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List of Acronyms

AFRII	African Innovations institute
AWF	African Wildlife Foundation
CHIRPS	Climate Hazards Group InfraRed Precipitation with Station data
COP	Chief of Party
COPACSO	Coalition of Pastoral Civil Society Organizations
CCD	Climate Change Department
DWD	Directorate of Water Development
DWRM	Directorate of Water Resources Management
E&SA	Eastern and Southern Africa
EAC	East African Community
EAGC	East African Grain Council
ESIPPS	Environmental Surveys, Information Planning and Policy Systems
EO	Earth Observation
EU	European Union
FAO	Food and Agriculture Organization
FEWSNET	Famine Early Warning Systems Network
FIT Uganda	FIT Uganda Limited is Uganda's leading business development consulting company.
GEF	Global Environment Facility
GIS	Geographic Information Systems
GIT	Geo-Information Technology
GIZ	Gesellschaft für Internationale Zusammenarbeit
ICPAC	IGAD Climate Prediction & Applications Centre
ICPALD	IGAD Centre for Pastoral Areas and Livestock Development
IGAD	Inter-Governmental Authority on Development

IGAD-HYCOS	Intergovernmental Authority on Development- Hydrological Cycle Observing System
ILRI	International Livestock Research Institute
IUCN	International Union for Conservation of Nature
LULC	Land Use Land Cover Change
LULCE	Land-use, Land-cover & Ecosystems
LVEMP	Lake Victoria Environmental Management Programme
LVFO	Lake Victoria Fisheries Organization
MAIIF	Ministry of Agriculture, Animal Industries and Fisheries
MDAs	Ministries, Departments and Agencies
MWE	Ministry of Water and Environment
NaFIRRI	National Fisheries Resource Research Institute
NARL	National Agricultural Research Laboratories
NASA	National Aeronautics and Space Administration
NDVI	Normalized Difference Vegetation Index
NEMA	National Environmental Management Authority
NFA	National Forestry Authority
NFRI	National Forestry Research Institute
NSDI	National Spatial Data Infrastructure
NOAA	National Oceanic and Atmospheric Administration
NGO	Non-government organization
OVP	Office of the Vice President
OPM	Office of the Prime Minister
PENHA	Pastoral and Environmental Network in the Horn of Africa
PREPARED	Planning for Resilience Through Policy, Adaptation, Research and Economic Development
RCMRD	Regional Centre for Mapping of Resources for Development
SACCO	Savings and Credit Cooperative Organization

SMS	Short Message Service
UBOS	Uganda Bureau of Statistics
UNFCCC	United Nations Framework Convention on Climate Change
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Emergency Fund
UNMA	Uganda National Meteorological Agency
UNNFE	Uganda National Farmers Federation
USAID	United States Agency for International Development
UNISDR	United Nations International Strategy for Disaster Reduction
UWA	Uganda Wildlife Authority
VIA	Vulnerability Impact Assessment
VLSAs	Village savings and loan associations

EXECUTIVE SUMMARY

SERVIR E&SA has prioritized user engagements in the design and development of services in four service areas that include Land Cover Land use and Ecosystems, Agriculture and Food Security, Weather and Climate, and Water and Hydro-climatic Disasters to ensure that they address the needs of the stakeholders and users. In order to achieve this, SERVIR E&SA builds on the institutional partnerships and networks in Eastern and Southern Africa together with the network and partnerships associated with USAID country missions in the region.

SERVIR E&SA conducted needs assessments in Uganda to identify and understand existing and emerging needs in the use of Earth Observation and geospatial technologies in informing decision making in the four thematic areas. Key governmental, non-governmental agencies, private agencies, and research institutions were involved in these assessments. The assessments took the form of stakeholder presentations to understand the roles, achievements, challenges and existing initiatives that use or are potential users of geospatial technologies and also to understand decision-making contexts in addressing environmental management issues and how geo-information is used to inform decision-making processes.

Additionally, SERVIR-E&SA led the participants through a group exercise to identify at development problems related to climate change in each of the four service areas while also understanding the factors, both climatic and non-climatic, that contribute to these problems. This exercise identified various areas that could be improved relating to data and tools, data sharing and access, outreach, feedback and capacity development.

The participants highlighted deforestation and land degradation, wetlands destruction, loss of livelihoods due to climate change in wildlife corridors, flood and water quality monitoring, low crop productivity and poor rangeland management as serious development problems in the country.

Some of the areas highlighted for improvement include development of a tool to aid in classification of Land Use Land Cover (LULC) mapping to enable faster LULC maps production, capacity building on advanced image processing and improvement of biodiversity hotspots maps, development of an operational online data sharing platform, technical support for climate knowledge management system (CKMS) which is currently in development, specifically, in its establishment and operationalization, in stakeholder mapping and supporting the development of a climate atlas. Improvement of climate data archives, weather forecasting models and the training of technical analysts to process and analyze climate data to generate

useful information for policy formulation are other areas that would improve climate services in the Uganda. In its commitment to report emissions to the UNFCCC, the Climate Change Department further requires assistance to build its capacity in the estimation of carbon and methane emissions. The department further requires assistance to develop and regularly update their climate vulnerability products.

Flooding and water quality of major lakes were also identified as serious developmental challenges in Uganda. Tools and products to monitor water quality and predict, monitor and map floods were highlighted as equally important and urgent priorities. It was noted that availability of such tools and products and the capacity on the use of hydrologic models for flood prediction and flood mapping is limited. Other areas that require support are in the development of maps on agricultural productivity, soil assessments, and invasive species.

There is an urgent need to address the challenges policymakers face in interpreting information coming from technical analysts as this impedes the use of information coming from EO and geospatial technologies to inform decisions and policy making. SERVIR E&SA is strategically placed to address this challenge leveraging from experiences within the diverse teams of experts within the project and its experiences working with partners dealing with policy making.

I BACKGROUND INFORMATION

SERVIR is a joint initiative of United States Agency for International Development (USAID) and National Aeronautics and Space Administration (NASA) to help developing countries improve environmental management and resilience to climate change by strengthening the capacity of governments and other key stakeholders to integrate Earth Observation information and geospatial technologies into development decision-making. SERVIR operates in a global network of hubs in Africa, Asia, and South America. The Regional Centre for Mapping of Resources for Development (RCMRD) hosts SERVIR Eastern & Southern Africa (E&SA) programme.

The all-encompassing goal of the SERVIR-E&SA is to improve environmental management and resilience to climate change by strengthening the capacity of governments and other key stakeholders to integrate Earth observation information and geospatial technologies into development decision-making. Basing development decisions on better information in Eastern & Southern Africa help to achieve more resilient outcomes in the following thematic areas which are key to the region; agriculture, coastal zone management, disaster risk management, water resources, and land use.

The specific objectives of SERVIR-E&SA are to: improve the institutional capacity of RCMRD and plan for sustainability of SERVIR Eastern and Southern Africa, Improve Capacity to use Information, improve Awareness of and Access to Information, and to increase Provision of User-Tailored Data and Tools for Decision-Making.

To achieve these objectives and to ensure that user needs in the Eastern and Southern Africa region are addressed, SERVIR-E&SA organized two-day user needs assessment/stakeholder consultation workshop in Uganda, from May 23 to 24, 2016 where governmental, non-governmental, academic, and private sector institutions participated. The total number of participants were 18 from 15 institutions within Uganda. (See Figure 1 group photo and Annex B for participant list).

1.1 Objectives of the workshop.

The main objective of the needs assessment workshop was to engage with stakeholders from various institutions, understand the projects they are implementing and map out climate-related development problems, the needs and gaps inform of geospatial data availability and acquisition, data sharing challenges, geospatial tools used and capacity building needs.



Figure 1: Workshop participants in Kampala, Uganda

1.2 Methodology

A participatory approach was used in the workshop involving the formation of groups. The groups were formed based on SERVIR’s four thematic service areas (i) Land Use, Land Cover Change & Ecosystems (LULC&E), (ii) Weather and Climate, (iii) Agriculture and Food Security, (iv) Water Resources and Hydro-climatic Disasters.

The workshop was organized into two stages; stage one (day one) comprised of stakeholder presentations where the stakeholders focused on showcasing their institutions’ mandate/activities and achievements to create institutional activity awareness.

In stage two (day two), in-depth development problem identification, scoping and analysis was done. This was through group discussions using a guiding questionnaire (see Annex E). The discussions concentrated on the following: (1) Identification of development problem, various institutions either directly or indirectly involved in a particular development problem, (2) Identification of factors (climatic and non-climatic) influencing the development problem, (3) decision-making related to the development problem identified, (4) identification of existing efforts towards various development problems, and (5) identification of potential opportunities which included user engagement, data sharing, access and management, capacity development, outreach, uptake and feedback.

2 INTRODUCTORY AND STAKEHOLDERS' PRESENTATIONS.

The opening remarks were made by representatives from RCMRD, USAID Kenya & East Africa Region and USAID-Washington, after which an introduction and synopsis of SERVIR-E&SA project was presented by RCMRD.

The participants were then grouped into two groups and made presentations on their key activities, the achievements, and challenges they experience in the implementation of their activities and decisions they undertake related to their mandates. *The presentations are summarized below.*

2.1 Land Use Land Cover and Ecosystems (LULC&E).

The Land Use Land Cover and Ecosystems ((LULC&E) service area had two stakeholder institutions, National Forestry Authority (NFA) and African Wildlife Foundation (AWF). The main roles for NFA include central forest reserve management and water catchment management while those of AWF are the establishment of conservancies, gazette biodiversity-rich areas, and land use planning. AWF implements the USAID Uganda Biodiversity Programme and is working closely with NFA and Uganda Wildlife.

2.2 Weather and Climate

The Uganda National Meteorological Agency (UNMA) and the Department of Climate Change (CCD) at the Ministry of Water and Environment represented the weather and climate service area. The activities of UNMA includes monitoring of weather and climate through the collection, archiving, analysis, and dissemination of weather and climate-related information such as forecasts and advisories to various sectors and user groups , research and training, develop policies, an archive of historical weather and climate data, available from their online databases . CCD is mandated with the role of coordinating Uganda implementation of the UNFCCC and the Kyoto Protocol, coordination of climate change actions and strengthening conservation and protection against degradation of wetlands, water catchment areas and water bodies.

2.3 Water Resources and Hydro-climatic disasters

Four institutions represented the water resources and hydro-climatic disasters thematic area namely: Directorate of Water Resources Management (DWRM), Lake Victoria Fisheries Organization (LVFO), National Fisheries Resource Research Institute (NaFIRRI) and Makerere University. The activities of DWRM are monitoring of water quality, surface water, ground water by use of telemetric stations, automatic and manual stations, assessment of water resources in terms of water availability or flooding-comes up with a water resources assessment report, and early warning systems in

different basins (e.g. Lake Kyoga basin) for flooding (use telemetric stations). LVFO is charged with the mandate of undertaking fisheries census, collecting water quality parameters, and harmonizing national and regional policies. NaFIRRI has the mandate of monitoring impacts of water quality on fish, aquatic weed mapping, and addressing climate change impacts on the fisheries. Lastly, Makerere University which is charged with monitoring water quality using satellite imagery and development of wetlands atlas in collaboration with wetlands department (linking the info with food security issues).

2.4 Agriculture and Food security

Four organizations participated in this session, namely: ESIPPS (Environmental Surveys, Information planning and policy systems), NARL (National Agricultural Research Laboratories), UNNFE (Uganda National Farmers Federation) and Vital Signs /AFRII (African Innovations institute). ESIPPS activities include rangeland and agricultural monitoring through the SERVIR grants funded project (hay making in climate-stressed rangelands), integrated water resources mapping and rangeland health assessment for the Karamoja region, Glam data (information on crop conditions), crop monitoring (STARS) project with a focus on Sorghum, and data dissemination through online platforms.

NARL is mandated to develop updated soil maps, provision of information on crop suitability in the face of climate change, promoting climate-smart agriculture, and implementation of Sustainable land management practice/project. UNFE creates network for farmers, collaborate with government (NARL, Ministry of Agriculture (MAIF) and Agri-Pro-Focus), development of agri-insurance products, advisory services- agricultural inputs, suitable crops from NARL, sustainable land management practices, provide input in agricultural extension policy development in the country, capacity building to farmers, data dissemination and provision of market information. Vital Signs/AFRII collects data on agriculture, ecosystems and human wellbeing, conduct agricultural sustainability and land degradation assessment.

2.5 Institutional challenges

The major challenges faced by the institutions aforementioned include access to geospatial data, gaps in existing data, inadequate skills in advanced spatial analysis and modelling, and low capacity hardware.

3 CLIMATE-RELATED DEVELOPMENT PROBLEMS

On day 2, the participants were grouped into the four SERVIR-E&SA service areas. (See Annex C for more detailed SERVIR-E&SA service areas and figure 2 for breakout session group on Agriculture and food security service area). Development problems related to climate were discussed in the groups using a guiding questionnaire (see Annex D) and details highlighted below.



Figure 2: Agriculture and Food Security Break Out Session.

3.1 Land Use Land Cover and Ecosystems.

The LULC and Ecosystems discussion group identified two development problems namely forest degradation and deforestation and destruction of wetlands.

3.1.1 Deforestation and forest degradation.

It was noted that in the recent past, the country experienced extensive deforestation (forest cover reduced by almost 30% between 2005 and 2010). Currently the existing forests are experiencing degradation. These problems are attributed to changes in land use, e.g. changes from forests to agricultural land and also from agriculture to residential caused partly by the increasing population.

Factors contributing to the problem, geospatial data and stakeholders

The climatic factors affecting the problem were found to be rainfall and temperature variability, while the Non-climatic factors were as follows: (1) Population increase and urbanization which has led to encroachment of forests, (2) Poor farming methods leading to degradation of productive lands, (3) Requirement of more agricultural land leading to clearing of forests and change of land use from forests to agriculture, and (4) Demand for biomass energy leading to cutting down of trees.

The geospatial data that were identified as important in addressing the problem are cloud free medium and high resolution satellite images, NDVI for analysis of historical trends, weather station data (rainfall and temperature) and forecast/prediction models for LULC and change analysis.

The stakeholders involved in this development problem are Ministry of Water and Environment, NFA, NEMA, wetlands department, Forestry Sector Support Department), National Forestry Research Institute, District local governments and local communities.

Decision-making Context

Key decisions relating to this problem are on implementation of regulative policies for forest conservation, investments resource allocation decisions so as to inform budget allocation, national development planning and infrastructure planning. It was also noted that Uganda already has a land use policy in place. The major information requirement for these decisions are LULC maps. To make improvements to this decision making process, NFA preferred to have new maps every two years which is currently not available.

User Capacities and Needs

The users of the information are Environment and Natural Resources Committee, infrastructure development users (railways, electricity transmission, roads, etc.), NGOs, academic institutions, tree farmers (private forest owners), parliament, Uganda Bureau of Statistics (UBOS) (using the information to aid in their development of statistical abstract), AWF and local communities. There are no restrictions in accessing the LULC data from NFA and various institutions get the data for their work.

Existing Efforts

Various efforts exist in Uganda concerning this development problem. NFA indicated that they are already working with the Wetlands Department in the Ministry of Water and Environment on the development of land cover maps for Uganda. The Environment Information Network coordinated by NEMA is also working on various GIS related tasks. Other sectors interested or already working in the same area are Disaster Centre and Ministry of Oil and Energy. It was noted that Uganda has an active chapter in Society for Conservation GIS with several NGOs as members.

There also exists initiatives in Uganda that are dealing with the deforestation problem and they include afforestation, promoting use of good practices on sustainable energy use such as energy saving jikos initiative by GIZ and Ministry of Energy, development of Biomass Energy Strategy in 2013, development of landscape land use plans by NFA, IUCN, Forest Landscape Restoration, Green Economy and local

governments, forest biomass monitoring, establishment of national reference emission levels and development of a National Forest Information System.

Opportunities to improve

Several areas of improvement to help solve the problem were identified as:

- Regularly conducting workshops where partners and other stakeholders dealing with deforestation and forest degradation problem will help in creation of awareness of other efforts, This will help to avoid duplication as well as create awareness of information available for use.
- The development of an online data repository for public domain data and a data catalogue for other data to enhance data sharing and accessibility efforts.
- Reduction of the time spent on the production of the land cover maps to ensure more timely release of the maps to the users.
- Development of land cover classification and validation models to improve the accuracy of the maps.
- Improvement in geospatial data management.
- Skills enhancement in advanced image data processing, e.g. creating a mosaic using cloudless images of different days to get a clear image of a bigger area, processing, and further analysis using the recently released sentinel 2 data.

3.1.2 Wetlands Destruction

The second development problem in this service area was identified as wetlands destruction. It was noted that wetlands in Uganda are being encroached upon mainly by the public and developers who seek more productive agricultural land and space for residential use. This pressure is increasing with increasing urban population and the increasing demand for agricultural products.

Factors contributing to the problem, geospatial data and stakeholders

The climatic factors contributing to this problem are rainfall and temperature variability, while non-climatic factors are farming especially of paddy rice since it needs clearing of vegetation, use of chemicals on the paddies further destroys the living organisms in the wetlands thereby tampering with the ecosystems of the area and poor urban planning.

The geospatial data identified to address the problem are cloud free medium and high-resolution satellite images, historical data – NDVI, rainfall station data, and forecast/prediction models for LULC change analysis.

The stakeholders involved or affected by development problem are NFA, AWF, Ministry of Water and Environment (NFA, NEMA, wetlands department, Forestry Sector Support Department), National Forestry Research Institute, district local governments, Uganda Wildlife Authority (UWA), NGOs (Wildlife Conservation Society, World Wildlife Fund, etc.), and local communities.

Decision-making context

Key decisions related to this problem included determination of buffer zones for the wetlands, identification of suitable and environmentally compatible uses of the wetlands and development of a National Development Plan.

The information used to make these decisions are mainly the wetlands biodiversity hotspots maps that show the size, type, water quality and animal and plant species of a wetland. Social economic activities around the wetland are also used to inform decision making as well as livelihood data of the population around the wetland. Satellite images used in creating the wetlands biodiversity maps are available for download from online sources and are also provided by NFA. The wetlands department in the Ministry of Water and Environment also collects data from the wetlands.

User capacities and needs

The users of this information were identified as Uganda Wildlife Authority (UWA), NEMA, Academic institutions, Infrastructure development users (railways, electricity transmission, roads, etc.), NGOs and local communities.

Currently, efforts to improve wetlands management by demarcating them is ongoing. The wetlands management unit in the Ministry of Water and Environment was elevated to a department headed by a commissioner to give it more mandate.

Opportunities for improvement

The group identified several areas that could be improved to help solve the problem, namely:

- Convening workshops where partners and other stakeholders that dealing with the same problem to create awareness and avoid duplication.

- Creation of user groups or communities of best practices to champions for wetlands conservation and management.
- Development of an online geospatial data repository to enhance archiving and access
- Regular updating of the wetlands Atlas to ensure the information on the ground is well reflected.
- Capacity building in advanced image processing to improve the production of maps.
- Improvement of dissemination structures to create awareness and improve sharing of available information.

3.2 Weather and Climate

3.2.1 Loss of livelihoods as a result of changing weather and climatic conditions within the cattle corridor of Uganda

The cattle corridor of Uganda experiences persistent droughts leading to losses of livelihoods. These losses are attributed largely to climate change and variability in the cattle corridor region (a region that extends beyond Uganda). Increasing precipitation variability and increasing trends in temperatures are the most evident climate factors. They interact with population increase (people and livestock), land use and land cover changes, ecosystem degradation, land tenure systems, policies (low enforcement and compliance), land use planning (land governance), high illiteracy and poverty (among the pastoral communities), high migration of pastoralists, water and pasture availability and access driving migrations (decreasing rangelands productivity), and inaccurate weather forecasts.

To address this problem, various geospatial data were identified as prime. They are meteorological data (temperature, rainfall, and humidity), vegetation health (availability of forage), hydrological data (ground water availability), land use land cover data, land tenure maps and population (people and livestock).

Weather and climate datasets acquired from ground weather stations maintained by the Uganda National Meteorological Authority (UNMA) are supplemented by satellite estimates. Additionally, data from station-satellite blending initiatives such as CHIRPS is available at UNMA. However, it was noted that gaps exist in the data archived at UNMA. Other datasets such as land cover land use data are available from other institutions such as RCMRD. It was also noted that the Uganda Bureau of Statistics provides data and information on people and livelihoods.

Various stakeholders identified to be involved in addressing this problem included government agencies such as the Ministry of Water and Environment, Climate change department, local governments, research institutions and NGOs.

Decision-making Context

The data and information derived from these agencies are required for decision making in early warning, climate warning (forecasting), land use planning, livelihood diversification, and governance (inter-agency coordination). The type of information required for decision making includes weather and climate risk information, biophysical information, cropping systems, the location of grazing lands, land/range productivity, and location of invasive species e.g. lantana camara.

User Capacities and Needs

The users of the information above included: local farmers, cooperatives, extension workers, pastoralists, humanitarian agencies, district local government, and national decision makers (e.g., the Parliamentary Forum on Climate Change). Even though the above users have access to some of these data and information, they experience challenges due to insufficient technical skills to process some of the data, especially satellite data and in using this information for decision making. Inadequate infrastructure (hardware and software) is equally a big challenge for many of these users.

Other challenges include:

- Inadequate skills in medium range forecast for agro-meteorological purposes.
- Databases management systems – well-structured databases are non-existent leading to cascading problems with use of data and information generation from data
- Information packaging and dissemination to users
- Operating GIS software is fairly good but challenges exist in working with the data e.g. at the climate change department.
- Skills in carbon estimation from land cover maps are inadequate. For instance, the climate change department would want to know how changes in land cover are affecting carbon sequestration and the implication of this on different sectors.
- No skills in the estimation of methane emissions (from wetlands, livestock density and distribution and farming/agriculture).

Existing Efforts

There are various efforts that are ongoing and are related to the problem identified above. They include the development of a climate knowledge management system (information network) through an initiative co-led by Makerere University. A national climate atlas is also being developed with the coordination of

the climate change department. The atlas will be accessible online and is part of the inputs to the climate knowledge management system.

Other programs include:

- USAID Feed the Future program
- USAID is working with GIZ to support UNMA on the establishment of more weather data- stations
- Land Cover mapping by RCMRD
- Climate change Vulnerability assessments supported by USAID through the PREPARED project
- Earth Networks is establishing a network of ground weather stations to aid mobile based weather advisory to various users and user groups
- UNDP is supporting early warning systems
- Vulnerability mapping is ongoing - nationally needed maps/information for near-term and long-term adaptation investments

Opportunities to improve

Participants identified the following areas for improvement; packaging (communication and interpretation) and dissemination of information, improvement in data collection and analysis, improvement of database management systems, mapping end users and service providers (stakeholder mapping), and integrated dissemination networks e.g. climate information knowledge network.

From these discussions, it was noted that in the development of the climate knowledge management system and the national climate atlas, CCD and partners lack sufficient skills and technologies to facilitate or enhance their activities. These skills range from methods of data collection and analysis and the integration of various datasets to develop policy relevant and scientifically credible products. Additionally, it was noted that there is a need to develop long-term adaptation investment decision support tools such as the development of future climate vulnerability products and tools, all of which would feed the knowledge management system and the climate atlas.

3.3 Water Resources and Hydroclimatic disasters

In-depth roundtable discussions were held on the second day involving participants from Directorate of Water Resources Management (DWRM), Lake Victoria Fisheries Organization (LVFO), National Fisheries Resource Research Institute (NaFIRRI) and Makerere University. Two major development problems, flood and water quality monitoring, were identified and discussed by the participants.

3.3.1 Flood monitoring

Flooding is a major problem in Eastern Uganda (L. Kyoga basin) and the Kasese area (Nyamwamba basin). These basins are affected by floods every rainy season and due to the catchments being very small, especially the Kyoga basin sub-catchments like Manafwa, travel time from up-stream to down-stream is reduced hence flood waters have a great impact on the people living downstream.

The climatic factors contributing to this problem are longer rainfall periods, erratic and highly variable precipitation (causing a decline in vegetation), increase in temperature especially in the Nyamwamba area (Ruwenzori Mountain's ice melting). The non-climatic factors include land use issues leading to land degradation i.e. deforestation, poor farming methods, population increase, land fragmentation and settling in floodplains/wetlands thus blocking the waterways.

To address the problem, geospatial data which has been used includes water levels and quantities from water gauging stations, temperature and rainfall data, population data, and land cover data. These datasets are provided by different government institutions like the Uganda National Meteorological Authority and the Uganda Bureau of Statistics.

Different institutions are involved and affected by issues related to flood monitoring. They include the Ministry of Water and Environment, Office of the Vice President, Uganda Red Cross, academic institutions, GIZ, IGAD, and UNICEF.

Decision-making context

Key decisions related to flood monitoring are Preparation of evacuation strategies, early warning, and forecasting, resettlement of the affected people, planning for relief services, mitigation measures within the flood affected areas and medical supplies for water-borne diseases. In order for the above decisions to be made by the relevant institutions, information required include areas affected, the number of the people affected, financial support availability, magnitude of the floods, water levels, water quantity and rainfall intensity. This information is provided by various government institutions, water levels/quantities by Ministry of Water and Environment, rainfall intensities by Uganda National Meteorological agency and population statistics by Uganda Bureau of statistics and Office of the Prime Minister.

User capacities and needs

The information on flood monitoring is required by different users such as Directorate of Water Resources Management, Office of the Prime Minister, Ministry of Agriculture, Ministry of Health, local government (district offices under the different agencies) and Ministry of Works (Uganda National Roads Authority).

The users mentioned above have no access to raw data on water levels and quantities. While information generated by the mandated institutions is shared to users, raw data sharing is only possible within an institution.

Institutions mandated to process data and develop products on flooding and other water resources issues have limited skills in the transformation of data to information for use by other agencies while hardware, and software is also limited. Users of this information have the capacity to understand and use the information for decision making.

Existing efforts

A number of activities are on-going in response to flooding issues. They include USAID project (managed by GIZ) implementing capacity building in modelling for flood monitoring and UNDP building capacity by strengthening scientific information for early warning through a 5-year initiative, the objective of which is to establish surface water monitoring stations in Lake Kyoga and Upper Nile basin. Also IGAD-HYCOS capacity building for flood monitoring and early warning involving installation of weather stations and monitoring surface water levels for trans-boundary Rivers.

Opportunities to improve

A number of opportunities to improve how the institutions respond to the problem of flood monitoring were identified and these include: implementation of water information system to help in decentralizing access to some of the data for the water sector, capacity building on EO data availability and access and use, capacity building in methodologies for developing flood maps, and developing web-based platforms for dissemination of data and information to users. Current modes of dissemination include sector reports, emails, and hard disk drives.

3.3.2 Water quality monitoring

Surface water problems in urban areas and contaminated shallow waters are major challenges. Kampala water comes from L. Victoria and some industries effluent goes into the channels delivering the water. The proliferation of aquatic weeds is prominent in Lake Kyoga and Lake Albert.

Climatic factors contributing to water quality issues are increased temperatures leading to a proliferation of aquatic weeds and seasonal rainfall variations causing, receding water levels in the lake as a result of prolonged low amounts of rainfall. Non-climatic factors include sedimentation from the inflow channels, poor agricultural practices, deforestation in the upstream catchment areas like Kalangala, industrial activities within the contributing areas, and waste disposal.

To address the problem, geospatial data being used includes physical and chemical water quality parameters, satellite information (Landsat and MODIS) and in-situ water quality parameters in the different lakes. These datasets are provided by government institutions like the National Environmental Management Authority (Uganda), LVFO and research institutions like NaFIRRI.

Institutions involved and affected by this problem of water quality include the National Environmental Management Authority (Uganda), LVFO, NaFIRRI, National Water and Sewerage Corporation and Ministry of Health.

Decision-making context

Key decisions related to water quality monitoring include waste discharge permits, management of the sources of pollution and intervention strategies, (different agencies involved), strengthening and implementation of the water quality policy. In order for the above decisions to be made by the relevant institutions, information required includes pollution extent/quantity, sources of the pollution, lake levels, river discharges and rainfall intensity data. The information is majorly provided by MWE (lake/river levels) and NAFIRRI, MWE (in-situ water parameters). LVFO does the coordination of the activities in the region.

User capacities and needs

The information on water quality monitoring is required by different users for decision making. The users are MWE, National Water and Sewerage Corporation, NEMA, fisheries corporations and private industries. However, the users mentioned above have no access to raw data on water levels and pollution. While information generated by the mandated institutions is shared to users, raw data sharing is only possible within an institution.

The Institutions mandated to develop/process data on water quality analysis like Ministry of Water and Environment (MWE) have limited geospatial skills for processing and analysis of satellite information. Funding to collect in situ data and carry out analysis is also a challenge. Skills for processing EO data for water quality parameters are limited. Other agencies have the capacity to understand the information coming from these agencies for decision making.

Existing efforts

A number of activities are on-going in response to water quality monitoring, namely:

- *GIZ* – mobile lab for emergencies.
- *LVEMP* is putting up an intervention for monitoring of water quality in Lake Victoria
- *GEF* – cleaner production technologies for curbing pollution.

- *Makerere University* – research on using EO data to monitor water quality, training of the various stakeholders on the use of EO for water quality monitoring.
- *Uganda Environmental Journalism Association* – publicizing about pollution issues within Uganda.
- *MWE* – development of a water information system.
- *MWE and UNMA* - in the process of developing a platform to help in data sharing.

Opportunities to improve

A number of opportunities to improve how the institutions respond to water quality issues were identified and they include joint planning and coordination of the different initiatives by utilizing and strengthening what is already available, capacity building on EO data availability, access and use, capacity building in methodologies for water quality parameters especially from EO data, and identification of the available tools which can be applied in water quality monitoring.

3.4 Agriculture and Food security

Round-table discussions with ESIPPS (Environmental Surveys, Information planning and policy systems), NARL (National Agricultural Research Laboratories), UNNFE (Uganda National Farmers Federation) and Vital Signs /AFRII (African Innovations institute) lead to the identification of two development problems namely low crop productivity and poor rangeland management.

3.4.1 Low crop productivity

The eminent decline on soil fertility, changes in nutrient levels due to land management practices and cropping systems, lack of information on appropriate fertilizer application based on soil nutrient assessment, an increase in crop diseases and aflatoxins have led to low crop productivity in the country. Lack of a comprehensive land use planning program and lack of sufficient information on suitable crops for different agro-climatic zones is contributing to the low crop productivity being experienced in the country. Lack of a robust extension service to provide complete, timely and relevant information to farmers, flooding in dry areas due to intense rainfall events upstream were also identified as contributing factors.

Climatic Factors contributing to the problem

Unpredictable rainfall patterns, late onset of rainfall during the growing periods, increased intensity of rainfall events leading to destruction through floods, prolonged droughts, shorter first season followed by an intensification of rainfall in the second season especially around the lake region were listed as some of the climatic factors contributing to the problem.

The non-climatic factors identified include increase in disease outbreaks due to climate change, insufficient appropriate policies to support agricultural related activities, farm inputs such as seeds are expensive and sometimes of questionable quality (fake seeds), poor water management infrastructure, insufficient of access to water for subsistence farmers since dams are drying due to climate change. Service provision from the extension services was termed as poor and uncoordinated. The government has also stopped providing livestock advisory through the extension services. Existing actors such as farmers federations, NGO's and other advisory groups focus more on providing information on inputs rather than advisory services.

The geospatial data required or used to address the problem were identified as crop suitability maps, agricultural suitability maps that are guided or incorporate land use planning information and farming system maps, land use and land use planning maps, comprehensive soil maps (currently being developed by NARL), soil fertility maps to help advice farmers on appropriate fertilizer usage and high-resolution imagery such as Sentinel 2 to inform crop assessments.

Institutions involved or affected by this problem are National Agricultural Research Laboratories (NARL), Ministry of Agriculture, Animal Industries and Fisheries (MAIIF) offering extension services, Local Government, Ministry of Water - Directorate of Water Development (DWD), Uganda Bureau of Statistics (UBOS), UNMA and Office of the Vice President (OVP)-Disasters Management Unit. Private sector and NGO's which provide agricultural support services include UNNFE, FEWSNET, Feed the Future, ESIPPS, FAO, FIT Uganda, Farm Gain, East African Grain Council (EAGC) and Grameen Foundation. Financial institutions such as insurance companies, SACCOS and VLSAs (Village Savings and Loan Associations) also provide essential services to farmers and farmer groups. Other stakeholders include universities and research institution such as Makerere University which has been working closely with MAIIF and NARL. Farmers, traders, and community-based institutions are also central to agricultural productivity decisions.

Decision-making context

Key decisions made concerning crop productivity include policies to guide agricultural extension and policies (MAIIF and Directorate of agriculture extension), planning for value addition for agricultural processing industries (such as milk dairies, flour millers), inputs decisions e.g. quality of inputs such as seeds, fertilizers. Disaster management decisions through seasonal crop monitoring, forecasts and provision of mitigation strategies in the event of drought are also made. Others are development of climate change related policies and strategies (NARL, MAIIF, and UNMA), NARL is involved in research and development of drought resistant or early maturing crops suitable for different agro-climatic zones, advisory services provision (inputs, climate information, crop cultivar selection and climate information) by MAIIF and

UNMA, provision of market information from the private sector players such as local traders, FEWSNET, East African Grain council, FIT Uganda and Farm Gain (disseminate SMS-based market information) and financial service provision by SACCOS and VSLA.

The information required by the stakeholders include climate/weather information, yield information, market information, soil information, seasonal crop forecasts, input selection and land management advisory, insurance information, disaster management information and financial information. This information is required by government ministries such as: UNMA, NARL, MAAIF, OVP/Disasters Unit; private organizations (East Africa Grain Council, FIT Uganda, Farm Gain, Grameen Foundation); FEWSNET; crop insurance providers/organizations; financial institutions (SACCOS, VLSAs); district production officers and local government officers and farmers.

Farmers have access to some market information from EAGC, Farm Gain, Fit Uganda, Grameen Foundation, crop suitability information from NARL and they have access to some advisory services from MAIF but it is not sufficient. Community-based organization have access to some advisory services which they disseminate to their users such as farmers. District production officers and local government have access to some climate information through Bulletins from UNMA. Farmers groups have access to financial services from SACCOS, VSLA, and cooperatives.

User capacities and needs

Institutions mandated to develop or process data on agricultural productivity lack sufficient hardware, software, and skills to successfully do their work i.e. NARL lack sufficient capacity to develop the crop suitability maps. MAIF needs the capacity to develop sufficient and comprehensive tools and information to support the extension services. Government institutions lack sufficient capacity to provide local level interpretation of products and disseminate them to their users.

Existing efforts

A number of activities are on-going in response to this problem. They include Grameen foundation disseminating market information through Short Message Service (SMS), disaster management and crop monitoring efforts from the OVP, development of policies and strategies related to climate change by NARL, MAIF and UNMA, development of drought-resistant and early maturing crops by NARL, dissemination of climate information through district production officers by UNMA and extension service advisory to farmers through MAIF.

Opportunities to improve

Below are some of the opportunities identified to improve how the stakeholders are responding to the problem of low crop productivity:-

Data sharing, access, and management: development of tools that are simple for non-GIS users, e.g. visualization apps and tools that help the user to assimilate products and information. Provision of satellite imagery to institutions such as MAIIF to assist in crop monitoring.

Capacity building: Enhance skills of different institutions to promote better service delivery. Build the capacity of Government Ministries for better service delivery especially in the provision of advisory services.

3.4.2 Poor rangeland management.

The Uganda cattle corridor is an important rangeland to the pastoral and agro-pastoral communities. Frequent droughts during the dry season exacerbate water and pasture access problems. Changes in land ownership along the corridor where more people are owning and fencing off land has reduced the land available to pastoral communities and also posing the problem of carrying capacity with the land owners. In Semambule and Karamoja areas which are drier, the problems are more pronounced. The cattle corridor is also prone to invasive species such as Lantana Camara. The cyclical nature of drought during the dry season coupled with poor management of scarce resources means that the rangeland is stressed throughout the year.

Factors contributing to the problem.

Unpredictable rainfall patterns, late onset of rainfall during the growing periods, increased intensity of rainfall events leading to destruction through floods, prolonged droughts, shorter first season followed by an intensification of rainfall in the second season especially around the lake region were listed as some of the climatic factors contributing to the problem. The non-climatic factors identified include an increase in disease outbreaks due to climate change, overstocking and overgrazing, poor land management, failure to match breeds with the environment, limited extension advisory and land ownership where land is enclosed land marginalizing other livestock keepers hence traditional pastoralists have lesser land to use.

The geospatial data required or used to address the problem includes comprehensive feed resource maps (biomass) (International Livestock Research Organization (ILRI) was developing some maps, ESIPPS also mapped hay biomass in part of the corridor), water body maps, breed suitability maps (MAIIF was developing the maps together with maps on the location of abattoirs), rangeland extent maps, forage availability/quality/quantity maps, climate information and fire occurrence.

Stakeholders involved in rangeland management include government agencies such as National Agricultural Research Laboratories (NARL), Ministry of Agriculture, Animal Industries and Fisheries (MAIIF), Extension Services, Local Government, Ministry of Water – Directorate of Water Development (DWD), Uganda Bureau of Statistics (UBOS), Uganda National Met Agency (UNMA), Office of the Vice President (OVP) and Uganda Wildlife Authority (focused on range management). Private Sector/NGOS such as FEWSNET, ESIPPS, FAO, UNDP's Dry Lands Project, ILRI, ICPALD (IGAD Centre for Pastoral Areas and Livestock Development), PENHA (Pastoral and Environmental Network in the Horn of Africa), COPACSO (the Coalition of Pastoral Civil Society Organizations) and universities and research institutions such as Makerere University. Financial institutions, local traders, and farmers are also involved.

Decision-making context

Key decisions to be made concerning rangeland management include policies to guide livestock related decisions and advisory (MAIIF and Directorate of animal production). At the local level, local government district veterinary officers need to provide advisory services. Planning for value addition for processing industries such as meat, milk, hides, and skins businesses also involves decision making. Others decisions include livestock breeding, market accessibility, range resource management (carrying capacity, water, pasture availability), insurance and fire management.

To make these decisions information on climate/weather information, feed and feed resources (non-pasture-based), market information, breed suitability, drought assessments, pasture management, water information/water resource, index-based livestock indicators for insurance and fire information. This information is required by government ministries such as UNMA, NARL, MAAIF, OVP/Disasters Unit; private organizations such as organizations such as ICPALD (IGAD Centre for Pastoral Areas and Livestock Development), PENHA (Pastoral and Environmental Network in the Horn of Africa), COPACSO (the Coalition of Pastoral Civil Society Organizations), FIT Uganda; livestock insurance providers/organization; financial institutions, SACCOS, VLSAs; district production officers and local government officers. Livestock owners, breeders, fatteners and traders also require information to guide their decision-making processes.

Livestock farmers have access to information from PENHA, FAO, UNDP dry lands project, FIT Uganda, and other private and non-governmental organizations. Community-based organizations have access to some advisory services which they disseminate to their users including farmers. District production officers and local government have access to some climate information through bulletins from UNMA. Farmers groups have access to financial services from SACCOS, VSLA, and cooperatives.

User capacities and needs

Institutions mandated to develop or process data on rangeland management lack sufficient hardware, software and skills to successfully do their work i.e. MAIIF is no longer providing livestock advisory through their extensions service. MAIIF needs the capacity to develop sufficient and comprehensive tools and information to support re-introduction of livestock advisory through their extension services. Government institutions lack sufficient capacity to provide local level interpretation of products and disseminate them to their users.

Existing efforts

There have been different initiatives that are ongoing in response to rangeland management. They include PENHA providing support to pastoral communities by providing them with resilient goat breeds and financial services, FAO working in Karamoja on hay making and establishing water harvesting in all districts in the cattle corridor, UNDP dry lands project promoting sustainable land management and improving market access, FIT Uganda providing capacity building through agro-pastoral field schools and conducting research in pastoral regions and Makerere University conducting research on fodder production.

Opportunities to improve

There are a number of opportunities to improve how institutions respond to the problem of poor rangeland management and they include:-

- User engagement (coordination of the stakeholders for better service delivery specifically between the private sector and government ministries) and capacity building efforts targeting small livestock owners through the provision of information and resources to boost smallholder livestock production systems.
- Develop livestock and other dry land tools that focus on the cattle corridor outside Karamoja.
- Support assessment of invasive species (there was an invasive species program in NARO secretariat).

4 WAY FORWARD

The user needs assessments in Uganda has set a foundation for user participation in identifying priority needs that will form the basis for future assistance to address those needs by SERVIR E&SA. Opportunities for SERVIR's contribution in existing and future efforts to improve environmental management and resilience to climate change were identified. SERVIR E&SA assistance will take the form of strengthening the capacity of governments and other key stakeholders to integrate Earth Observation information and geospatial technologies into development decision-making. With this in mind, there are potential areas of improvement that could be addressed through ongoing activities and other initiatives that SERVIR E&SA is participating in but prioritization of the needs through a 'value-addition approach' will be required. There is need for further engagements/consultations with the relevant stakeholders in order to be able to design productive and effective services. This approach further will also address the issue of user buy-in, a result that would potentially increase the use of geospatial technologies in decision making in the country.

Finally, the results of this assessment and of further engagements and consultations will form a core component of SERVIR E&SA's future work plans.

Annex A: Workshop Agendas

Day 1: Monday 23 May		
8:30 – 9:00	Registration	Stella/Lilian/Faith
Introductions		Mubea
9:00 – 9:05	Opening Remarks by RCMRD	Robinson
9:05 – 9:10	Remarks by USAID Kenya & East Africa Region	Chihenyoy
9:10 – 9:15	Remarks by USAID Washington	Albert
9:15 – 09:20	Remarks by RCMRD – Focal Point	Ogaro
09:20 – 09:40	Introduction to SERVIR-E&SA	Robinson
09:40 – 10:10	Group Photo Session /Health break	
Stakeholders' Presentations		
Land-cover/Land-use & Ecosystems (GIT Cross-Cutting)	Mubea/Anastasi a	Water Resources & Disasters (GIT Cross-Cutting)
		Robinson/Faith
10:10 – 10:20	Environmental Surveys, Information, Planning And Policy Systems (ESIPPS)	Ministry of Water and Environment
10:20 – 10:30	National Forest Authority	Office of the Prime Minister
10:30 – 10:40	ASARECA - NRMB	Lake Victoria Fisheries Organization
10:40– 10:50	African Wildlife Foundation (AWF)	Uganda National Fisheries Resources Research Institute
10:50 – 11:00	Ministry of Lands - Land Information Management Systems	Geo-Information Services at UBOS
Agriculture and Food Security	Carlos/Lilian	Weather & Climate (GIT Cross-Cutting)
		Chihenyoy/ Denis
11:00 – 11:10	Agriculture and Environmental Sustainability Programme.	Uganda National Meteorology Authority
11:10 – 11:20	Ministry of Agriculture, Uganda	Makerere University Centre for Climate Research and Innovation (MUCCRI)
11:20 – 11:30	NARO	Ministry of Water and Environment - Climate Change Department
11:30 – 11:40	Uganda National Farmer's Federation (UNFFE)	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)
11:40 – 11:50	Uganda National Fisheries Resources Research Institute	Chemonics Inc.
12:10 – 12:30	Questions/Comments/Suggestions on theme presentations	Questions/Comments/Suggestions on theme presentations
12:30 – 14:00	Lunch	
14:00 – 15:00	Further discussions/clarifications on the presentations	Further discussions/clarifications on the presentations
15:00 – 15:15	Health Break	
15:15 – 16:55	Thematic Groups Report Back	
16:55 – 17:10	Summary of the Days Discussions	

Day 2: Tuesday 24 May		
08:45 – 09:00	Recaps/Day's Instructions	Kasera
09:00 – 11:00	Thematic breakout groups discussions:	
	I. Land-cover/Land-use & Ecosystems	Mubea/Anastasia
	II. Weather & Climate	Chihenyoy/Denis

	III. Agriculture & Food Security	Carlos/Lilian
	IV. Water & Water Related Disasters	Robinson /Faith
11:00 – 11:15	Health Break	
11:15 – 12:00	Groups Discussions (Contd.)	Kasera
12:00 – 13:00	Lunch Break	
	Group Report Back	Joseph
13:00 – 13:20	Climate & Weather	Denis
13:20 – 13:40	Water & Water Related Disasters	Faith
13:40 – 14:00	Agriculture & Food Security	Lilian
14:00 – 14:20	Land-use, Land cover, & Ecosystems	Anastasia
14:20 – 14:40	Linking geospatial tools and products to decision making	Ngugi
14:40 – 15:25	Poster Presentations	Lilian/Anastasia/ Faith/Denis
15:25 - 15:40	Health Break	
15:40 – 16:10	Plenary Discussions	Anastasia
16:10 – 16:25	NASA support to SERVIR	Ashutosh (via Skype)
16:25 – 16:35	Way Forward	Robinson
16:35 – 17:00	Remarks from Participant	One Participant
	Remarks from USAID	Albert/Chihenyo
	Closing Remarks from RCMRD	Shannon (USAID)

Annex B: List of Participants

No	Name	Organization	E-mail	Gender (M/F)
1	Dr. Julius Okwadi	Africa Innovations Institute	juliusokwadi17@gmail.com	M
2	Mr. Methodius Mukhwana	African Wildlife Foundation (AWF)	mmukhwana@awf.org	M
3	Dr. Jane Bemigisha	Environmental Surveys, Information, Planning and Policy Systems	director@esipps-int.org ; bemigisha@yahoo.co.uk	F
4	Dr. Robert Kayanda	Lake Victoria Fisheries Organization	bobkayanda@yahoo.com / rkayanda@lvfo.org	M
5	Dr. Antony Gidudu	Makerere University	agidudu@cedat.mak.ac.ug ; anthony.gidudu@gmail.com	M
6	Mr. E.W. Ogaro	Ministry of Lands - Land Information Management Systems(LMIS)	ogaro@mlhud.go.ug	M
7	Mr. Michael Mugarura	Ministry of Water and Environment - Climate Change Department	mugarura.michael@gmail.com	M
8	Jalia Namakula	NARO (National Agricultural Research Laboratories _ Kawanda)	komutungae@gmail.com , jalianamakula7@gmail.com	F
9	Mr. John Diisi	National Forest Authority	johndiisi@gmail.com	M
10	Mr. Anthony Munyaho	Uganda National Fisheries Resources Research Institute	ataabum@yahoo.com , taabu@firi.go.ug	M
11	Mr. Godfrey Mujuni	Uganda National Meteorology Authority	grmujuni@yahoo.com	M
12	Ayebare Prudence	Uganda National Farmer's Federation (UNFFE)	ayebareprudence@yahoo.com	F
13	Moses Ojara	Uganda National Meteorology Authority	ojacksmoz@gmail.com	M
14	Henry Mulinda	NARO (National Livestock Resources Research Institute)	mulindwahe@yahoo.com	M
15	Caroline Nakalyango	Ministry of Water and Environment	caroline.nakalyango@gmail.com	F
16	Ambrose Gahene	ABC Africa	gahene66@yahoo.com	M
17	Drake Nyamu	E. A. Business week	nyamudre@gmail.com	M
18	James Eukeit	East FM Radio station	ekaetusa@yahoo.com	M

Service Areas and Services



Food security

- Agricultural monitoring
- Drought management
- Crop productivity
- Rangeland decision support
- Aquaculture decision support

Weather and climate

- Weather monitoring and forecasting
- Climate modeling and scenario planning
- Air quality monitoring
- Adaptation planning

Water resources and disasters

- Water resources monitoring and forecasting
- Flood management
- Hazard monitoring and forecasting
- Fire monitoring
- Water quality monitoring

Land cover/land use and ecosystems

- Land cover/land use change mapping
- Ecosystem management
- REDD+ decision support
- Land use decision support
- Low emission development planning

Annex D: Break Out Questions

Needs assessment questions (Break-out Groups)

Identify a plenary presenter and plan approximately 20 minutes per question (120 minutes total)

1. Problem Description and Stakeholders

- a. What is the major development problem in this thematic area? (e.g., drought, flood, water availability, crop failure, pest outbreaks, land use change, etc.)
- b. What climatic factors contribute to the problem?
- c. Are there other non-climatic factors/issues that contribute to the problem? If yes, list them here.
- d. What geospatial data are required and/or are currently being used to address the problem above? And how do you acquire the data used?
- e. What stakeholders are affected and involved? (Including government, civil society, private sector)

2. Decision-making Context

- a. What are the key decisions related to this problem? (What decisions are getting affected by the problem)
- b. What information is needed to make these decisions?
- c. Is this information being provided? If so, by whom?

3. User Capacities and Needs

- a. Who is the target information user (or users) to make these decisions?
- b. Does the user have access to the necessary data or information?
- c. Does the user have the necessary hardware, software, and/or skills to use the information?

4. Existing Efforts

- a. What related activities are on-going in response to these needs?

5. Opportunities to improve

- a. What could be done to improve how you tackle the problems above in the following areas? (Consider feasibility of your options)
 - i. User engagement
 - ii. Data sharing, access and management
 - iii. Developing Products and tools
 - iv. Capacity development – skills development/enhancement
 - v. Outreach, uptake and feedback
 - vi. Coordination of on-going efforts