SERVIR-Eastern and Southern Africa

Needs Assessment Report

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List of Acronyms

CIP	Crop Intensification Program
COP	Chief of Party
DEM	Digital Elevation Model
DIWRM	Department of Integrated Water Resources Management
DRR	Disaster Risk Reduction
E&SA	Eastern and Southern Africa
EAC	East African Community
ESRI	Environmental Systems Research Institute
EO	Earth Observation
EU	European Union
GHG	Greenhouse Gas
GIS	Geographic Information Systems
GIT	Geo-Information Technology
ICPAC	IGAD Climate Prediction & Applications Centre
IFAD	International Fund for Agricultural Development
IGAD	Inter-Governmental Authority on Development
INES	Institut d'Enséignement Supérieur de
IWRM	Integrated Water Resources Management
LULC	Land Use Land Cover Change
LULCE	Land-use, Land-cover & Ecosystems
MIDIMAR	Ministry of Disaster Management and Refugee Affairs
MINAGRI	Ministry of Agriculture in Rwanda
MINIFRA	Ministry of Infrastructure
NASA	National Aeronautics and Space Administration
NISR	National Institute of Statistics Rwanda
NSDI	National Spatial Data Infrastructure
NGO	Non-government organization
OPM	Office of the Prime Minister
RAB	Rwanda Agricultural Board
RCMRD	Regional Centre for Mapping of Resources for Development

RHA	Rwanda Housing Authority
RMA	Rwanda Meteorological Authority
RNRA	Rwanda Natural Resources Authority
SPN	Smart Pump Network
UR-CGIS	University of Rwanda Centre for GIS
USAID	United States Agency for International Development
WB	World Bank

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. 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 assessment in Rwanda 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 first understand the roles, achievements, challenges and existing initiatives that use or are potential users of geospatial technologies. These assessments further sought to understand decision making contexts in addressing environmental management issues and how geo-information is used to inform decision making processes.

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. The problems included land use decision support, LULC change mapping, weather and climate information to reduce economic losses and damages, vulnerability to climate change, increasing soil erosion, low crop productivity, landslides monitoring and sediment pollution/siltation in major rivers. This exercise identified various areas that could be improved relating to data sharing and access, outreach, feedback and capacity development in order to address these problems.

Areas of improvement were identified as the development of LULC maps at a higher resolution especially for the hazards hotspots areas, capacity building on advanced LULC change analysis and other advanced GIS such as site suitability analysis. There is also need to improve tools used by Rwanda Meteorology Agency (RMA) to forecast and manage meteorological data, enhancement

of climate risk modeling and spatial analysis skills of technical experts. Landslides are increasingly becoming regular in Rwanda. The development of an operational rainfall-triggered landslide monitoring system was is an area that requires improvement. The Ministry of Agriculture and the Rwanda Agricultural Board also sought support in the development and establishment of a portal to support aggregation, cloud storage and dissemination of data. Further, capacity building on GIS and RS, development of maps for erosion risk modeling and crop suitability together with data provision such as Sentinel 2 were mentioned as priorities, particularly as they address crosscutting issues.

While most of the needs relate to generation of information from geospatial data, it was noted that across the service areas, there is an overarching priority to address the challenges policy makers face in interpreting information coming from technical analysts. This is was identified as an area that impedes the use of information coming from EO and geospatial technologies to inform decisions and policy making.

1 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) hub.

Development decisions based on better information in Eastern & Southern Africa will help to achieve more resilient outcomes in the SERVIR service areas which are key to the region. 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 Rwanda, from May 26 to 27, 2016 where governmental, non-governmental, academic, and private sector institutions participated. A total of 19 participants from 15 institutions participated in the workshop held in Kigali, Rwanda. (See figure 1 for the 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 in form of geospatial data availability and acquisition, data sharing challenges, geospatial tools used and capacity building needs.

Figure 1: Workshop participants in Kigali, Rwanda.

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 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. First stakeholder presentations where the stakeholders focused on showcasing their institutions' mandate/activities and achievements to create institutional activity awareness. Secondly, 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 of RCMRD and USAID. After which an introduction and synopsis of SERVIR-E&SA project was presented by RCMRD. The participants were then grouped into two groups (Land Use Land Cover & Ecosystems and Agriculture and Food Security and Weather & Climate and Water Resources & Disasters.) 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 as per the four service areas.

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

The Rwanda LULC stakeholder consultation consisted of the following four institutions: Rwanda Housing Authority (RHA), a government institution mandated with promotion of housing & construction sector development, promotion of urbanization & planned rural settlement, management of government buildings, asbestos removal and management, city master plans and street addressing; Rwanda Environmental Conservation Organization (RECOR), an NGO involved in education for sustainable development, water harvesting, water hygiene, sanitation, and biodiversity conservation in national parks where there are conflicts with farmers; RUHENGERI Institute of Higher Learning (INES), an academic institution offering higher learning and carrying out academic research and projects; and ESRI Rwanda, a commercial institution that provides desktop and server GIS software, develop GIS solutions, data harmonization, portal development and advisory services.

2.2 Weather and Climate

The Rwanda Meteorology Agency (RMA), Ministry of East African Community Affairs (MINEAC), and the Severe Weather Consult (SWC) represented the weather and climate group in the discussions. RMA is charged with the mandate of monitoring 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 through various channels e.g., mobile sms, online portals, emails. RMA is also involved in weather and climate research and training in the field of meteorology, development of online Climate Map Rooms blended with satellite-station meteorological datasets. The main role of SWC is to develop tools and applications for monitoring of severe weather in Rwanda in consultation with RMA. They also help with the provision of timely severe events alerts to various user groups (farmers, fishermen and tourists).

2.3 Water Resources and Hydro-climatic Disasters

Three institutions represented the water resources and hydro-climatic disasters service area. These are the Department of Integrated Water Resources Management under the Rwanda Natural Resources Authority (DIWRM-RNRA), the University of Rwanda - Centre for GIS (UR-CGIS) and Ministry of Disaster Management and Refugee Affairs (MIDIMAR). DIWRM-RNRA is charged with the responsibility of developing catchment management plans, issuing water permits, river flow and water quality monitoring, early warning systems on extreme weather events, watershed rehabilitation and water resources assessment. UR-CGIS does flood modelling, hydrological modelling for disaster risk management, soil erosion mapping, spatial development framework guide for future organization of the country, malaria vulnerability mapping, national risk atlas of Rwanda, and mapping of wetlands in Rwanda.

2.4 Agriculture and Food security

Four organizations participated in the exercise. However, only three gave presentations. Ministry of Agriculture (MINAGRI), Rwanda Agricultural Board (RAB) (Climate change & GIS), National Institute of Statistics (NISR) and Smart Pump Network (SPN). MINAGRI's main roles include policy formulation, crop area mapping and crop intensification program in relation to land suitability, fodder mapping, advisory, planning and monitoring of agriculture & livestock and crop assessments. RAB focuses on land husbandry (soil conservation), agriculture & livestock research & extension, climate change and GIS, irrigation and mechanization.

NISR's main role is producing official statistical data and coordinating all statistical activities. Other roles include developing a comprehensive food security and vulnerability analysis survey, producing seasonal Agricultural surveys, conducting population & housing censuses every ten years, conducting household living conditions surveys every three years, conducting demographic health surveys every three years, data dissemination through website and portals, and developing DevInfo that allows users to access NISR statistics and generate their own maps. SPN provides hydro powered irrigation pumps to farmers especially those who are already members of a cooperative focusing on maize or rice production.

2.5 Institutional challenges

The major challenges faced by the institutions aforementioned include data quality issues, inadequate skills needed to acquire, process and analyze geospatial data, no regular updates to the data, high cost of hardware and software, lack of data sharing policy – individual requests made and treated on a case by case basis and some data not even ready for sharing, some of the outputs not reaching the local intended users who need them, and accessing and processing high resolution imagery.

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 LULCE break out group). Development problems related to climate were discussed in the groups using a guiding questionnaire (see Annex D) and details highlighted below.

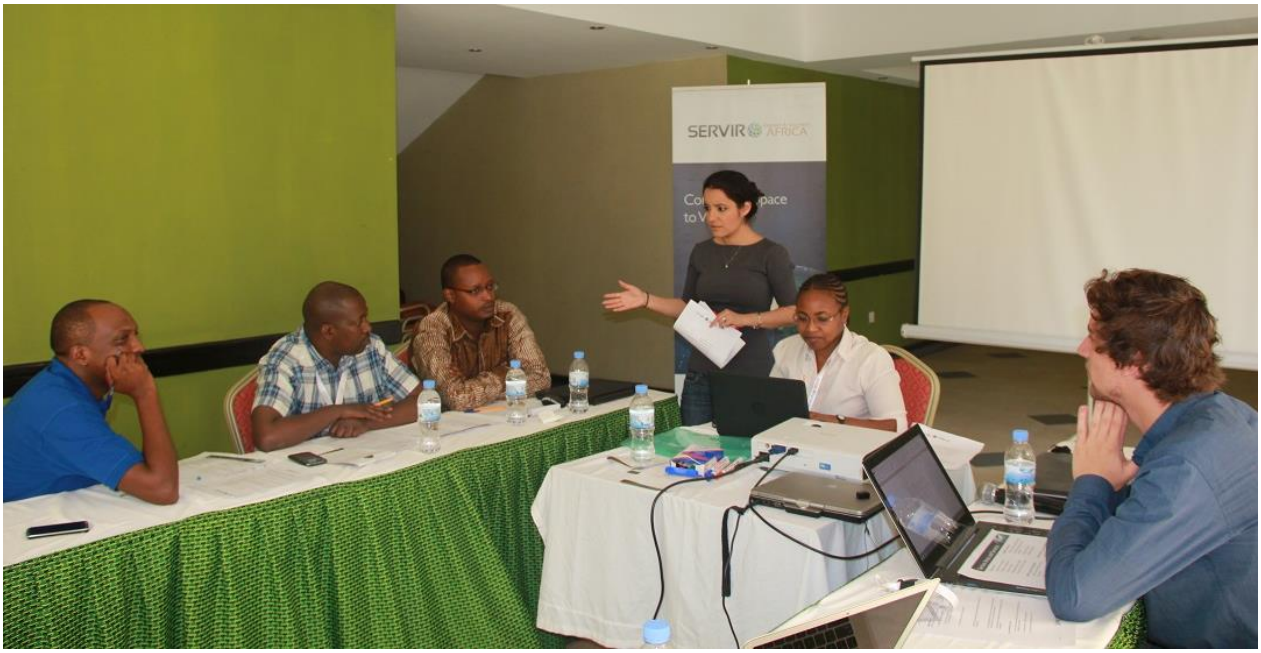

Figure 2: LULCE Break Out Session in Kigali, Rwanda.

3.1 Land Use Land Cover and Ecosystems

The LULC and Ecosystems discussion group identified two development problems namely land use decision support based problem and land cover land use change mapping.

3.1.1 Land Use Decision Support

People get affected by hazards such as landslides and floods and identifying high risk areas and the possible effects on populations in such areas including the number of households is a challenge. The identification of the risk areas is also required to enable decisions on where settlements can be located including the type of structures in order to minimize damages and also proper vegetation that can mitigate landslides.

Factors contributing to the problem

The climatic factor that contributes to the problem is rainfall while the non-climatic factors are: (1) Slope

– (above 50^0 slope should be forests and not for agricultural uses), (2) demographic pressure – dense population, (3) vegetation type in an area, and (4) type of structures already built in an area.

Various types of geospatial data are required and some currently being used to address the problem they include: (1) DEM – SRTM 30m and topography maps with contours at 10m are available at RNRA, (2) National topography maps - available at RNRA, (3) population settlement information, (4) Sentinel 2 at 10m – available for download, (4) ground observations of area characteristics – from local government, (5) land use maps and secondary cities master plans – land use maps are available at RNRA while cities master plans are available at RHA, and (6) Orthophotos (2008) - available at RNRA.

There are several stakeholders who are involved in addressing this problem. They are, Ministry of Natural Resources, RNRA, MININFRA and RHA (cities master plans and housing), MIDIMAR, Ministry of Finance, Ministry of Defense, Local governments (district one stop centres), civil society , private sector e.g. ESRI and media.

Decision making context

Among the various types of decisions that are made relating to this development problem are: (1) Relocation of people from high risk areas in order to reduce losses in case of a disaster such as landslides, (2) Whether people can people can settle in a certain area or not – this is based on risk assessment on the area, (3) Determination of suitable sites for relocation, (4) Services and infrastructure planning for settlement sites, and (5) areas for reforestation.

In order to make these decisions the involved institutions require certain types of information such as the identified high risk areas, the number of people to be relocated, the types and magnitude of risk, the socio-economic data and livelihood activities in the area and finally the existing land use plans. While the small settlements information is available with the local chiefs, and the classification data of the population with local authorities, consolidated population data is not readily available. The information with the local chiefs and other local government authorities would need to be collected, collated and put into a usable format before being used for decision making. Rwanda also has One-Stop District Centres that are used to disseminate and avail different types of information to the general public.

User capacities and needs

The main decision makers and users of the information stated in the previous section are central government (MINALOC, MINECOFIN and MININFRA), local government (cell, sector and district) authorities and local communities.

The data required to make decisions is, however, not readily available and would require processing and packaging to extract required information and to make it informative enough for decision making. There's also a challenge of skills to analyse and use the geospatial data, all the way beginning from national to cell level. The hardware and software to process the geospatial data is also not adequate.

There are already existing efforts to address this problem within the government institutions such as: development of cities and rural master plans and infrastructure planning by MININFRA, sector level equipment being provided by DFID through RNRA (provision of computers, GPS, and training on use of GPS), demarcation of wetlands and relocation of those settled in wetlands, reforestation week observed in the whole country (targeted to cover 30% of the country) and community work that includes tree planting every last Saturday of the month.

Opportunities for improvement

Various areas of improvement were identified under different categories.

User Engagement: Empowerment of local leaders to disseminate certain information to the communities as well as involving them in joint monitoring activities would improve user engagement in the decision making process. There is a Joint Action Development Forum that is held every 3 months and coordinated by the Office of the Prime Minister (OPM).

Data sharing and management: There are restrictions in data sharing within public institutions. Having public domain data available online would improve data discovery and accessibility. Development and enforcement of geospatial data standards should be maintained by all institutions to ensure compatibility within different platforms and improve re-usability. Having a leading authority for the data sharing and standardization efforts would greatly improve the situation.

Developing products and tools: The government plans to update land use plans every 5 years. If this is realized it will provide a good basis for land use monitoring. There is need to develop maps showing current land use combined with the high risk areas. This will give more information on relocation of settlements and how land use in high risk areas can be changed and improved to reduce the risks.

Capacity development: overall the skills required to address this development problem are inadequate especially on identification of high risk areas and land use monitoring, both rural and urban. Basic training on geospatial data acquisition, processing and analysis are required. Documentation of the data in order to make it useful and sharable is required.

3.1.2 LULC Change Mapping

There have been various changes in use of land especially from agricultural land to residential and other uses i.e. urban expansion into agricultural land and there's need to monitor these changes. There is also expansion of informal settlements without compliance to the established master plans.

Factors contributing to the problem

Factors contributing to this problem are: less productivity of the land – farmers closer to urban areas sell their land and it's turned to other uses, sub-division of existing land parcels, and socio –economic factors such as rural to urban migration, employment opportunities in urban areas, education levels and opportunities, strengthening of service and technology sectors by government as a policy attracting people to the cities. Several types of geospatial data that are required to address this development problem. They include Google Earth maps, Orthophotos, medium resolution satellite images (multi-temporal for change analysis) such as Landsat, sentinel 2 and Aster.

There are a number of stakeholders who are involved in the LULC change mapping and who would benefit from the results. They are Ministry of Natural Resources, RNRA, MININFRA, RHA, REMA, UN-Habitat, local governments including district one stop centers, ESRI, World Bank, Institute of Property Valuation, Association of Urban Planners and Rwanda Sustainable Development Initiative.

Decision making context

The decisions that are made relating to LULC change mapping that were identified are official change of land use for a certain area, infrastructure planning for settlement areas and food production strategies based on area available for agriculture.

To make these decisions, the decision makers need to know the areas where particular land uses can be expanded by using the land use and master plans and land cover maps. This information is available with RHA, RNRA, City of Kigali and district one-stop centres. Regular updating however required in order to keep the information current.

User capacities and needs

The main users of LULC change mapping information are infrastructure developers, central and local government institutions (MININFRA, RHA, MINAGRI, RNRA and cell, sector and district authorities) and local communities. All information that is available such as land use plans, master plans and land cover maps is accessible online. Information on informal settlements is not yet available online. There's inadequacy of hardware and software especially at the local government institutions and immediate need

to improve skills especially to use GIS to model urban expansion and other changes in land use.

Existing efforts in this area include creation of awareness on land use being done by RNRA where officials reach out to the communities and informal settlements identification and infrastructure planning and development.

Opportunities for improvement

One key area that was identified is the need to improve data sharing and dissemination efforts. Lack of proper coordination of data sharing procedures within government institutions is a challenge.

3.2 Weather and Climate

In this service area two major development problems were discussed by the participants. They include economic losses and damages related to weather and climate and vulnerability to climate change.

3.2.1 Weather and climate information to reduce economic losses and damages

Rwanda has experienced losses and damages associated with weather and climate related phenomena such as floods, droughts, high impact weather related events (strong winds, intense rainfall), and lightning; all of which have impacted negatively on people and the economy. Food production that's heavily dependent on rainfall has had the highest impacts when droughts and dry spells occur affecting subsistence agriculture. Disasters, mainly from floods and landslides have equally been responsible for damages and losses amounting to millions of USD. With an estimated 12M people (2016 UN estimates), and an expanding economy, it is expected that these losses and damages will increase in the future.

Factors contributing to the problem

High variability in precipitation and increasing temperature (both of which are manifests of climate variability) are contributing factors to these losses, often resulting into severe weather events; El-Nino, strong winds, droughts, floods, intense rainfall. These factors alone do not solely contribute to the problems identified, rather, they interact with non-climatic factors such as poor and vulnerable populations (relatively high poverty rates in the country; 40% of the population is considered to live below the poverty line while 24% lives in extreme poverty), high population, topography (hilly terrain), poor/weak infrastructure (housing), and generally a lack of awareness by service providers to give the right information e.g., low confidence in forecasts produced by the Rwanda Meteorology Agency-RMA).

To address this problem, various institutions use geospatial data and weather station data, they include precipitation, temperature, winds, and humidity to understand and monitor weather patterns in the

country, and finally lightning monitors data. Satellite data includes CHIRPS precipitation and ENACTS precipitation and temperature. These datasets span >30 years of consistently satellite-station blended data from the 1980s to present. Weather forecast models have also been used mainly for short term weather forecasts. These include the ECMWF and the WRF models.

Stakeholders involved include the ministries of agriculture, natural resources, disaster management and refugee affairs, energy and health. Non-governmental institutions include private sectors working in the insurance sector, the Red Cross Society, NISR, RCMRD and research institutions.

Decision-making Context

The stakeholder agencies and users use different information for making various decisions: in disaster management, the agencies require information such as the location/occurrence, severity and frequency of weather/climate related hazardous events such as flooding. The government through the Ministry of Finance and Planning requires disaster/hazard risk information to inform decisions on location of future development projects. This information is also required in budget making for contingency planning and generally, to allocate resources for disaster risk reduction activities e.g. climate risk (including vulnerability of key sectors). Advisory to farmers e.g. on the timing of planting, harvesting relies on weather information, all of which help in reducing losses. Additionally, information from NISR has been used in risk and vulnerability assessments in the country, including recently by the PREPARED project. This information is being used to locate vulnerable communities and to allocate resources for resilience building through adaptation investments.

User Capacities and Needs

As with many agencies, lack of adequate data, skills and technology was cited as a big challenge both in the production, dissemination and utilization of data and information from geospatial technologies. Different ministries as highlighted above require capacity to be able to fully utilize these technologies and opportunities from existing efforts that address use of climate information in decision making. Lack of awareness and low appreciation of the value of this information by high-level decision makers and even by local populations further exacerbates the problem. For instance, even with risk information available, people still put up structures in areas considered vulnerable to climatic risks.

Existing Efforts

Several initiatives addressing this problem exist. These include:

1. Climate change vulnerability assessments coordinated by the EAC. Vulnerability products have been

generated, though these focus largely on the LVBC region of Rwanda. Capacity building has also been undertaken through the project, mainly focusing on the management of climate data using the GeoCLIM software developed by FEWSNET/USGS for the PREPARED project.

2. The National Risk Atlas of Rwanda was recently published to the public. This is an ambitious project that makes available data about hazards and disaster risks in the whole country. This effort was supported by UNDP with co-funding provided by the World Bank GFDRR.
3. The UNECA supported the RMA in data rescue activities but that supported was terminated in early 2016.
4. ENACTS and CHIRPS initiatives continue to support RMA in blending their weather station datasets with satellite estimates.
5. Partnerships with the EU funded programs through the African Union (AU) such as MESA continue to support data acquisitions such as through the e-stations.

Opportunities to improve

A number of opportunities to improve response and solution to this problem are: raising the awareness of users of weather and climate information; establishment of data sharing policies is hoped to lead to data formats harmonization, reduction in overlaps, redundancies, and addressing the issue of data quality; improvement of weather forecasting tools (models) is becoming a priority at RMA and is hoped to lead to cascading effects such as better products/reliable forecasts that will improve the user acceptance of the products for decision making; improvement of data collection tools/equipment and quality control; improvement of data and information dissemination tools and products; training of data managers and users of weather and climate information (e.g. how to interpret forecast information); improvement of provider-user interaction for feedback; and enhanced integration of various complementary initiatives such as CHIRPS and ENACTS that seek to address a common problem.

3.2.2 Vulnerability to Climate Change, Climate Variability and Extremes

Coping with increased vulnerability to climate variability and change negatively impacts the economic development of Rwanda. This problem is closely related to the first problem and even though it's more closely related to adaptation planning, it borrows heavily on similar issues raised in the previous problem.

Recent research by the Rwanda Environment Management Authority (REMA) and other stakeholders estimated that effects of climate change cost the country about 1.4% of the GDP, especially in the agriculture sector. With projected growth of the national economy, these costs can only increase. For instance, a fall in crop yield is projected to disrupt supply chains and increase competition for scarce

resources thus affecting economic growth. More frequent, severe and unpredictable floods and droughts are expected to reduce agricultural productivity and increase post-harvest losses (currently estimated at 30%). Observations and projections of climate descriptors show increased variability in precipitation, increased temperatures and increases incidences and severity of weather and climate related events. These evidences of climate change in Rwanda have caused food shortages (due to droughts), floods (unpredictable precipitation- amounts, duration), water stress, and an increase in the suitability of climate sensitive diseases such as malaria.

Governance (development and enforcement of relevant policies), land degradation (e.g. siltation of wetlands, deforestation etc.) and the effects of GHGs and other anthropogenic pressures such as pollution are paying a contributing role in increasing the vulnerability of livelihood systems to climate change and variability. Population increase for instance is increasing demand of subsistence farm products thus leading to expansion of agricultural areas at the expense of forests which act as natural carbon sinks.

Factors contributing to the problem and stakeholders involved

Generally, weather and climate data in addition to population data, poverty data and GHG emissions (carbon, methane, nitrogen and sulphur) are datasets being used to address this problem. High variability in precipitation and increasing temperature (both of which are manifests of climate variability) are contributing factors, often resulting into severe weather events; El-Nino, strong winds, droughts, floods and intense rainfall. These data come from weather stations and from satellite measurements while datasets related to people and livelihoods come from socio-economic surveys carried out by the NISR. RMA has archives of weather and climate related data and maintains a network of ground weather stations in the country.

The stakeholders involved in this issue include the ministries of finance and economic planning, disaster management, agriculture, health, and energy, research institutions, local populations, private companies and NGOs.

Decision-making Context

Decision makers in government, NGOs, private sectors and in the local communities require information to identify vulnerable elements (e.g. communities, systems etc.) and carry out short, medium, and long term planning e.g. in disaster response, advisory to farmers (timing of planting, harvesting), contingency planning, development planning (location of infrastructure, reconstruction and rehabilitation, mitigation). The RMA requires data and information for weather forecasts (alerts and warnings) to key sectors on

multiple temporal scales; daily, 3-day, 10-days, and seasonal scale and climate warnings (e.g. extreme events, shifts in length of seasons etc.). The different kinds of information required to perform the above tasks are: GHG emissions and air quality, location and severity of weather and climate related hazardous events e.g. floods, droughts, occurrences and frequencies of weather and climate related hazardous events, climate risk information (including vulnerability), and information about people (demographic etc.).

Various institutions provide various information that users require to inform decision making. RMA provides weather and climate information through various media such as the Map Rooms to provide access to data while they use radio and online websites to provide weather forecast information. NISR provides data about people (e.g. from surveys such as DHS, LCS, etc.). MIDIMAR provides risk and vulnerability information (e.g. the National Risk Atlas of Rwanda) while REMA has a directorate in charge of climate change and international obligations which provides climate change national communications and strategies (e.g. NAPAs).

User Capacities and Needs

The capacity to manage, analyze and share data is insufficient. Users of information derived from such data lack sufficient skills to interpret and integrate the information in decision making processes.

Existing Efforts

ENACTS initiative led by IRI has developed climate datasets that go back to 1981 for both temperature and precipitation for the whole country. This data is now being used by a USAID funded project, the Rwanda Climate Services for Agriculture, managed by CCAFS to assist farmers cope with the impacts of climate change in agriculture. It seeks to reach close to five million farmers to have timely access to useful climate services through rural radio programming. CHIRPS is also openly accessible to researchers and analysts who require climate data (mainly precipitation) in their work flows.

Opportunities to improve

The following were mentioned as areas that require intervention: improvement on data and information dissemination tools and products and Improvement of methodologies for vulnerability assessments; and involvement of communities in the identification of vulnerabilities and setup of climate adaptation programs.

3.3 Water Resources and Hydro-climatic Disasters

In this service area two major development problems were discussed by the participants namely landslides and sediment pollution/siltation of major rivers.

3.3.1 Landslides monitoring

Landslides affect most part of Rwanda which includes the northern, western and partly on the southern provinces. Landslides occur every rainy season affecting communities living in these zones. Landslides have led to loss of lives, injuries, and left many homeless. According to the National Risk Atlas of Rwanda, little research and literature exists about landslides hazard in Rwanda and there exists significant data gaps on historical landslide events. A systematic recording of the disasters by MIDIMAR started in 2010.

Factors contributing to the problem

Climatic factors contributing to landslides are rainfall intensity, and elongated rainfall seasons. There are two rainy seasons in Rwanda and in both, landslides cases are reported. There are non-climatic factors contributing to landslides with the major ones being deforestation, topography of the area (most parts of Rwanda are mountainous), settlement of people on steep slopes, soil types, weak construction materials, and poor agricultural practices in the sloppy areas.

The geospatial data needed include soil information (soil types and depth), satellite imagery for deriving land cover types, road networks data, geology maps, topographical maps and Digital Elevation Models. These datasets are provided by different government institutions including the Rwanda Housing Authority, the Rwanda Natural Resources Authority, Department of Lands and Mapping and Department of Mining and Geology.

Different stakeholders are involved in landslide monitoring.They include the Ministry of Natural Resources and most specifically the Department of Lands and Mapping and Department of Mining and Geology, the Ministry of Disaster Management and Refugee Affairs (MIDIMAR), local government, the Ministry of Agriculture, the Ministry of Defense, the National Police, the Ministry of Finance, one United Nations agency, Rwanda Red Cross, the University of Rwanda, the Ministry of Infrastructure and the local communities living in the affected areas.

Decision-making Context

In cases of landslides occurrence, key decisions made include relocation of the affected communities, development of rural resettlement policies, development of reforestation/forest management policies and development of landslides mitigation plans. In order for these decisions to be made by the relevant

institutions, information required includes location/areas affected, landslide prone areas/areas with unstable slopes, rainfall intensity, areas for relocation, affected socio-economic (infrastructure, settlements) structures, major economic activities taking place in the affected areas among others. The information is majorly provided by MIDIMAR and the RNRA's Department of Lands and Mapping.

User Capacities and Needs

The information generated by MIDIMAR and RNRA is required by different users for decision making. The information users in case of a landslide are settlement planners (District level), institutions involved with response and relocation (Ministry of Defense, MIDIMAR), Ministry of infrastructure (to know which type of infrastructure is affected), and Ministry of Education (to know how many schools are affected).

Some of the users mentioned above have no access to raw data on landslides or on any other disaster especially if they have no technical mandate to deal with the disaster. This is due to the fact that sharing policies within Rwanda are stringent. Information generated from such data by the mandated institutions is however shared to all users. One example is the National Risk Atlas of Rwanda which was developed by MIDIMAR and department of lands and mining. The atlas is freely available to all users through hard copies and soft copies accessible from MIDIMAR's website.

Institutions mandated to develop/process data for disaster risk information like MIDIMAR and Department of Lands and Mining have limited skills in the use of geospatial data and tools which has been associated with high staff turnover and limited training opportunities for staff due to the decision makers not understanding the value of geospatial technologies. At the district level, only a few technical staff have geospatial skills. The University of Rwanda is helping in building the capacity of the district officers on the use of GIS.

Existing Efforts

A number of activities are on-going in response to landslides and in general all the disasters. Some of them are listed below: (1) National Risk Atlas of Rwanda which highlights all landslides prone areas and contains risk, hazard and vulnerability maps at national level was produced by MIDIMAR under funding by World Bank. (2) Relocation of people from landslides prone areas: - being done by RHA, MIDIMAR, local government, Ministry of Defense. (3) An early warning system (for all hydro meteorological disasters) is currently under development. (4) Disaster Risk Reduction web-portal has been established at MIDIMAR with support from RCMRD/SERVIR-E&SA. (5) Landslides management projects that are helping with establishment of mitigation strategies. This is a collaboration between MIDIMAR and University of Lucerne

in Switzerland. Contingency plans are in place for response in case of landslides occurrences. (6) Disaster management plans at district level (23 already done out of 30) are under development by MIDIMAR. (8) Disaster communication and reporting system has been put in place. This system uses servers and mobile phones for people in other sectors to send reports on locations, type of hazard, etc. (9) Each district has a District Disaster Management Officer in place to deal with preparedness, response, coordination among others. (10) MIDIMAR is participating in forums to establish a National Spatial Data Infrastructure (NSDI). (11) Mainstreaming of DRR in all other sectors like in the Ministry of Agriculture and Ministry of Infrastructure, etc.

Opportunities to improve

A number of opportunities to improve how the institutions respond to disasters were identified and they include: integration of the disasters risk reduction in all sectors, awareness creation involving local people, enforcement of existing legal master plans especially the settlement plans, data sharing policies to be made developed and implemented, improvement in data storage/archiving, improvement of the weather forecast information, need for geospatial tools/products for landslides monitoring, training on use of geospatial tools for landslides and other disasters and use of the disaster communication system within MIDIMAR for efficient outreach.

3.3.2 Sediment pollution/siltation of major rivers

Sedimentation and siltation of rivers in Rwanda is another developmental problem. Almost all rivers in Rwanda are affected but most prominent are the Nyabarongo and Nyabugogo rivers. The siltation is due to soil erosion within the upper catchments. Nyabarongo River drains into Akagera River and then Lake Victoria. Nyabarongo River has the biggest hydropower output capacity in the country and the government is planning to add another station within the same river hence siltation is a major challenge and it is becoming very expensive to dredge the rivers.

Factors contributing to the problem

The climatic factors contributing to siltation are rainfall intensity and elongated rainfall seasons (extended duration). The non-climatic factors are poor agricultural methods on the upper catchments, topography of the area, deforestation in the upper catchment, riparian areas encroachment, mining practices and poor soil types.

To address the problem, geospatial data which has been used include land use/land cover maps, rainfall data, river discharges, topographical maps and Digital Elevation Model (DEM). These datasets are provided

by different government institutions including, Rwanda Natural resources Authority- Department of lands and mapping (for land use/cover data and DEM), DIWRM provides river discharges while Rwanda Meteorological Authority provides rainfall data.

Different stakeholders are involved in siltation problem. They include the Ministry of Natural Resources and more specifically the Department of Lands and Mapping and Department of Mining and Geology, local government, the Ministry of Agriculture, the Rwanda Agricultural Board, the University of Rwanda, mining industries, the Rwanda Integrated Water Security Program and the IWRM program.

Decision-making Context

Key decisions related to siltation of rivers include hydropower development, watershed management (development of strategies in the upper catchments), riparian area protection, portable water supply, sediments discharge by miners (construction of sediments traps) and sediment fingerprint tracking. In order for the above decisions to be made by the relevant institutions, information required includes sources of the sediments, quantity/concentration of the sediments, river discharges and rainfall intensity data. The information is majorly provided by RNRA, rainfall data by RMA, sediment locations fingerprinting by DIWRM, University of Rwanda - Faculty of Agriculture and Science provides information on soil types while Rwanda Agricultural Board provides soil sampling results.

User Capacities and Needs

The information generated by DIWRM and RNRA is required by different users for decision making. The information users are hydropower development companies, water treatment municipalities, catchment management institutions under the Ministry of Natural Resources, Ministry of Agriculture and districts/local NGOs involved in looking at catchment rehabilitation. Some of the users mentioned above have no access to raw data on sediments yet since it is still under development but once the fingerprinting project is completed, information generated will be shared on demand basis.

The users of the information on sediment fingerprint tracking are based at national level since it's a new activity. Capacity development is however required on sediment monitoring and also the relevant software for this. Other skills required are for soil and sediment analysis.

Existing Efforts

A number of activities are on-going in response to siltation namely: Sediment source determination through finger printing (identification of the sources of sediments) being spearheaded by RNRA (DIWRM), a local NGO Rwanda (Integrated Water Security Program funded by USAID) and Florida International

University (helping in collecting and analysis of the samples); Nyabarongo upper catchment rehabilitation plan being implemented by RNRA and other stakeholders like local governments/riparian districts and aimed at reducing the amount of sediments going to the dam reservoir; and IWRM program (Water for Growth) funded by the Dutch government which will begin after the sediment fingerprint tracking is completed. This project is aimed at continuing to monitor sediments flow.

Opportunities to improve

A number of opportunities to improve how the institutions respond to siltation of the major rivers were identified and they include: (1) Putting up task force under all the sectors to improve coordination in sediment monitoring, (2) Enhance data collection and have a database integrating all the processes in place, (3) development of tools for sediment monitoring, (4) Develop skills on sediment modeling and monitoring, and (5) improve linkage between the technical institutions and the community for proper mitigation strategies.

3.4 Agriculture and Food Security

In agriculture and food security service area, two development problems were identified by the participants. They are soil erosion and low crop productivity.

3.4.1 Increasing Soil Erosion

Erosion was considered because it has been termed as a key environmental problem in Rwanda and also due to the impact on crop productivity, livelihoods, fishing, and energy due to hydropower schemes. Due to Rwanda's topography, poor land management on hilly areas has resulted in high levels of erosion and land degradation leading to large sediment deposition in rivers.

Factors contributing to the problem

Increasing rainfall, with changing long term and cyclical patterns and an increase in the frequency and intensity of extreme events are the climatic factors influencing erosion. Non climatic factors such as soil quality, topography, land cover, poor land management practices and an increasing population leading to agricultural intensification contribute to the problem.

Geospatial data required or used to address the problem are high resolution topography (10m DEM), climate data (ENACTS), plot level data (available from RNRA but not yet integrated in MINAGRI and NISR work), soil data and LULC maps.

Institutions involved or affected in erosion management decisions include government agencies such as MINAGRI and its extension service, RAB, RNRA's Water Department, Ministry of Disasters (Vulnerability mapping), Ministry of Energy, MININFRA and REMA. Private Sector stakeholders such as construction companies and their workers who are at risk due to landslides and other hazards. At the local level, the stakeholders include local government, farmers and farmer federations (e.g. rice farmers' federation and water users associations).

Decision making context

Key decisions made concerning increasing erosion include mitigation based decisions such as afforestation, enforcing land use master plan, revision of priority crops and advisory on farming practices e.g. rotational cropping/cropping systems. Remediation oriented decisions such as land use planning, land management practices, housing policies (group housing in rural areas), failure to follow housing policies, agricultural practices (e.g. terracing) and infrastructure policies that were planned without erosion in mind.

The information required to make these decisions on managing erosion include erosion hotspots (location and intensity of erosion), topography models that provide decision support tools such as information to model the impacts of different scenarios, rainfall patterns (particularly for landslides). Erosion risk maps that show potential risk areas which are prone to erosion, landslides, etc. Earthquake data and maps on changes in landform such as soil deposition, gulley formation and land degradation from radar and satellite imagery and soil maps.

The information required by government is mainly provided by consultants. For example, consultants from MINAGRI and RNRA provide topography data (matrix) to map erosion risk but there is need for a more dynamic and robust model. RMA provides climate data through the online map room. MINAGRI provides erosion risk maps which currently derive hotspots from slope and therefore not adequate. There's therefore a need for them to be improved to incorporate other parameters. RAB provides soil data while RNRA provides topography data and high resolution ortho-photos. Seismology Research Centre from Congo produces the earth quake data but it's not available to these institutions.

This information is required by heads of departments in National Ministries (MINAGRI, RNRA, RAB), district focal persons in local government, extension workers at sector (location) and administrative (cell level), farmers promoters and subsistence/commercial farmers, construction, irrigation and agricultural companies. Different stakeholders have different levels access to the information they require. Rainfall data is available at national up to sector level but it requires repackaging to allow for assimilation at

different decision making levels. Topography data is available from RNRA while soil maps are available from RAB.

User capacities and needs

Insufficient hardware and software and skills for government ministries to allow for adequate and appropriate service delivery, insufficient staffing and unreliable private sector are some of the challenges experienced while addressing this problem.

Existing efforts

There are different initiatives that are ongoing in response to erosion mapping and monitoring. They include: (1) MINAGRI has produced the land resilience model (developed using slope and soil depth maps). (2) MINAGRI has been funded by EU to develop methodology on soil erosion monitoring using landscape features i.e. terracing. The project is ongoing but the scope is limited due to the number of parameters being used as inputs. (3) FAO and NFA's WISDOM (Wood fuel Integrated Supply/Demand Overview Mapping) project mapped tree cover and produced a geo-referenced database on wood fuel and charcoal demand.

3.4.2 Low Crop Productivity

Low crop productivity is a food security problem affecting livelihoods. It influences government planning on how much inputs and seeds purchase or store in case of drought. Due to the terrain, poor land management practices leading to erosion, wrong choice of inputs are some of the factors that have contributed to the declining crop productivity.

Factors contributing to the problem

Drought, changing rainfall patterns and climate change are some of the climatic factors that have contributed to low productivity. Pests and diseases, poor farming and farm management practice, poor soil management, inappropriate inputs supply such as wrong fertilizer application and wrong seeds that do not match climatic and soil conditions and poor access to financial services are some of the non-climatic factors contributing to low productivity.

The geospatial data required or used to address the problem were identified as crop suitability maps, climate information and nutrient deficiency maps.

Institutions involved or affected in agricultural monitoring decisions include government agencies such as MINAGRI and its extension services, RAB, RNRA's Water Department, Ministry of Disasters

(Vulnerability mapping), and REMA. At the local level, the stakeholders include local government, farmers and farmer federations, e.g. Rice farmers' federation and water users' associations, NGOs and CBOs.

Some of the stakeholders identified are government agencies such as MINAGRI and its extension service, RAB, RNRA-Water Department, MIDIMAR and REMA, NGOs and CBOs, and Farmers and farmer federations.

Decision making context

Key decisions to be made concerning crop productivity include crop selection, crop distribution, suitable inputs such as fertilizers, storage and market access. Required information for decision making includes climate information, soil maps, crop seasonal forecasts, crop suitability maps, soil fertility maps, soil nutrient deficiency maps, market information and disease prevalence. The required information is provided by different actors. RMA provides climate data through the map room (data dissemination is not adequate for decision making), soil maps are available from RAB while nutrient deficiency maps which are supplied to all agro-dealers are developed by IFD and MINAGRI.

This information is required by heads of departments in national ministries (MINAGRI, RAB), district focal persons in local government, extension workers at sector (location) and administrative (cell level), farmers promoters and subsistence/commercial farmers, construction, irrigation and agricultural companies. Access to this information varies. Rainfall data is available at national up to sector level but it requires repackaging to allow for assimilation at different decision making levels since no interpretation is provided. Crop suitability maps are not available at district and cell levels (farmers apply same recommendations despite changes in climate and soil variability.

User capacities and needs

Institutions mandated to develop or process data on crop productivity lack sufficient hardware, software and skills for adequate service delivery. Government institutions lack sufficient capacity to provide local level interpretation of products and disseminate them to their users. The private sector, which could provide consultancy services was termed as not being strong or reliable.

Existing efforts

Different initiatives already exist to help solve this problem, namely: (1) CIP (Crop Intensification Program) is being implemented by MINAGRI and is partially funded by European Union (EU) and other partners with the goal of increasing agricultural productivity in high potential food crops. Its main focus is improving advisory services, stimulate private sector involvement, provide access to markets and improve seed and

fertilizer usage. (2) One cow per poor family is a government initiative to improve livelihoods in the country by promoting crop and livestock integration. This helps generate manure for use in crop farming. (3) MINAGRI has been funded by EU to develop methodology on soil erosion monitoring using landscape features i.e. terracing. (4) Irrigation project which is funded and implemented by different partners (Government, IFAD, JICA, GIZ, WB, ADB). (5) Feed the future program in Rwanda is focusing on improving agricultural productivity and investments in agriculture.

Opportunities to improve

The opportunities to improve how the stakeholders are responding to the problem of soil erosion and low crop productivity include:

User Engagement – improve the capacity, data and instruments for decision making by building the capacity of the decision making units in government and private sector. Also to promote awareness of the need for making strategic decisions where intervention is needed and make data readily available and interpretable. Supporting design and implementation of decision making tools at different levels such as maps, reports and use crowd sourcing for collecting and sharing information also requires improvement.
Data sharing, access and management: - improve accessibility and dissemination of the data. Government ministries need to explore cloud storage/database management system for better data management and implementation of proper archiving methods and tools. For proper dissemination of available data and information, explore mobile applications to provide updates, alerts and interactions with farmers on issues of low productivity (i.e. CABI initiatives). For developed products to benefit end users, user specific products and tools are needed. Finally, promotion of standardization of data processing/production methods would also be beneficial.
Data and tools: MINAGRI would benefit from seasonal crop forecasting tools for assessing windows for planting, diseases, etc.
Capacity development: - There is need to build the capacity of the government and private sector for better service delivery. This includes building capacity in preparing the data for dissemination (skills, staffing). There is need to improve the GIS curriculum that fits market needs and incorporate it in applied disciplines and promote it in higher education centers. Provision of skills at intermediate and advanced level to be able to process and use the available data is required as well as provision of specialized courses/thematic trainings e.g. mapping erosion.
Outreach, uptake and feedback: - Data dissemination platforms to ensure data and information are available to end users need improvement/development while promoting use and access to available data.

Users also require training on use of existing dissemination channels, interpretation of developed outputs and how to give feedback. To assess the efficacy of products in meeting the needs of users, network of professional associations can be used to collect feedback.

Coordination of on-going efforts: - This can be done by using existing inter-ministerial technical working groups.

4 WAY FORWARD

The user needs assessment in Rwanda set enabled user participation in identifying priority needs that will form the basis of engagements and services to address development problems by SERVIR E&SA. Opportunities in existing and future efforts to improve environmental management and resilience to climate change were identified. SERVIR E&SA services 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, the areas identified as requiring improvement could be addressed through ongoing activities and other initiatives that SERVIR E&SA is participating in. Prioritization of the needs through a 'value-addition approach' will be required. This prioritization would focus on the areas identified in the assessments complemented by further engagements/consultations with the relevant stakeholders. An assessment of their feasibility would further be based on available technical capacity, financial resources and ease of collaboration with the stakeholders.

While the outcome of the assessment is described in this report, the design of services to address the identified needs will require SERVIR-E&SA to continue to engage the stakeholders that participated in the assessment workshops and those that are involved in similar efforts but did not participate. This is an approach that will ensure the right services are designed and developed and that they address key decision making gaps in each of the SERVIR service areas covered. This approach further addresses the issue of user buy-in, a result that would potentially increase the use of geospatial technologies in decision making in the Rwanda.

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

Annex A: Workshop Agenda

Day 1: Thursday 26 May		
8:30 – 9:00	**Registration**	Stella/Lilian/Faith
Introductions		Mubea
9:00 – 9:05	Opening Remarks by RCMRD	Kiema
9:05 – 9:10	Remarks by USAID	Albert
9:10 – 9:15	Remarks by RCMRD – Focal Point	Leonard
9:15 – 09:20	Introduction to SERVIR-E&SA	Robinson

STAKEHOLDERS' PRESENTATIONS			
Land-cover/Land-use & Ecosystems (GIT Cross-Cutting)	**Kiema**	**Water Resources & Disasters (GIT Cross-Cutting)**	**Robinson**
09:30 – 09:40	Rwanda Housing Authority	INES-Ruhengeri	
09:40 – 09:50	Rwanda Environment Management Authority (REMA)	WASH program World Vision	
09:50 – 10:00	Ministry of East African Community Affairs (MINEAC)	RNRA/ Dept. of Water Resources Management	
10:00 – 10:20	**Group Photo Session /Health break**		
10:20– 10:30	RECOR (Rwanda Environmental Conservation Organization)	University of Rwanda - CGIS	
10:30 – 10:40	RNRA/Dept. of Lands and Mapping	MIDIMAR	
Agriculture and Food Security	**Kiema**	**Weather & Climate (GIT Cross-Cutting)**	**Robinson**
10:40 – 10:50	National Institute of Statistics of Rwanda	Severe Weather Consult.	
10: 50 – 11:00	Ministry of Agriculture(MINAGRI)	Rwanda Meteorology Agency (MINIREMA)	
11:00 – 11:10	CIAT-Rwanda	Red Cross Rwanda	
11:10 – 11:20	Rwanda Agriculture Board	UNDP Rwanda.	
11:20 – 11:30	ASARECA -Rwanda	Kigali Independent University	

11:30 – 12:30	Questions & Answers	Questions & Answers
12:30 – 14:00	**Lunch**	
14:00 – 15:00	Thematic Groups Report Back	Mubea
15:00 – 15:15	**Health Break**	
15:15 – 16:15	Discussions/Questions	Kasera
16:15 – 16:30	Summary of the Days Discussions	

Day 2: Friday 27 May		
08:45 – 09:00	Recaps/Day's Instructions	Kasera
09:00 – 09:15	Service planning	Albert
09:15 – 11:00	Thematic breakout groups discussions:	
	I. Land-cover/Land-use & Ecosystems	Africa/Anastasia
	II. Weather & Climate	Mubea/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.)	
12:00 – 13:00	Lunch Break	
	Group Report Back	Mubea
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 – 15:25	Plenary Discussions	Mubea

15:25 - 15:40	Health Break	
15:40 – 16:10	NASA support to SERVIR	Africa
16:10 – 17:00	Remarks from Participant	One Participant
	Remarks from RCMRD focal point	Leonard
	Way Forward and Closing Remarks from RCMRD	Robinson

Annex B: List of Participants

No	Name	Organization	Email address	Gender (M/F)
1	Dominique Mvunabandi	Severe Weather Consult. Kigali Independent University	dmvunabandi2020@gmail.com	M
2	Dr. Herve Habonimana	University of Rwanda - CGIS	habonimanah@gmail.com	M
3	Leonard Kayonge	RNRA/Dept. of Lands and mapping	Grace.Nishimwe@rnra.rw/Leonard.Kayonga@rnra.rw	M
4	Mr. Bernard Musana	Ministry of Agriculture (MINAGRI)	bmusana@gmail.com	M
5	Mr. Dismas Karuranga	Rwanda Natural Resources Authority	karurangadismas@yahoo.fr	M
6	Mr. Fred Nzasabimana	Ministry of East African Community Affairs (MINEAC)	fnzasabimana@mineac.gov.rw, frednzasaba@gmail.com	M
7	Mr. Jean Baptiste Nsengiyumva	MIDIMAR (Ministry of Disaster Management and Refugee Affairs)	jbatigol@yahoo.com	M
8	Mr. John Ntaganda Semafara	Rwanda Meteorology Agency (MINIREMA)	john.semafara@mininfra.gov.rw, johnntaganda@yahoo.com	M
9	Mr. Leonidas Habiyakare	INES-Ruhengeri	hbykreleonidas@yahoo.fr	M
10	Mr. Musoni Didas,	RMA (Rwanda Meteorological Agency)	mdidace@hotmail.com	M
11	Mr. Ngoga Tenge Gislain	Rwanda Agricultural Board	ngogatenge@gmail.com	M
12	Mr. Nyirimanzi J. Claude	National Institute of Statistics of Rwanda	claude.nyirimanzi@statistics.gov.rw	M
13	Philip Kibui	UNHCR	kibui@unhcr.org	M
14	Vincent de Paul Kabalisa	RNRA/ Dept. of Water Resources Management	kabalisa@hotmail.com	M
15	Alexander Riedel	RECOR (Rwanda Environmental Conservation Organization)	alex.riedel@gmail.com	M

16	Mutaganda Theophile	Rwanda Housing Authority	theophile.mutaganda@rha.gov.rw	M
17	Rwaka Maxime	ESRI Rwanda	m.rwaka@esri.rw	M
18	Bihinda J.Bosco	SPN (Smart Pump Network)	hbihinda@gmail.com	M
19	Gatera Jean Piere	ESRI Rwanda	j.gatere@esri.rw	M

Annex C: SERVIR 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