

THE GMES & AFRICA ACTION PLAN

1. WATER RESOURCE MANAGEMENT

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4. INTRODUCTION

4.1. THEMATIC CONTEXT

With its 5400 km³ of renewable resources (10% of the world), water represents one of the major development drivers in Africa. It includes over 40 million ha of irrigation potential and 1.4 million GWh of hydro power potential. Today, major river systems suitable for navigation represent a major infrastructure for inland transport. In addition, water bodies, rivers lakes and wetlands represent a harbour of biodiversity, fisheries and an ecology attraction for tourist use. In spite of this potential, Africa still faces significant challenges to ensure effective use and efficient management of its water resources:

- The multiplicity of trans-boundary water resources (more than 60 trans-boundary basins) significantly increases water governance and risk;
- There is low level of development and water utilization. For instance, only about 4% of the available water is used in the whole continent. In the case of irrigated areas, the actual use amounts to less than 10 % of potential, while only the 6% of the hydropower potential has been developed. Concerning water supply and sanitation the figures are dramatic: over 300 million of Africans lack safe water supply and adequate sanitation.
- It is estimated that by 2025 about 600 million people will be exposed to water scarcity situation (<1000 m³/capita/yr).
- Huge infrastructure gaps with less than 50 m³/person storage capacity compared to over 3000 m³/person in Europe and 5000 m³/person in USA.

In this complex and challenging context, water information systems are fundamental for improving water governance and implementing Integrated Water Resource Management (IWRM) successfully. Today, in many African countries, policies and management decisions are based on sparse and unreliable information. This water information gap is a major limitation to attain the water-related Millennium Development Goals (MDGs) and put in practice IWRM plans to face the current and coming challenges of the African water sector.

4.2. PRESSURES (OR CONSTRAINTS).

Developing an IWRM information system is a huge challenge, even for the wealthier and more organized countries in Europe and Africa. This is particularly more demanding in Africa where, in several countries, water information systems are severely degraded¹, policies and management decisions are based on unreliable information and donor institutions are reluctant to provide long-term support for remnants of out-dated observation networks that will never become adequate for IWRM requirements². Consequently, resultant conflicts for competing demands of water both in terms of quantity and quality in Africa have not been resolved. Without an urgent action to assist African stakeholders in IWRM to bridge the information gap, IWRM will remain a dream, and the water related MDGs will remain unattainable in Africa.

GMES and Africa should enable full African participation in the rapidly evolving global 'Earth Observing' System, and so benefit from the coming GMES Space Component capacity (e.g., European Space Agency (ESA) Sentinel series, national contributing missions) to collect, manage and disseminate water related information, in cost effective and sustainable ways.

5. POLICY DRIVERS AND NEED ANALYSIS:

5.1. POLICY DRIVERS

The "Africa Water Vision for 2025"³, endorsed by the African Ministerial Conference on Water (AMCOW) and by the Heads of State of the African Union at the Extraordinary Summit on Water and Agriculture at Surte, Libya, in February 2004, serves as a basis for long-term national, sub-regional and regional policies and programmes for the equitable and sustainable use of water for socio-economic development of the continent. The framework for

¹ *Africa Water Vision for 2025.*

² *Report of the World Panel on Financing Water Infrastructure: Financing Water for All, M Camdessus, World Water Council et al, 2003.*

³ <http://www.uneca.org/awich>

achieving this vision calls for strengthened governance of water resources and considers the ability to generate and receive knowledge and information to be critical success factors in view of growing water scarcity due to natural phenomena and human factors. The importance of water Resource management cannot be overemphasized. Water, as one of the MDGs goals is intricately intertwined with agricultural productivity and energy generation in Africa, the main drivers of socio-economic development.

The African Union Science and Technology plan⁴ consolidates the science and technology plans of the African Union Commission and NEPAD. It places issues associated with the development, supply and management of water high on the agenda owing to the fact that water scarcity and related insecurity is one of the sources of the continent's underdevelopment and increasing economic decline. It explicitly identifies scientific assessment of Africa's water resources and systems, research and technologies to assess and monitor water-related disasters and water knowledge and technologies to improve water quality and quantity as the indicative water projects to be implemented in 2006 – 2010.

The WSSD plan of implementation recognizes the role of science and technology in meeting the water goals. In paragraph 27, it commits governments to:

“improve water resource management and scientific understanding of the water cycle through cooperation and joint observation and research, and for this purpose encourages and promotes knowledge sharing and provide capacity building and the transfer of technology, as mutually agreed, including remote sensing and satellite technologies, particularly in developing countries and countries with economies in transition”.

The table below mentions other policy drivers relevant to the Water thematic area besides the Sirte Declaration on Agriculture and Water in Africa, the African Water Vision 20025 and MDGs on Water supply and Sanitation already discussed above.

<ul style="list-style-type: none"> • AU Sharm El- Sheikh declaration on water and sanitation • eThekweni ministerial declaration on sanitation • Declaration on Climate Change in Africa • Tunis ministerial declaration on water security • Africa – EU statement on Sanitation • AU guideline on establishing cooperative framework in transboundary basins • AU Abuja action plan 	<ul style="list-style-type: none"> • AU comprehensive African agricultural development plan (CAADP) • NEPAD infrastructure Action plan • NEPAD Environmental Action plan • African programme on action on implementation of the African regional strategy on disaster risk reduction • African regional position paper launched at 5th World Water Forum, Istanbul.
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5.2. THE NEED ANALYSIS

The conclusion and recommendation derived from the First African Water Week organised in Tunis by the African Water facility under the AMCOW mandate in March 2008 states:

“Information about water is as essential to life as the water itself. Good information aids decision-making and enables better choice and design of infrastructure. Data enables monitoring progress towards the MDGs. Despite this, insufficient resources are invested in the supply and dissemination of water information and therefore not enough information is produced. In order to ensure water security, data and information on quantity and quality of available freshwater is crucial for the planning and efficient and sustainable water resources development and management in Africa. “

In December 2007, The ‘Lisbon Declaration on GMES and Africa’ was adopted under the aegis of the Portuguese Presidency of the Council of the European Union. This calls for the first draft of an action plan to be submitted to EU and African constituencies by end 2008. The European Commission and the Commission of

⁴ Africa’ Science and Technology Consolidated plan of Action. 2006, NEPAD Office of Science and Technology, Johannesburg, South Africa

the African Union will jointly prepare an action plan for endorsement at the next EU-Africa Summit foreseen for the end of 2009.

In this context, the objective of *GMES and Africa* water thematic area will be:

1. To enhance African technical, human and institutional capacity to meet the need for timely, quality long term information covering African national, regional, trans-boundary and continental scales as a basis for sound decision making, improved Integrated water resource management and effective climate change adaptation and mitigation plans;
2. To build upon existing initiatives and programs to establish long-term sustainable end-to-end information systems and services in major national and trans-boundary river basins in Africa enabling African water authorities and water sector stakeholder to fully exploit the global 'Earth Observing' System, and the coming GMES Space Component capacity to collect, manage and disseminate water related information, in cost effective and sustainable manner;

6. IDENTIFICATION OF COMMUNITIES:

To achieve the *GMES and Africa* objectives, it is of fundamental importance to mobilize resources, expertise and contributions from different sectors at National and International levels concerned with the problems faced by Africa countries in the collection of relevant geo-information for implementing integrated water management plans. In this context, *GMES and Africa* process should foster partnerships between the end beneficiaries (water authorities), space agencies and data providers, the expert centres in Earth Observation applications for water management (e.g., key universities and international research organizations), the private sector (e.g. value adding companies), NGOs and financial and development agencies. All these organizations collectively represent the **GMES and Africa Water Theme Stakeholder Group**. The table below categorizes the main stakeholders groups. Further details are available in the Annex 2:

Level	Category	Interests
UN agencies	UN-Water; UNESCO – IHP; UNEP DEWA programme; UN-Habitat Water and Sanitation Programme; World Hydrological Cycle Observing System (WHYCOS) of WMO; UN-ECA	<ul style="list-style-type: none"> • Global trends on the status, quality and quantity of water resources and improving access to water • Provision of in-situ networks and improving free exchange of data to compliment EO based observation and modelling • Capacity building • Early warning and assessment
International	GEO; CEOS; World Water Council; World Water Partnership; Ramsar Secretariat; Global Energy and Water Experiment (GEWEX); ESA; EUMETSAT; GEONETCast	<ul style="list-style-type: none"> • Earth Observation data providers for water management and dissemination • Promotion of better practices on water management in Africa • strategic framework for Water resource management • Provision of in-situ networks to compliment EO based observation and modelling
Continental	AU, AMCOW; Experts Centres for Water Science and Technology promoted by NEPAD; Regional Economic Communities in Africa (SADC, ECOWAS, CEMAC, IGAD, COI); African Space Agencies; AMESD; TIGER; ARSIMewa; AARSE; African Water Academy; Groundwater Commission of Africa	<ul style="list-style-type: none"> • Political direction in water management issues across Africa • Ensuring the provision of African EO data to African stakeholders • Networking among African players involved in IWRM • Capacity building
Regional	River Basin Authorities (e.g. Réseau Africain des Organismes de Bassin, based in Dakar); Regional and trans-boundary organizations; Regional Remote Sensing Centres in Africa (e.g. AGRHYMET, RCMRD); OSS; NBI etc	<ul style="list-style-type: none"> • Networking, developing and implementing regional water management plans in Africa including capacity building • Potential providers of geo-information in support of envisaged water management plans • Provision of in-situ networks to compliment EO based observation and modelling
National	Local universities; Research Institutions; Water Resource management Authorities,	<ul style="list-style-type: none"> • Capacity building

	Ministries of Water; National institutions (e.g CERSGIS, CRTS; SAC; CSIR)	<ul style="list-style-type: none"> Developing and implementing national water management plans in Africa Provision of in-situ networks to compliment EO based observation and modelling Scientific research on water related issues in areas of jurisdiction
Donors	African Water Facility; European Commission; World Bank; Global Environmental Facility; Development agencies	<ul style="list-style-type: none"> Provision of resources aimed at supporting African Countries to achieve MDGs water targets
International and local NGOs	WaterNET etc.	<ul style="list-style-type: none"> Water advocacy Community based mobilization

7. MAPPING EXERCISE:

There are several projects, programmes and initiatives that are completed, ongoing or planned in Africa using EO technology dealing with water resource management and cannot all be highlighted in this document. TIGER Africa Initiative and AMESD programme typify African - European cooperation in water resource management applications using space technology and are continental in scale, operational in nature and thus relevant to and can be used as a model for *GMES and Africa*.

The Table below is not exhaustive and aims only at providing an overall panorama of potential information services that have been developed. Details of these major programmes are provided in Annex 3.

Programmes	Information services and scale		Data collection, accessibility		Products, Monitoring and Assessment	
	Service	Scale	Data Collection	Data Access	Products	Monitoring and Assessment
TIGER (2nd phase on-going)	<ul style="list-style-type: none"> Ground water resources; Catchments characterization; Mapping of hydrological network; 	National (e.g., Morocco) ; National (e.g., Ghana)	EO Data Field data	Yes	<ul style="list-style-type: none"> Mapping of the groundwater potential (Morocco); Groundwater exploration maps (Ghana); Infiltration areas (e.g., lineaments and geophysical features); Hydrological network; Water extraction estimates; Irrigation areas; Land use, land cover and crop maps; DEMs; 	Derived water consumption and extraction estimations
		Trans-boundary shared aquifer systems (e.g., SASS involving Algeria, Libya and Tunisia and SAI shared aquifer involving Mali, Nigeria, Niger)	EO Data Field data	Yes	Land use changes; surface water extension and dynamics, water balance	
	Surface water mapping	National (e.g., Burkina Faso) National (e.g., Niger)	EO Data Field data	Yes	Mapping of surface water extent and changes; mapping transient natural waters in arid and semi-arid areas	water availability estimation and Flood mapping

		National (e.g., Zambia)			(Niger)	
	Water Quality	Regional (e.g., Lake Victoria, Alke Chad) National (Lake Manzalah, Egypt)	EO Data Field data	Yes	Operational turbidity; chlorophyll-a; temperatures; suspended sediment concentration; lake levels; water hyacinth monitoring	
	Wetlands management	Continental (Algeria, Egypt, Kenya, Lake Chad, Senegal and South Africa)	EO Data Field data	Yes	Land-cover/use information over complex landscapes	land change monitoring
	River and lake water levels	Continental	EO Data Field data	Yes	Relative values of water level variations at cm resolution	Water management
	Soil Moisture estimation	Regional (SADC)	EO Data Field data	Yes	NRT soil moisture maps	Estimation of drought and flooding "hot-spots" determination
AMESD (ongoing)	Water Management for Cropland and Rangeland Management	Regional (ECOWAS)	Field Data EO Data	Thematic data	Vegetation state; Extent and dynamics of small water bodies;	Yield estimation and drought risks delineation
	Water Resource Management focusing on environmental aspects of watersheds	Regional (CEMAC)	Field Data EO Data	Thematic data	NRT water level for the Oubangui river	Low water alert system
SERVIR Africa	Environmental monitoring and management	Continental	Field Data EO Data Modelling	Thematic data	Flooding and droughts	Mitigate against natural disasters
UNESCO G-WADI	Global Real-time Precipitation	Continental	Field Data EO Data Modelling	Visualize on server	Operational precipitation estimates	Forecast and mitigation of hydrologic disasters
Water Cycle and Drought Monitoring over Africa	Real-time monitoring of land surface hydrological conditions	Continental	Field Data EO Data Modelling	Thematic data	Precipitation, evapotranspiration, runoff, snow and soil moisture	Water Cycle and drought monitoring over Africa

8. IDENTIFICATION OF GAPS AND SUITABLE PROGRAMMES:

8.1. GAPS:

Based on the experience gained in the last years through the different activities dedicated to support service development in Africa, several general blocking factors and gaps have been identified that need to be addressed by the *GMES and Africa* process in order to ensure the successful development and implementation of operational sustainable services in Africa.

- **Institutional blockages** including lack of awareness of EO capabilities and limits; low level of penetration of Information Technology -IT in several African institutions, lack of solid links between users (water authorities) and potential service providers in Africa; lack of solid institutional established procedures to integrate geo-information into management practices and planning; lack of a solid consolidated group of potential service providers in Africa including technical centres, universities and private sector;
- **Human blockages:** including lack of skilled technicians and EO operators; training required to educate professional operators and the high turnover of skilled personnel, lack of skilled personnel in water authorities with a good knowledge of GIS and EO technologies, lack of sufficient high education curriculum in African universities ensuring the consolidation of a critical mass of African professional in the area of EO applications;

- **Technical blockages:** including the limit of current EO systems that will be significantly enhanced with the advent of the Sentinel series; needs for in situ data infrastructures; need for long-term granted continuity and easy EO data provision and access; need for suitable software and hardware infrastructures in African institutions; needs of fast internet connectivity;

GMES and Africa should build upon existing programs and implementation models with the long-term target of developing a end-to-end African ownership of the full service chain, which will allow the long-term sustainability and the required institutional and user acceptance of the GMES process.

Space- based observation needs

Scale	Identification of Gaps	Dimensions that GMES Africa service would provide
Continental	A core set of continental scale products covering different components of the water cycle: e.g., Precipitation; Evapo-transpiration; Soil moisture; Water levels;	GMES should ensure the provision and accessibility of these products at continental scale; Capacity Building in EO applications, in situ and modelling integration to forecast and produce hydrological process early warning tools.
Regional (trans-boundary river basins)	Local Operational observational incapacibilities for information services addressing the needs of riparian (member) states and stakeholders on major trans-boundary river basins : e.g., <ul style="list-style-type: none"> • Base mapping for supporting infrastructure development (water supply and sanitation); • Irrigation areas, Crop mapping; • Ephemeral water bodies);Flooding; 	GMES should support the empowerment of key African institutions at trans-boundary level being able to operate and run information services allowing the observation and monitoring of water resources over major trans-boundary river basins and lakes in Africa, while offering a coherent service to their riparian countries (e.g., national water authorities to better exploit and integrate potential GMES African water services into the national planning and decision making activities

In-situ based observation needs

Concerning in-situ networks, from 4.2 above, reference is made to severely degraded or out-dated in-situ networks for collection of water related data in Africa, hence information derived from them is unreliable to validate EO data. Some existing programs such as WHYCOS facilitates the installation and free exchange of data obtained from several in-situ networks to compliment EO based observation and modelling.

For *GMES and Africa* service, it is proposed that a strong effort shall be dedicated to enhance permanent in-situ network infrastructures allowing data to be regularly collected, harmonised, standardized, and structured in accessible and interoperable databases. This is mandatory in order to develop and validate effective operational services that may integrate both EO and in situ data in a scientifically sounded manner.

Scale	Identification of Gaps	Dimensions that GMES Africa service would provide
Continental	Inappropriate In-situ networks for water management and monitoring; In situ data is also mandatory for validation/calibration of EO based services in Africa;	Problem solving Focus on Basin –wide water budget (rainfall and evapo-transpiration), trans-boundary river discharges, water extraction (information on well depths, piezometric measurements, well density and pumping rate) for aquifer management, water consumption, water-related infrastructure and investments,

Gaps related to Global Climate change

Water resources are inextricably linked with climate, so the prospect of global climate change and variability has serious implications for water resources and regional development in Africa. In future, Climate change adaptation and mitigation strategies require hydrological data and information to enable assessment of the impacts of climate change. Earth Observation technology can provide a major contribution to face the water information gap in Africa. Within *GMES and Africa* water thematic area, beneficial synergies need to be created with Climate for Development in Africa Program (ClimDevAfrica) spearheaded by the African Union Commission.

8.2. EXISTING OR PLANNED THEMATIC FUNDING PROGRAMS:

- **European Water Facility:** In 2004, the EU Council decided to consider allocating a total amount of € 500 million for an ACP-EU Water Facility, to be funded from the conditional €1 billion of the 9th EDF. The establishment of the ACP-EU Water Facility and its funding was endorsed by the ACP-EU Council of Ministers at its meetings in Gaborone in May 2004 and Luxemburg in June 2005. The two tranches of € 250 million each have been made available.
- **European Development Funds:** The European Development Fund (EDF) funded by the Member States is the main instrument for providing Community aid for development cooperation in the ACP States and the OCT. ACP States will continue to be funded by EDF at least for the period 2008-2013. The tenth EDF covers the period from 2008 to 2013 and provides an overall budget of EUR 22,682 million. Of this amount, EUR 21,966 million is allocated to the ACP countries allocated accordingly: EUR 17,766 million to the national and regional indicative programmes, EUR 2,700 million to intra-ACP and intra-regional cooperation and EUR 1,500 million to Investment Facilities. An innovation in the tenth EDF is the creation of "incentive amounts" for each country.
- **7th Framework Program:** Research and development program of the European Union supporting also activities related to GMES and service development.
- **African Water Facility:** The African Water Facility (AWF) is an initiative led by the African Ministers' Council on Water (AMCOW) to mobilize resources to finance water resources development activities in Africa through the establishment of the African Water Facility Special Fund. The African Development Bank (AfDB) hosts the Facility on the request of AMCOW. AWF applies fast-approval and flexible procedures and can provide support to communities as well as to national and multinational institutions. For the duration 2008 – 2010, it is envisaged that EURO 236 million will be disbursed to support water projects in Africa.
- Dedicated programs also exist in other donors (World bank) and national developing agencies;

9. BUILDING GMES –AFRICA SERVICE

9.1.SERVICE DEFINITION AND PROVISION

It is worth noting from a technical viewpoint that to set up an operational observation and information program for water in Africa, it is mandatory to dedicate significant resources to further consolidate, develop and validate a solid portfolio of scientifically sound information services based on the results of existing initiatives, projects and programs in African and Europe. This should give special attention to the synergistic use of EO data, in situ networks and suitable models.

The following table provides a summary of some of the potential operational services that maybe the basis for *GMES and Africa* water component today. Some of the services listed below have already been demonstrated and validated in several areas within the TIGER initiative and other programmes:

Scale	Service description	Users
Continental	<p>A core set of continental scale products covering different components of the water cycle at low resolution (approx. 1 Km): e.g.,</p> <ul style="list-style-type: none"> • Soil moisture; • Rivers and lakes water levels; <p><i>Other continental scale products such as precipitation or evapo-transpiration are still in a research stage;</i></p>	<p>National authorities, basin authorities, hydrological services, local communities, farmer communities, fisheries industry.</p> <p>Many of the proposed service also address transversal needs. In particular many of them may cover the needs of:</p> <ul style="list-style-type: none"> ○ Environmental agencies; ○ Developing agencies (monitoring and assessment purposes); ○ Forestry departments; ○ Weather services; ○ Civil protection services;
National and basin scales	<p>Base mapping for enhancing infrastructure development with focus on water supply and sanitation at high resolution (approx. 10m);</p> <p>Catchments characterization including a core set of products at basin scale at high resolution(10-20 meters): e.g.,</p> <ul style="list-style-type: none"> ○ Land cover and land use; ○ Crop mapping; ○ Irrigation areas; ○ DEMs; 	

	<ul style="list-style-type: none"> ○ Hydrological network; 	
	Ephemeral water bodies identification and monitoring in arid and semi-arid regions at high resolution (10-20 meters);	
	Water quality monitoring in large lakes at medium resolution (250 meters) including: <ul style="list-style-type: none"> ○ Chlorophyll; ○ Water turbidity; ○ Yellow matter; ○ Water surface temperature; ○ Floating vegetation; 	
	Support ground water management including (from 10 to 250 meters): <ul style="list-style-type: none"> ○ Estimation of water extraction; ○ Ground water exploration (e.g., identification of infiltration areas); 	
	Rapid mapping of flood maps at high resolution (10-20 m);	
	Early warning for droughts;	
	Wetlands monitoring and mapping at high resolution (10-20m) including: <ul style="list-style-type: none"> ○ Water extension dynamics monitoring; ○ Inundated vegetation dynamics; ○ Land mapping and change analysis; 	

Additionally, a number of advanced information services are still in the research domain may be considered as part of a long-term development process aimed at exploiting in a synergistic manner the next generation of EO data (e.g., Sentinels), in situ and suitable advance hydrological models: e.g., runoff modelling, risk of floods mapping, water availability and water balance, etc...

9.2. CAPACITY BUILDING:

9.2.a. NECESSARY ELEMENTS

A major component of *GMES and Africa* shall be devoted to ensuring the development of the required human, technical and institutional capacity to empower African institutions to implement and run the *GMES and Africa* services in a sustainable manner. This will require a significant effort dedicated to:

- Enhance the long-term formation of African operators, technicians and scientist with the capabilities to exploit EO technology for IWRM;
- Enhance the technical capacity of potential African service providers (institutions with technical competences, regional centres, remote sensing centres) with the capacity to provide upstream GMES services to water authorities;
- Ensure the enhancement of the in situ networks (e.g., via HYCOS) that may contribute establish GMES services;
- Develop an African private sector of value added companies being able to provide downstream GMES service to African users. This will require a significant effort in terms of subsidising the initial steps in the development process;
- Enhance the institutional links between service providers and water authorities establishing long-term links and partnerships that may be the basis for long-term Service Level Agreements;
- Enhance the capacity of water authorities to understand, integrate and use GMES services into their management and operational practices ensuring clear short-term impacts in the field.

9.2.b. STRATEGY

All this efforts need to be built upon the experiences of existing initiatives and capacity building efforts carried out by different institutions (developing agencies) and programs (e.g., TIGER Capacity Building Facility,

AMESD, WHYCOS, etc...) and taking into account key African players already involved in Capacity Building Activities in the water sector (e.g., regional technical centres such as RCMRD or AGRHYMET, WaterNET, etc.);

In this context, it is also worth mentioning the major role that the Experts Centres for Water Science and Technology promoted by NEPAD may play in *GMES and Africa*. In particular, *GMES and Africa* may further support the development of those key centres as a basis for service development, service provision and best practice sharing in Africa. However, *GMES and Africa* strategy for capacity building should mobilize significant dedicated resources in order to address the needs above identified with the major focus:

In the short term:

- A critical mass of African technical centres and value adding companies need to be established and supported with the capacity to develop, run and operate information services addressing the information needs of the African water sector.
- Users (water authorities) need to be supported with the capacity to exploit GMS services and EO-based geo-information to enhance water governance and decision making;

In the long-term:

- High-level educational programs in Africa need to be developed and supported in order to ensure the continuous provision of post-graduate technicians and managers with a solid knowledge of EO technology and their applications in the water sector (among others);

9.3. PRIORITIZATION OF REQUIREMENT AND ACTIONS

Implementing operational information services involving EO technology, in situ observations, and models is a complex process. In Europe the GMES initiative represents an excellent yet unique reference on how services can be defined, developed and implemented at large scales involving multiple partners and institutions at different political, technical and institutional levels. In this context, the *GMES and Africa* Program Implementation may follow a similar approach as the one used in GMES:

The following key points for implementation are crucial for the success of the *GMES and Africa* water thematic area:

- Suitable mechanisms shall be established in order to maintain a long-term dialogue with the different actors in the ***GMES and Africa* Water Theme Stakeholder Group**. This shall exploit existing mechanism and forums such as the African Water Week, the World Water Week or the World Water Forum and organized relevant programs such as AMESD and TIGER may support this process. Such *GMES and Africa* forums shall be coordinated at high level by the EC and the AUC with the support of the *GMES and Africa* coordination group.
- A key element of the consultation process shall be dedicated to improve the communication between water authorities and service providers. In the specific case of the water thematic area, AMCOW shall play a key role in this process, being the African interlocutor in support of AU.
- *GMES and Africa* shall be an African driven process aimed at establishing long-term sustainable information services in Africa addressing African priorities and needs. In this context, governance shall ensure that African institutions retain the ownership and programmatic leadership of the process.
- Concerning the access to the data, GMES data policy shall enable long-term free access to GMES data (e.g., Sentinel data, contributing mission) to African institutions to implement *GMES and Africa* services. This data sharing policy will be harmonized with the GEO portal being developed by GEO as a single Internet gateway to the comprehensive and near-real-time data produced by GEOSS integrating diverse data sets and access to models and other decision-support tools. Also, more ground receiving stations covering Africa should be established at African Regional Centres and encouraged to broadcast data using the inexpensive GEONETCast system. EO data from weather satellites will be very important to provide key information on rainfall predictions to assist flood event mapping and forecasting.
- The essence of the value addition to EO data should be primarily to address Water resources monitoring systems and Early Warning systems capabilities. Also the data value addition should

address vulnerability assessment and formulation of adaptation strategies in IWRM especially within the global climate change domain. Modelling techniques will be used to enhance the predictive capabilities of the information services

- Similarly, within *GMES and Africa*, African Space Organizations (Nigeria, Algeria, Egypt, and South Africa) should be persuaded to contribute to the GEO data-sharing principles thus allowing free access of data from their missions to ensure the full and open exchange of data, metadata and products.
- Observational infrastructure and network integration will also be a key feature to achieving the operational sustainability of *GMES and Africa* initiative. This will harmonize the structures for collecting and sharing in-situ data since some countries have more advanced structures than others and therefore an independent coordination and harmonization exercise of networks at the African and European level is necessary.

9.4. ORGANIZATIONAL SCHEME:

The African ownership of the service definition and development of decision-support tools for (African) users is the key element that should be taken into account for *GMES and Africa* service model. In this context, the organization scheme for *GMES and Africa* shall ensure an African driven process involving the following points:

- AMCOW should represent the main political driver for the initiative. In this context, *GMES and Africa* shall be endorsed by AMCOW as far as the water implementation plan is concerned.
- *GMES and Africa* should consider the basin authorities from sub-national to trans-boundary scales and national water authorities as the main user of the services and hence the main end-beneficiaries of the process;
- Services should be operated from a number of technical centres (or value adding companies) in Africa at regional or local level with the required capacity. It is worth noting that in many cases, the trans-boundary water authority incorporate technical units with the capacity to operate and run a number of information services. In this context, the trans-boundary basin commissions may play the role of regional service providers for the different national authorities (e.g., LCBC);

9.5. TIMETABLE

A three phase implementation strategy is suggested covering the following:

- **Phase 1 (3 years). Consolidation period:** aimed at fully developing, validating and consolidating an initial set of services on the basis of existing initiatives, projects and programs in African and Europe. In this context, to successfully define sustainable and fully accepted GMES services for the African water sector, a number of key issues should be taken into consideration:
 - Identification of needs and service definition shall involve a close consultation process with water authorities and national and basin level under the leadership of AMCOW;
 - Ownership of the service definition and implementation at all levels shall remain African: defined by African and implemented by African Institutions.
 - The identification of needs and service definition shall ensure that the different characteristics, conditions and requirements of different institutions and regions are taken into consideration. A one-fits-all approach will not work: e.g., water scarcity is a problem in certain areas of Africa and not in others, where the key problem may be associated with floods or infrastructure management.
 - Suitable service models shall be developed depending on the regional and national existing institutional set ups and partnerships (e.g., maximising the roles of Trans-boundary basin authorities).
- **Phase 2 (3 years): Scaling up period,** where on the basis of the results achieved on the previous phase, a number of selected services shall be further developed and scaled up extending the user base and further developing the African capacity to operate and run the selected services. This shall involve a large capacity building effort and institutional development process in order to build a solid basis to establish operational and sustainable services in the 3rd phase

- **Phase 3 (4 years): Implementation Period,** In this phase services shall be implemented and run in an operational manner.

9.6. INDICATIVE DEVELOPMENT PLAN AND BUDGET ESTIMATE:

Taking into account the required effort against the existing pre-conditions in Africa and with the example of the GMES process in Europe, a proposed budget to implement the water component shall amount to no less than 60 Million distributed as:

- Phase 1: 10 Million;
- Phase 2: 20 Million;
- Phase 3: 30 Million;

In this context, suitable funding programs (European development Funds) shall be mobilised in order to cover the needs to develop and implement *GMES and Africa* water thematic area.

10. RECOMMENDATIONS:

In section 9 above, the following priority actions were highlighted:

- Development of information services addressing water resources monitoring and early warning systems including vulnerability assessment and formulation of adaptation strategies in IWRM especially within the global climate change domain;
- Broadcasting of EO data using inexpensive GEONETCast system amongst other channels;
- A proposed initiative for data calibration and validation;

The following recommendations are proposed for the *GMES and Africa* water thematic area:

Ownership

- It is recommended that African ownership of the service definition and development of decision-support tools for (African) users is the key element that should be taken into account for *GMES and Africa* service model

Operational scale

- It is recommended that the basin authorities from sub-national to trans-boundary scales and national water authorities will be the main user of the services and hence the main end-beneficiaries of the process

Capacity building

- It is recommended that a dedicated Capacity Building Program at continental scale is created to develop a critical mass of expertise, African technical centres and value adding companies with the capacity to develop and operate EO-based water information services.

Partnerships

- It is recommended that a mechanism be created to interface the Basin Authorities with international programmes e.g. ESA, EUMETSAT for EO data acquisitions including supplementary EO data from ARMC, WHYCOS for in-situ measurements/ networks and other international projects e.g. EC / JRC AQUAKNOW.

11. SUMMARY

Water, one of the MDGs is intricately intertwined with agricultural productivity and energy generation in Africa, the main drivers of socio-economic development. In the case of irrigated areas, the actual water use amounts to less than 10 % of 40 million ha irrigation potential and only about 4% of the 1.4 million GWh of hydro power potential is developed within the Continent. Despite all this potentiality, Africa faces significant challenges to ensure an effective use and efficient management of its water resources. It is further estimated that by 2025 about 600 million people on the African continent will be exposed to water scarcity situation (<1000 m³/capita/yr).

Developing an Integrated Water Resource Management (IWRM) information system is challenging in Africa, where, water information systems are severely degraded, policies and management decisions are based on unreliable information, and donor institutions are reluctant to provide long-term support for upgrading out-dated observation networks.

In this context, *GMES and Africa* represents a unique opportunity to:

- Enhance African human, technical and institutional capacities to meet the need for timely, quality long term information covering African national, regional and trans-boundary scales as a basis for sound decision making and improved Integrated water resource management and water governance.
- Improve the decision making processes and planning in water resource management in Africa by establishing long-terms sustainable information services that overcome the water information gap in Africa by fully exploiting the increasing global EO capacity.

The *GMES and Africa* water resource model can build upon the solid basis of several initiatives (PUMA, AMESD, TIGER, UNESCO IHP, WHYCOS and HYCOS). These activities have demonstrated the strong potential of EO-based information to support African progress towards Integrated Water Management, at both national and trans-boundary levels. Key African stakeholders including the African Ministerial Council on Water have strongly supported some of these approaches (e.g., TIGER, WHYCOS).

Today, the policy basis is clear; user needs are identified, an initial set of users are strongly engaged, and methodologies have been validated and demonstrated in several countries. The critical issue for Africa is long-term sustainability.

The Lisbon Declaration now opens the prospect of a long-term cooperative AU-EU framework which could enable information services to be fully transferred to African partners and reach sustainability. In order to underpin the high-level Lisbon process, it is necessary to continue to build upon existing capacities in Africa, further develop existing cooperation with African partners, maintaining existing service capabilities, with special emphasis on capacity-building and building-on-capacity.

The information needs are broad, including support for establishing national and regional monitoring and evaluation mechanisms, for assessment of water quality and quantity, and for assessment and monitoring activities by River Basin Organizations. There are many relevant EO-based precursor services such as: Base mapping, Hydrological network mapping; Water availability estimation; Catchments characterization ; Large lake water quality; Ground water exploration; Water Infrastructure monitoring among others.

The proposed *GMES and Africa* will accelerate cooperation between African water authorities, European, and African service providers in the context of the AU-EU framework. The African water ministries, river basin authorities, regional and trans-boundary organizations are the principal users concerned. African Regional and National Technical Centres are the main service providers, along with universities, research centres and other national institutions.

A 10-year three phase implementation strategy is proposed including a consolidation phase (3 years) followed by a scaling up period of 3 years and a final implementation period of 4 years. The budget proposed for each phase is 15 M, 20 M and 30 Million Euro respectively.

12. ANNEXES

ANNEX 1: ABBREVIATIONS

AARSE	African Association of Remote Sensing of the Environment
ACP:	Africa Caribbean Pacific
AGRYMET:	Centre Regional de Formation et d'Application en Agrométéorologie et Hydrologie Opérationnelle, Niamey, Niger
AMCOW:	African Ministers' Council on Water
AMESD:	African Management of the Environment for Sustainable Development
AQUAKNOW:	Dynamic Virtual Space for Information sharing for water sector stakeholders
ARMC:	African Resource management Satellite Constellation
ARSIMEWA:	Applications of Remote Sensing for Integrated Management of Water Resources in Africa
AU:	African Union
AUC:	African Union Commission
CB:	Capacity Building
CEMAC:	Communauté Economique et Monétaire de l'Afrique Centrale
CEOS:	Committee of Earth Observation Satellites
CERSGIS:	Centre for Remote Sensing and Geographic Information Services
ClimDevAfrica:	Climate for Development in Africa Program
COI:	Commission de l'Océan Indien
CRTS:	Royal Centre for Remote Sensing, Morocco
CSIR:	Council for Scientific and Industrial Research, South Africa
DTM:	Digital Terrain Model
EC:	European Commission
ECOWAS:	Economic Community Of West African States
EDF:	European Development Fund
EO:	Earth Observation
ESA:	European Space Agency
EUMETCast:	EUMETSAT Broadcast system for Environmental Data
EUMETSAT:	European Organisation for the Exploitation of Meteorological Satellites
GEO:	Group on Earth Observations
GEONETCast:	Global Network of Satellite-based Data Dissemination Systems
GEOSS :	Global Earth Observation System of Systems
GEWEX:	Global Energy and Water Cycle Experiment
GIS:	Geographical Information System
GMES:	Global Monitoring for Environment and Security
GWh:	Gigawatt Hour
IGAD:	Intergovernmental Authority on Development
IT:	Information Technology
ITC:	International Institute for Geo-Information Science and Earth Observation
IWRM:	Integrated Water Resource Management
JRC:	Joint Research Commission of the EC
LC:	Land Cover
LCBC:	Lake Chad Basin Commission
LU:	Land Use
MDG	Millennium Development Goals
NBI :	Nile Basin Initiative
NEPAD:	New Partnership for Africa's Development
NGO	Non Governmental Organization
NHS:	National Hydrological Services
OSS:	Sahara and Sahel Observatory
PUMA:	Preparation for the use of Meteosat Second Generation in Africa
RCMRD:	Regional Centre for Mapping of Resources for Development
REC:	Regional Economic Countries
RS:	Remote Sensing
SAC:	Satellite Application Centre, CSIR, South Africa
SADC:	Southern African Development Community
SAI:	Iullemeden Aquifer System
SASS:	Système Aquifère du Sahara Septentrional or North-Western Sahara Aquifer System
SRTM:	Shuttle Radar Topography Mission
TCBF:	TIGER Capacity Building Facility based at ITC, Netherlands

TIGER: A European Space Agency led initiative dealing with Integrated Water Resource Management for Africa using Space Technology

UN-ECA: United Nations Economic Commission for Africa

UNEP – DEWA: United Nations Environmental Programme Division of Early Warning and Assessment

UNESCO -IHP: United Nations Education, Scientific and Cultural Organization International Hydrological Programmes

WHYCOS: World Hydrological Cycle Observing System

WMO: World Meteorological Organization of the United Nations

WSSD: World Summit on Sustainable Development

ANNEX 2: GMES WATER THEMATIC AREA STAKEHOLDERS

- **AU and the African Ministerial Council On Water (AMCOW):** Shall represent the main political drivers of the process. *GMES and Africa* shall directly respond to their needs and priorities.
- **African Water Authorities:** The main end-beneficiaries of the *GMES and Africa* Water Component are the African Water Authorities (represented at continental scale by the AMCOW), the Ministries of Water, and the relevant River Basin Authorities and other Regional and trans-boundary organizations with responsibilities to develop and implement water management plans in Africa.
- **The African Regional And National Technical Centres:** The main potential providers of geo-information for water management. This include not only the National or Regional Remote Sensing Centres in Africa but also Universities, Research centres and other agencies with the capabilities and mandate to provide geo-information in support of envisaged water management plans (e.g., AGRHYMET, RCMRD). An important role will be played by the Experts Centres for Water Science and Technology promoted by NEPAD.
- The **African Development Institutions:** such as NEPAD.
- The **African Regional Economic Institutions:** such as SADC, ECOWAS, CEMAC, IGAD or COI.
- **African and International Space Agencies:** Space Agencies and EO data providers will represent a key element in *GMES and Africa*. In this context, it is worth noting the role of CEOS, which coordinates the efforts of the Space Agencies worldwide in the planning of Earth Observation satellite missions and their applications. In addition, it is worth mentioning the role of African Space Agencies, which should joint the GMES Africa process ensuring the provision of African EO data to African stakeholders.
- **GEO:** GEO provides a framework within which governments and international partners can develop new projects and coordinate their strategies and investments in order to coordinate international efforts to develop a Global Observation System of Systems integrating satellite, in situ and airborne elements. As of March 2009, GEO's Members include 77 Governments and the European Commission. In addition, 56 intergovernmental, international, and regional organizations with a mandate in Earth observation or related issues have been recognized as Participating Organizations. GEO includes water as an strategic target and Societal Benefit Areas (SBA) of interest.
- **The International and African Agencies and groups which sponsor Integrated Water Management:** Integrated Water Resource Management is sponsored and promoted by different International organizations: e.g., UN Water African Group, Ramsar Secretariat, World Water Council, World Water Partnership, etc. In addition there are a number of African institutions that support the wide spread of better practices on water management in Africa such as the African Water Academy or the Water Operators Partnership.
- **The international and National funding Agencies for Integrated Water Resource Management:** National and International funding agencies and Ministries of Foreign Affairs involved in programming and funding development and implementation projects aimed at supporting African countries to develop and implement Integrated Water Resource Management Plans. The African Water Facility hosted at the African Development Bank, the Development program of the EC, the World Bank, The Global Environmental Facility and several National developing agencies (e.g., GTZ) are but few examples of such agencies.
- **The Private Sector:** Value adding companies (VAC) and service providers in Europe and Africa, who possess the capability and experience to develop, implement and operate geo-information services based on EO technology.
- **Non-Governmental Organizations (NGOs):** Number of National and International NGOs with operational capabilities to support African countries to improve the development and implementation of Integrated Water Management Plans. It is worth noting the role of NGOs (such as WaterNET) in capacity building activities for Africa as well as several existing networks of European-African Universities dedicated to sponsor exchange and Europe-Africa collaborations in Science and Technology. .

ANNEX 3: ELABORATION OF IWRM EO PROJECTS IN AFRICA

1. **The TIGER Initiative:** Recognizing the utility of satellite data for Integrated Water Resource Management and the need for action in Africa expressed at the World Summit on Sustainable Development (WSSD) held in Johannesburg, South Africa, the European Space Agency (ESA) in the context of the Committee of Earth Observation Satellites (CEOS), launched in 2002 the TIGER initiative aimed at: **“assisting African countries to overcome problems faced in the collection, analysis and dissemination of water related geo-information by exploiting the advantages of Earth Observation (EO) technology”**.

Since 2005, under the guidance of the African Ministerial Council on Water (AMCOW), with contributions from CEOS (e.g., ESA, the Canadian Space Agency), UNESCO, the African Water Facility (AWF) of the African Development Bank and in collaboration with the UN Economic Commission for Africa (UN-ECA) and several other African and international organizations (e.g. CSIR, CRTS, Ramsar-Africa, South African Department of Water Affairs) TIGER has supported African partners with access to space-borne data and products, by providing dedicated training on EO applications for water management, by funding North-South collaborative projects aimed at developing and demonstrating EO-based water information systems, and by favouring take-off, operationalization and technology transfer to African water authorities.

The projects covered:

- *Base mapping for enhancing infrastructure development with focus on water supply and sanitation;*
- *Catchments characterization and mapping of hydrological network;*
- *Monitoring agriculture and irrigation areas;*
- *Crop production forecast and information services in support to food security;*
- *Ephemeral water bodies identification in arid and semi-arid regions;*
- *Rivers and lakes water level monitoring service;*
- *Water quality monitoring in large lakes;*
- *Support ground water management and estimation of water extraction;*
- *Support ground water exploration (e.g., identification of infiltration areas);*
- *Flood mapping;*
- *Drought early warning systems;*
- *Soil moisture monitoring service;*

TIGER has completed its first implementation period (2005-2008) involving more than 150 African institutions (water authorities, universities, technical centres) through its projects and capacity building activities. The results and achievements of the first implementation period have been recognized at the First African Water Week organized by AMCOW in Tunis on 25-29 March 2008 with a direct recommendation:

“International initiatives like ... TIGER which provide useful tools to the countries to strengthen their capacities for ensuring water security should be encouraged and supported.”

As a direct response to this explicit African request, a second implementation period, 2009-2011, of the TIGER initiative was proposed by the Steering Committee at its 3rd meeting hosted by UNESCO in July 2008. In this context, ESA launched the TIGER second implementation period at the 5th World Water forum in Istanbul.

TIGER has established a long-term development process based on a three stages (support research, pre-operational development, and transitions to operations)⁵ aimed at supporting the consolidation of a full end-to-end African capacity to exploit the coming EO observational capabilities and translate it into operational services in support of the African Water authorities.

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- **Research Stage:** *aimed at supporting the consolidation of a critical mass of technical centres in Africa with the skills and capabilities to derive and disseminate space-based water relevant information to water authorities and the relevant stakeholders for IWRM.*
- **Pre-operational stage:** *aimed at developing and demonstrating tailored EO-based information services and systems to support African water authorities in collecting water-relevant information in a regular basis.*
- **Towards Operations:** *On the basis of successful development and demonstration results, sub-regional (e.g. trans-boundary river basins) or national projects lead by African water authorities will be implemented, aimed at supporting the transition from a pre-operational stage to a sustainable operational phase. This process is carried out in collaboration with development partners and donors, who support such a transition financially.*

2. **PUMA**, a EUMETSAT and WMO initiative spanned from 2001 to 2005 and equipped a Pan-African network of 53 countries in the five sub-regional economic communities with the infrastructure, training for 275 professionals and support required for receiving the latest space-based low resolution meteorological and environmental MSG data, images and products from EUMETSAT via the EUMETCast distribution system. The project received funding of about 11.4 million euro from the European Commission through the European Development Fund.

One of the six PUMA pilot projects to foster the use of Earth observation data for non-meteorological purposes in a pre-operational basis was "*The evaluation of water resources in Kasai River sub-basin*". The project, relevant to the water resources thematic area of *GMES and Africa* led to the rationale and integrated management taking inland navigation into account.

3. **The African Monitoring of the Environment for Sustainable Development (AMESD)** initiative takes the Preparation for Use of MSG in Africa (PUMA) project a stage further by extending the systematic distribution and promotion of the use of meteorological earth observation technologies and low resolution data products to environmental and climate monitoring applications. The importance and relevance of operational water resource management in Africa is clearly manifested by the approval of two projects out of five AMESD projects dealing directly to water resource management thematic area of *GMES and Africa*. One of the projects, *Water Management for Cropland and Rangeland Management* is being implemented in the ECOWAS Regional Economic Community. The key products to be developed include vegetation state for estimation of yields of cultural and pastoral land, dryland areas and drought risks delineation by dry matter productivity, phenology and fraction cover extent. Also the extent and dynamics of small water bodies to support livestock management and savannah fires products will also be distributed in near real time via EUMETCast.

The other project, *Water Resource Management focusing on environmental aspects of watersheds* thematic action is being implemented by CEMAC Regional Economic Community. Two services will be provided, one a near-real time water level product for the Oubangui river incorporating a low water alert system for navigation. The other service will be an offline water cycle service specifically targeting rainfall and evatranspiration for the Oubangui sub-basin. The services are in synergy with the African Network of Basin Organization, WMO -Congo-HYCOS programme and forests- water resources FORAF/OFAC project.

4. The **UNESCO IHP** programme is UNESCO's international scientific cooperative programme in water research, water resources management, education and capacity-building, and the only broadly-based science programme of the UN system in this area. The program objectives include : 1) to act as a vehicle through which Member States, cooperating professional and scientific organizations and individual experts can upgrade their knowledge of the water cycle, thereby increasing their capacity to better manage and develop their water resources; 2) to develop techniques, methodologies and approaches to better define hydrological phenomena; 3) to improve water management, locally and globally; 4) to act as a catalyst to stimulate cooperation and dialogue in water science and management; 5) to assess the sustainable development of vulnerable water resources; 6) to serve as a platform for increasing awareness of global water issues.
5. The **Applications of Remote Sensing for Integrated Management of Water Resources in Africa (ARSIMEWA)** project. ARSIMEWA seeks to develop infrastructural support that will enable African countries to access and use satellite data and information and communication technologies, including the Internet, Remote Sensing (RS) and Geographic Information Systems (GIS) for monitoring, assessing and managing their Water Resources, thereby playing a complimentary role to operational use of EO technology. The pilot project covers the participating countries Benin, Botswana, Côte d'Ivoire, Democratic Republic of Congo, Equatorial Guinea, Guinea, Mozambique, Niger, Nigeria, Senegal, South Africa and Zimbabwe.
6. Another initiative, the **World Hydrological Cycle Observing System (WHYCOS)** is a WMO programme aimed at improving the basic observation activities in the field of hydrology by primarily focusing on strengthening technical and institutional capacities of National Hydrological Services (NHSS) and improving their cooperation in the management of shared water resources.