impactmin.eu) Since the overall objective of ImpactMin is to develop new methods and a toolset for impact monitoring of mining operations using Earth Observations and in-situ data, it points towards a future wherein decision making is based on coordinated, comprehensive and sustained Earth Observation and information, which is the main objective of the Global Earth Observation System of Systems (GEOSS). Moreover, in the implementation of GEOSS, increased sharing of methods for modeling and analysis is essential to transform data into useful products will be advocated. ImpactMin will address the need of the provision of timely data and products for policy makers, thereby harmonising observations, real- or near real-time monitoring, integration of information from in situ and airborne and satellite observation through data assimilation and models.
- **Maloti-Drakensberg Transfontier Conservation and Development** Project (MDTP) (http://www.maloti.org.ls) It is a collaborative initiative between South Africa and the Kingdom of Lesotho to protect the exceptional biodiversity of the Drakensberg and Maloti mountains through conservation. The World Bank-funded programme aims to put a management strategy in place for the whole region, as well as create sustainable economic activity for the people who live there, enhancing current land use in a way that addresses both biodiversity threats and socio-economic growth requirements.
- **OFAC** (www.observatoire-comifac.net) The Observatoire de Forêts d'Afrique Centrale is a regional platform facilitated by the European FORAF project. It provides COMIFAC and other CBFP members a powerful steering and data sharing tool to promote better governance and the sustainable management of forest ecosystems.
- **Parcs de l'Entente** (http://www.parc-w.net/en/html/savoir-plus.html) Also known as the "Parc W" this biodiversity conservation ecosystem is one of the widest savannah protected areas of Africa (10 302 sq km) shared by Benin, Burkina Faso and Niger. It is the first transboundary biodiversity conservation site of West Africa and the largest internationally-shared protected biosphere in the world. Four of the Big Five mammals roam the Park: the elephant, buffalo, lion and leopard. Some of the great mammals that have vanished elsewhere, including the wild dog, the cheetah and topi still thrive in Park W. Roan antelope, various species of kob, hartebeest, bush buck, oribi and gazelles are also common. The W Park is home to over 450 species of birds, one of the largest varieties anywhere on earth.
- **REDD pilots**. The Bali Action Plan of 2007 encouraged Parties to develop pilot projects to assess the feasibility of a potential REDD mechanism. It is based on this that under the auspices of the European Space Agency (ESA) and in the framework of GMES Service Element on Forest Monitoring a pilot project was developed for REDD implementation and testing in Cameroon with user consultation and endorsement in 2007. REDD projects are also run in Tanzania and other East African countries. Some primarily focus on REDD readiness activities, such as establishing permanent monitoring plots and carbon baselines, and training government staff and community members in carbon monitoring, reporting, assessment, and verification (MARV). Others are facilitating performance-based payments to forest community members. Within these diverse contexts, some common lessons are emerging.
- **REDDAF** (www.reddaf.info) The REDDAF Project which is being implemented from 2011 – 2013 tests and provides improved methodologies using both optical and radar Earth Observation (EO) data for deforestation/degradation assessment within REDD (Reducing Emissions from Deforestation and Degradation) in Cameroon and the Central African Republic (CAR).
- **TIGER** (http://www.tiger.esa.int) An ESA initiative is to assist African countries to overcome problems faced in the collection, analysis and use of water related geo-information by exploiting the advantages of EO technology. The aim is to fill existing information gaps relevant for effective and sustainable water resources management at the national to regional scale in thus helping to mitigate the wide spread water scarcity in Africa.
- **TIGER-NET** (www.tiger-net.org) A major component of the TIGER initiative. TIGER NET develops a user-driven, open-source Water Observation and Information System (WOIS), which enables the production and application of a range of satellite earth observation based information products needed for Integrated Water Resource Management (IWRM) in Africa. The project is built upon on a close collaboration with the host institutions for the specification, testing and demonstration of the WOIS. The first key host institutions already actively involved in TIGER NET are the Nile Basin Initiative, Lake Chad Basin Commission, Volta Basin Authority, Department of Water Affairs South Africa and the Hydrologic Division of the Namibian Ministry of Agriculture, Water and Forestry.

- **Working for Water project** (http://www.dwaf.gov.za/wfw/default.aspx) WfW is a South African initiative run by the Department of Water Affairs and Forestry. It currently runs over 300 projects aiming to control invasive alien plants (IAPs). IAPs pose a direct threat not only to South Africa's biological diversity, but also to water security, the ecological functioning of natural systems and the productive use of land. They intensify the impact of fires and floods and increase soil erosion. IAPs can divert enormous amounts of water from more productive uses and invasive aquatic plants, such as the water hyacinth, effect agriculture, fisheries, transport, recreation and water supply.
- **GMES4Mining** GMES-based Geoservices for Mining Areas in Support of Processes in Prospection, Exploration and Monitoring for Environmental Protection and Operational Safety, (www.gmes4mining.de) The R&D project is funded by German Federal State of North Rhine-Westphalia and develops innovative and geographic information technologies. In particular high resolution hyperspectral and multispectral data as well as radar data will be tested in combination with innovative in-situ measures, e.g. latest geophysical exploration methods, ground-based radar and geo information technologies. All used methods will be bundled as cross-technology geo services and will be optimized towards the real requirements from industry within pilot studies in selected mining areas in Germany and abroad. Final target is the strengthening the support to all processes in prospection, exploration and monitoring for environmental protection and operational safety in mining.
- **MS.MONINA** Multi-scale Service for Monitoring Natura2000 Habitats of European Community Interest (www.ms-monina.eu) In the spirit of the International Year of Biodiversity 2010, the Copernicus project MS.MONINA is exploring biodiversity as a 'new emerging area' of global attention. The project offers remote sensing based monitoring services for observing and managing the state of Natura2000 sites and other precious habitats to reduce the loss of biodiversity. New concepts and methods combining Earth observation (EO) data and in-situ data are defined and implemented with the aim to support public authorities in implementing policies and measures. Pilot applications in a range of study areas all over Europe demonstrate the value and importance of monitoring for the conservation of biodiversity. While European nature conservation will substantially benefit from this initiative, the tools and services developed also have a global impact. The project supports the GEO (Group on Earth Observations) societal benefit area of biodiversity and demonstrates the power of EO-based methods for monitoring sensitive ecological sites in general.