GMES and Africa Service: Long-term management of natural resources

Implementation plan[1]

The African continent boasts of a rich resource of natural products and ecosystems on which over 90% if its population depends, either for subsistence or income generation. Yet, many of the African ecosystems are very fragile and prone to irreparable damage by fire, overgrazing, resource mining, unsustainable management practices or other human influence. If addressed at an early stage, regeneration or change to other productive systems is possible. There is therefore an urgent need for continuous environmental monitoring at national, regional and continental levels. An important precondition for broad cooperation at all levels and across boundaries is the generation, organisation and sharing of data in a transparent and comparable manner. Mechanisms are required for diagnosing, continuously monitoring and managing the African environment on a global to local scale, particularly the long-term trends and effects.

Expert opinion concluded that amongst the major drawbacks for earth-observation (EO)-based long-term management of natural resources in Africa is lack of appropriate and functioning EO acquisition and processing **infrastructure** and local **capacity**, for which adequate action is required. As there are many on-going individual initiatives, projects and programmes related to natural resource management (NRM) in Africa (for some examples, see Annex 1 of the Chapter), **networking** and the **consolidation of information** into a comparative and flexible format are also of high priority.

1. Needs

Technical experts, regional planning commissions, commercial enterprises and policy makers in Africa require reliable information to satisfy their different needs to assess for example, land cover change, ecosystem health, land and soil quality, or to monitor illegal logging or mining activities, etc. Beyond these needs, information is also required as a contribution to various important international agreements to which many African countries are signatories.

Given the large diversity of users and possible NRM applications, there are various EO and monitoring needs at different scales:

A) At **local/national scale**, long-term monitoring and assessment of natural resources is needed to set up **multi-scale information systems** that enable users or decision makers to identify pressures on local NR and design appropriate management responses through a knowledge of what natural resource is available locally, how it is used and/or how uses change. Examples include:
- Seasonal trends and variability in vegetation conditions (e.g., phenology, productivity, surface water availability, fires) which is essential to characterise land cover classes, detecting anomalies and drastic changes, and to evaluate ecosystem productivity, including for Payment for Environmental Services (PES) purposes.
- Trends and pressures on land and forest cover.
- Quantification of available resources: water, soil, vegetation, forested lands, pasture lands, hydrocarbons and minerals.
- Vulnerability assessment and identification of risk areas, including overgrazing and areas prone to wild fires that endanger ecosystem potential or can contribute to land cover change.
- Exploration, monitoring of the impact of the extractive industry on local/national environment and enforcement of environmental impact assessment measures.

B) At **regional scale** there is a need for **regional reference systems** for assessing and characterizing the state of natural resources and the environment (baseline mapping, monitoring changes, disturbances, hotspot / hope spot analysis), including:

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- Vegetation cover and/or fragmentation, biomass assessments, deforestation rate, invasive species management, biodiversity management.
- Land degradation rate, alteration of natural processes, available arable lands, etc.
- Related information to support climate change adaptation, including biodiversity assessments.

C) 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.
- Fire occurrence and fire regimes (trends and anomalies).
- Vegetation resilience, carbon sequestration potential.
- Climate change effects and impact.

2. Existing initiatives

Several fragmented projects are ongoing or planned that relate to these needs. While some projects operate at continental scale others operate at local or regional scales (e.g. FAO Forest Resource Assessment, Globcover, Agricab, BIOPAMA – more examples in Annex 1 of the Chapter). Space Agencies in several countries are providing data and products relevant for NRM. Several projects aim at improving and sustaining capacity for data access, agrometeorological modelling, early warning, agricultural statistics, biodiversity monitoring and forest mapping and have developed components of these services through specific case studies in various African countries. Others, such as OFAC, provide regional platforms for data sharing. The planned African Space Agency and the European Copernicus Sentinel satellite missions are also noteworthy initiatives in this respect.

Of particular relevance to GMES & Africa is the AMESD/MESA project which has been working on land-cover maps with a focus on five African regions: CEMAC, ECOWAS, IGAD, IOC and SADC. Efforts are ongoing to standardize and provide data across regions. Specific focus for IGAD is on Land Degradation assessment, Natural Habitat Conservation, Forest management and climate change monitoring and for SADC, on Agricultural and Environmental Resources Management.

3. Gaps

However, the current efforts are fragmented and do not provide user-friendly decision-support capacity. Because existing data is not harmonized, analysis and application across national or other borders is often not possible. Current land cover maps are incomplete, do not cover the entire African continent, are of insufficient accuracy or resolution for solid background information from which to draw reliable land-cover change assessments. Land cover and forest cover classes are not harmonized at continental level. A systematic land-cover assessment for African countries at national level would be very helpful.

Also, consolidated spatial data for non-renewable NR, required for better prospection as well as for the monitoring of ongoing exploitation, abandonment and post-mine closure management, would be helpful but so far does not exist, although magnetic maps exist for most countries (covering 80% of the African land area) through the African Magnetic Mapping project (AMMP). Specifically, there is a gap on acquisition and processing infrastructure for hyperspectral imaging. Consolidation at a central point at least at regional, if not continental level is required.

4. Suggested priority products and services

Based on the above analysis, two key priority products and services are suggested for GMES & Africa long-term natural resource management services:
1. Land cover and land cover change maps at different scales and standardised format to ensure coverage of the entire African continent.
2. Building on EO products and on *in situ* validations, a land-use monitoring tool and decision support mechanism to support land management policy processes.

4.1. Land-cover maps for Africa

At **continental (and sub-regional) scale**, two land cover maps are recommended following harmonized international standards in terms of legend, validation, and metadata to allow for land cover and land cover change characterisation. It will be important that the metadata are accessible to cater for different users/requirements.

1. Regular land cover characterisation at coarse resolution (300m) updated every 3 years locating the main land cover types.
2. Baseline map at medium resolution (20-30m) updated every 5-10 years, providing the baseline for land cover change assessment.

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.

In order to complement existing and ongoing activities within Africa (e.g. by MESA), a specific focus on **North Africa** is recommended as a priority.

As an important support function, both products should adopt a compatible legend (LCCS-compliant), with a focus on essential classes (e.g., forest resources, soils, agricultural domain) that can be related to specific ecosystem services (e.g., carbon content, biodiversity, biomass, water balance).

At **national scale**, land cover and forest cover change estimates 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 the implementation of sub-national development plans. The following types of products will be provided, following an assessment of the gaps at country level:

• National estimates which are 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 required accuracy) analysing extracts of medium resolution images every 5-10 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). 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.
• Improved models for automatic land cover change assessments.
• EO products supporting ecosystem services assessment, as well as their quantification in view of supporting their maintenance (for instance, replenishment dynamics of water bodies in vulnerable dry regions such as the Sahelian and Sub-Sahelian strings).

4.2. Decision Support Services for Early Warning Systems and Assessment of Long Term NRM Strategies in Africa.

Integrated land planning and land management is a complex task that requires dynamic responses depending on different situations. A useful EO-based support service for GMES & Africa will be a Decision Support System for African natural resource managers, land-use planners and national and regional decision takers based on a geographic information system (GIS), remotely sensed data (e.g. Sentinel, Landsat, airborne) and auxiliary data (geology, land use, land cover, topography, lineaments etc.). This will integrate an approach that uses satellite images and traditional information as an analysis tool for better management of the natural resources and mapping of their potential and evolution. DSS will be a generic decision support model for Africa with clearing-house functions which consolidates data from various projects, screening them for coherence and uniform format. This will be built using innovative methods, such as crowd sourcing, which will allow the number of data points to be increased without adding costs. It will be offered at three different scales (national,

regional and continental) and should be developed in a modular way to allow for integration at all levels. Specific elements include:

- A tool for the surveillance of changes affecting vegetation cover especially in protected areas, as well as for the reporting practices of public organizations responsible for environmental resources (complementing for example the efforts by BIOPAMA or OFAC). Compatible inventories and assessments are required at national/local level to provide and validate relevant information in a systematic way.
- An operational GIS-based system for biodiversity monitoring and habitat management. This would include: habitat maps derived from radar and optical EO data; land-cover and land-cover change maps, environmental gradients derived from elevation data; biodiversity assessment products; disturbance assessment (ex. landscape fragmentation due to clearance, fire); assessment of the fire role in the ecosystems (e.g. defining the fire regimes and their alteration); and zonation of resources.

5. Action Plan and timeframe

Phase 1 (consolidation period, 1 year)

During the consolidation phase, agreement will be reached amongst relevant stakeholders through a consultation process where best to place the GMES & Africa NRM services at each region and/or at the continental level. Priority candidates for these roles are existing institutions with technical capacities and infrastructure, as well as with the necessary mandate, duly associated with (or supervised by) the RECs and national space agencies.

In order to enhance vertical cross-scale interoperability and efficient NR management over the continent, national consolidated data sets must be collected that feed regional inventories in the RECs and the latter allow access to their data to build and maintain a continental/national level data repository on NR under coordination of the AU. National space agencies need to be supported and strengthened to provide the required information and feed it into regional inventories by RECs. A system ought to be considered with coordination by AUC, levelling down responsibilities to RECs and the national systems.

Specifically, the following will be achieved:

- Requirements for cross-cutting initiatives assessed, such as strengthening human capacity and existing data acquisition and processing infrastructure;
- Ownership by African institutions and African stakeholders in the process taken;
- Suitable service models developed, depending on stakeholder needs and regional and national institutional set-up and partnerships;
- Links to the private sector developed or strengthened, especially, but not only, for monitoring of non-renewable NR.

Phase 2 (scaling up period, 3 years)

During this phase, services prioritized during Phase 1 (maps, inventory, data base, models) will be scaled up and additional RECs and/or additional services will be added, if identified during test runs in Phase 1, or those with a lower priority at the initial phase. To support data processing, regional EO processing centres will be strengthened or developed at the RECs in coordination with other GMES & Africa services. Capacity building and infrastructure development will be an important component at this phase.

Phase 3 (implementation period, 4 years)

It is expected that during this phase, a fully-fledged pan-African GMES & Africa NRM service will be available. Activities will be coordinated at continental/regional/national level and implemented at regional/national/local level. RECs and regional processing centres will play a key role. Plans for future expansion of the service will be considered, taking stock of then available and planned infrastructure and based on comprehensive monitoring and evaluation procedures.