RSA
Rwanda Space Agency

RWANDA SPACE AGENCY BROCHURE

1. ABOUT RWANDA SPACE AGENCY

Rwanda Space Agency (RSA) is the National Space agency that was established in 2020 with the mission of developing Rwanda's space sector towards social-economic development.

RSA mandate is to regulate and coordinate all space activities in the country while also creating an environment that promotes entrepreneurial and industrial development to enable the creation of commercializable products that are globally competitive for local consumption and export markets.

Other key objectives of RSA include designing and implementing capacity building programs in space sciences and technologies, their applications and to build highly skilled professionals in space industry. This is implemented through various partnerships with different stakeholders.

Our mission

To develop Rwanda's space sector towards socio-economic development

Vision

To build a competitive space ecosystem at the global level

2. RWANDA SPACE AGENCY'S COMMUNITY OUTREACH AND SPACE WEEK CONFERENCE

Rwanda Space Agency (RSA) has successfully concluded a community outreach campaign, reaching every province of Rwanda. RSA, in collaboration with their partners, conducted workshops engaging people from various backgrounds, including space technology users, government officials, students, professors, and technicians.

The primary objective of these workshops was to simplify the concept of space and increase awareness of space technologies and their applications within Rwanda. This initiative was strategically timed in anticipation of World Space Week, which is celebrated annually from October 4th to 10th.

Building on this momentum, the Rwanda Space Agency is proud to host the first Rwanda Space Week Conference, bringing together individuals from diverse countries and fields to Kigali. This conference will provide a platform for space technology experts, leaders, policymakers, and academics to discuss how space technologies can be harnessed for the benefit of citizens and international collaboration.

Furthermore, the conference will offer an opportunity to explore Rwanda Space Agency's ongoing projects and future aspirations in the realm of space technology. This event is a significant part of the annual global celebration of World Space Week, observed from October 4th to 10th. During this conference, Rwanda Space Agency will also present awards to students from Rwandan Universities who have successfully developed an innovative technology that will be used by satellites in earth observation - technology consisting of AI algorithms that automatically assess land use and generate statistics.

This first Rwanda Space Week Conference is scheduled to take place on October 9th and 10th at the Kigali Convention Center (KCC). It follows a nationwide community outreach campaign by the Rwanda Space Agency, aimed at demystifying space and its technologies for the betterment of society.

This brochure was put together as a brief on Rwanda space, space technologies applications, and Rwanda Space Agency's ongoing projects. It consists of 7 sections, namely About Rwanda Space Agency, Space technology for Agriculture, Space Technology for Climate Change and Environment, Space Technology for Disaster Management, Connectivity Through Space Technology and Rwanda Space Agency Infrastructure Projects.

3. SPACE TECHNOLOGY FOR AGRICULTURE

Just like in other various sectors, Space technology is proving to be an enabler for precision agriculture, providing precise and real-time data from satellites and unmanned aerial vehicles that can be used to create detailed maps of fields, monitor weather conditions and predict crop yields, among other possibilities, which in turn allows farmers to make informed decisions and improve crop yields while reducing inputs. This eventually leads to more efficient and sustainable farming practices.

One of the key aspects of successful agriculture is the possibility to manage crops from the initial planting stages to harvest and storage, the use of Earth observation data makes crop management possible.

The technology has made it possible to be able to detect and monitor crop health as well as estimate crop yield during a specific agricultural season, hence enabling timely required interventions and management.

Recognizing the power of this technology and its potential in supporting other tools used in the Agriculture sector in Rwanda, Rwanda Space Agency is developing a Smart Agriculture solution which will be a source of key insights like crop classification, done through intelligent Machine Learning models, crop yield prediction, farm land delineation by using satellite data and machine learning models to automatically detect farmland boundaries and also detection of crop diseases by the use of satellite in combination of advanced machine learning algorithms.

Smart Agriculture solution will be part of other data sets within the GeoHub – a consolidated geospatial data center that is currently developed to serve different stakeholders including Government Entities, Academia and the private sector.

4. SPACE TECHNOLOGY FOR CLIMATE CHANGE AND ENVIRONMENT

- Satellite data provides insights and wealth of valuable information on the drivers and impacts of climate change.
- Satellite data helps us to understand the science behind the climate system composed of several elements namely

    - The atmosphere (the layers of gases that envelops the troposphere, stratosphere, mesosphere, thermosphere and exosphere)
    - The hydrosphere (the fresh and salt waters of the earth)
    - The cryosphere (the ice on the earth's surface)
    - The biosphere (all living plants and animals)
    - Lithosphere (solid land on our planet) that surround the earth.

- Satellite data plays a crucial role to monitor and assessing the climate change variables related to extreme weather and climate events that result to flooding, landslides, drought, storms, changes in farmland and other land use, land degradation, soil biodiversity loss, water use by crops, dramatic changes in water levels, salinization, decline in organic matter, droughts, deforestation, greenhouse gas and air particles emissions, wildfires, heat waves.
- Satellite data information plays a critical role in taking action against climate change by providing vital and reliable inputs to governments and industries towards the climate change adaptation and mitigation.

5. SPACE TECHNOLOGY FOR DISASTER MANAGEMENT

As we witness the ever-increasing frequency and intensity of natural disasters across the globe, it is imperative that nations invest in innovative technology solutions to mitigate their impact and save lives. The recent developments in Space technology especially Earth Observation have proven to critically contribute to these efforts. Rwanda Space Agency (RSA), was not left behind in leveraging this technology for enhancing disaster management in the country.

Established in 2020, the RSA has made it a top priority to develop space technology that supports national disaster management efforts. By utilizing satellite technologies to systematically collect images from around the world, RSA can identify disaster-prone regions and take proactive measures before calamity strikes. But their approach goes beyond prevention; they've created a holistic system for both prediction and response.

Take, for instance, the eruption of the Nyiragongo Volcano in May 2021. The RSA used space technology to monitor the volcano's activity and the movement of lava, assessing the risk of lava reaching Lake Kivu, which could have resulted in a catastrophic explosion due to the presence of methane gas. Through the monitoring efforts, decision makers were able to avoid the evacuation of the whole town of Rubavu.

In May 2023, when heavy rains claimed more than 130 lives in Rwanda's Western region, the RSA once again was able to provide its support using Space technologies. Satellite imagery, machine learning, and real-time monitoring was put a work to efficiently assess damages, identify safe locations for the evacuation of the population, and coordinate relief efforts. The real-time maps provided showcased topography, infrastructure, and accessibility in the disaster-stricken regions. This level of detail greatly enhanced coordination among relief teams, allowing them to plan aid distribution routes and allocate resources effectively. Lives were saved, and aid reached those in need promptly.

The RSA in collaboration with relevant authorities is building a robust Early Warning System towards enhancing Rwanda's preparedness for multi-hazard disasters in the future. In a world where disasters are becoming increasingly prevalent, it is becoming imperative to embrace Space technology and minimize its impact on the humanity.

6. CONNECTIVITY THROUGH SPACE TECHNOLOGY

Two main projects are ongoing at Rwanda Space Agency in order to develop key infrastructure for sustaining Space Technology in Rwanda.

National Geospatial Hub

Satellite have been used over the years to take imageries and collect other important data on the Earth. However, the development of Artificial Intelligence and Machine Learning has made this technology more meaningful to support the socio-economic development.

Since, its establishment, RSA started a project of establishing a National Geospatial Hub (GeoHub) that will support all critical sectors of the country including the Agriculture, Urban Planning, Natural Resource management, Mining, and Disaster management to name few.

The GeoHub infrastructure is expected

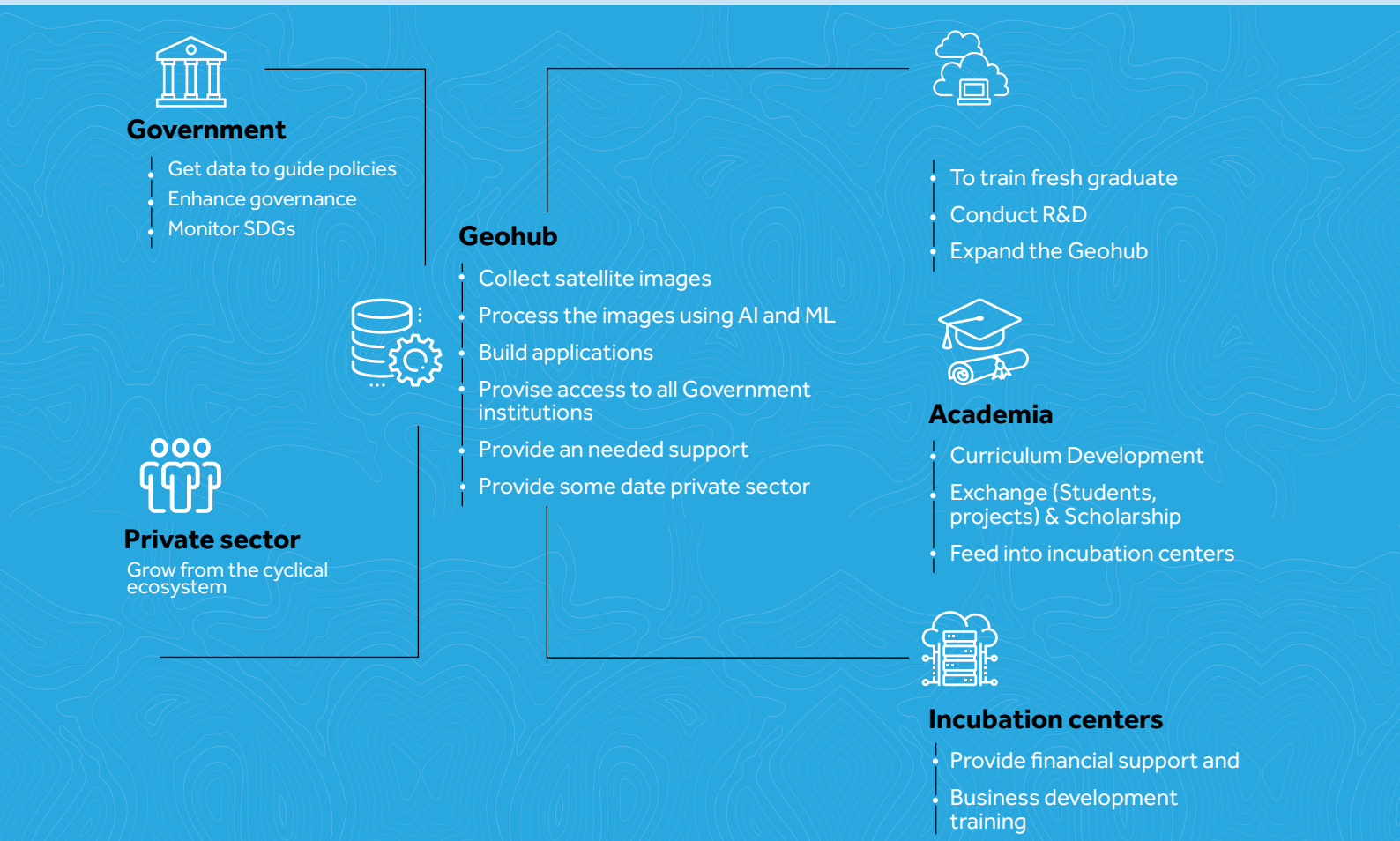


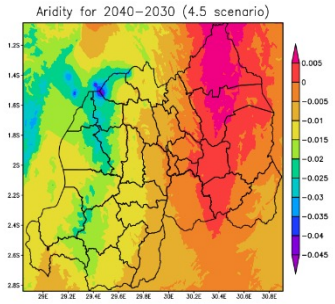
Diagram 1: Design of the Rwanda Geospatial Hub

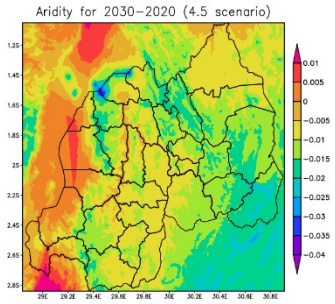
Case studies

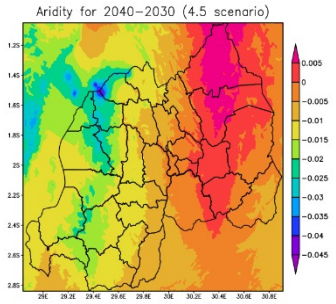
Role of climate model projections in improving policies on climate change mitigation and adaptation in the agriculture and food security

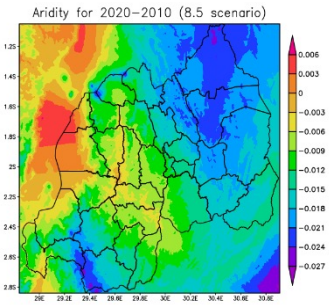
The climate projections are crucial for the sustainable fruitful collaboration of scientists and policymakers towards appropriate and effective climate change mitigation and adaptation. The agriculture sector is significantly contributing to the increase of the economy in Rwanda; however, it is severely affected by climate extreme conditions. This joint study evaluates historical data and future projections of heavy precipitation and aridity over Rwanda. The Coupled Model Intercomparison Project Phase 6 (CMIP6) and Phase 5 (CMIP5) have been used to play key roles in the insights of climate projections. The CMIP6 Shared Socio-economic Pathways (SSP) scenario namely SSP126, SSP245, SSP370, SSP585 while CMIP5 Representative Concentration Pathways (RCP) scenario namely RCP4.5 and RCP8.5 have been considered. The findings show remarkable changes in the amount of rainfall and aridity across Rwanda.

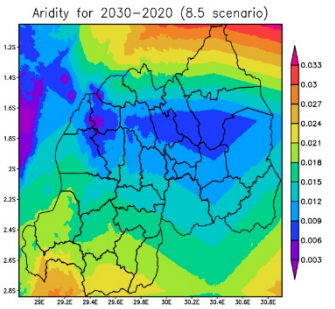
The maximum length of dry days (CDD) are projected to decrease in most areas under SSP1-2.6 and SSP5. The opposite is likely under SSP3-7.0. The intensity of maximum consecutive5-days (Rx5day) rainfall is projected to increase in most areas. Projected very heavy precipitation days (R20mm) show decreasing trends over many parts of the country with more decrease over southern and central plateau under RCP 4.5 and a decrease over the central plateau and the northern highlands under RCP 8.5 by 2050. The decrease [increase] in rainfall and severe aridity in some areas could lead to strong negative impacts and vulnerability of agriculture to by drought [flood], crop pests and diseases as well as soil degradation due to heavy rainfall. The findings of this research should be useful to policymakers to improve policies formulation on climate change mitigation and adaptation in agriculture and food security due to reduced crop yields.

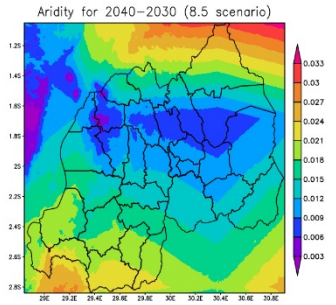


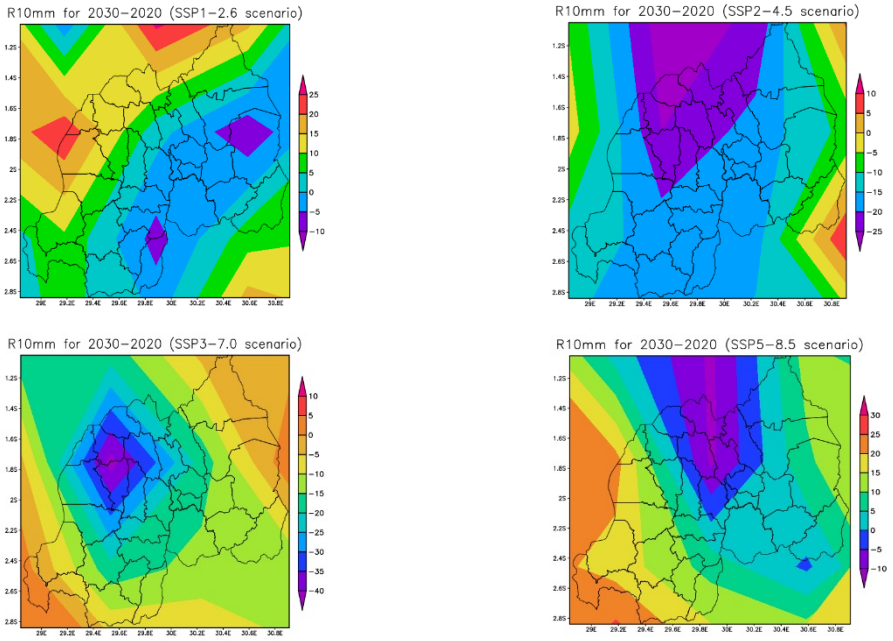






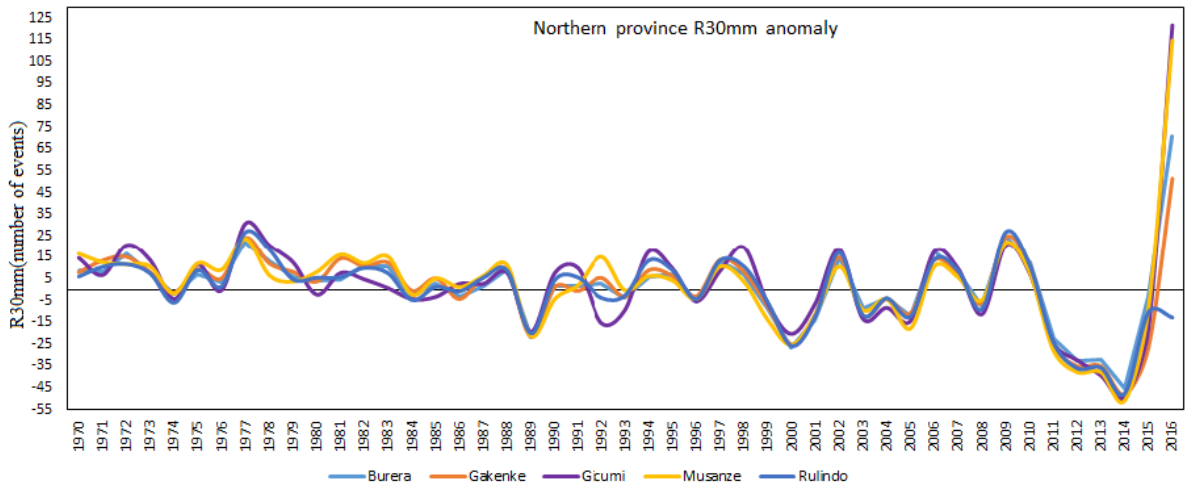


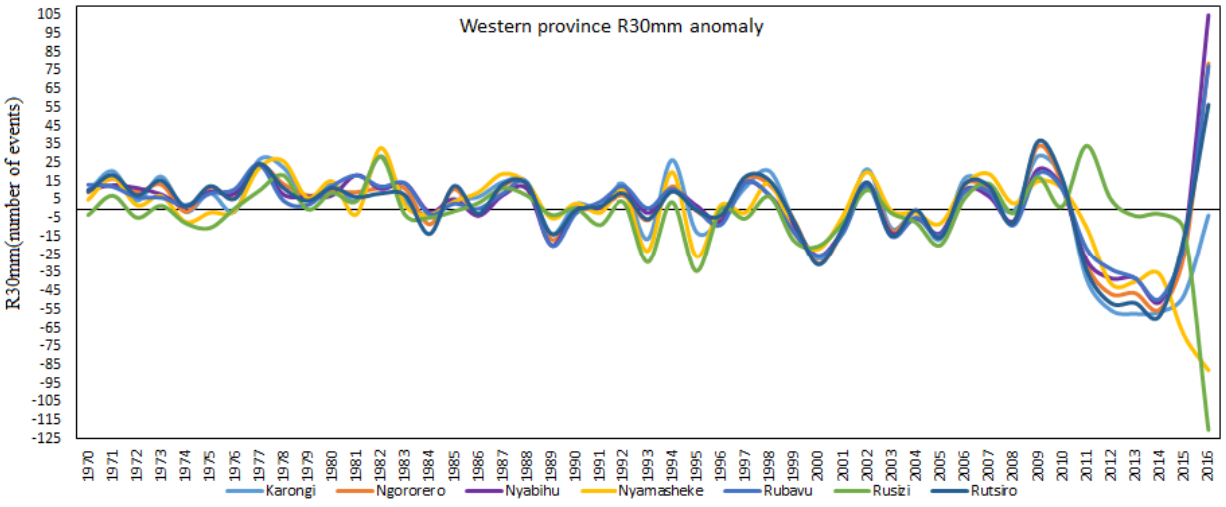


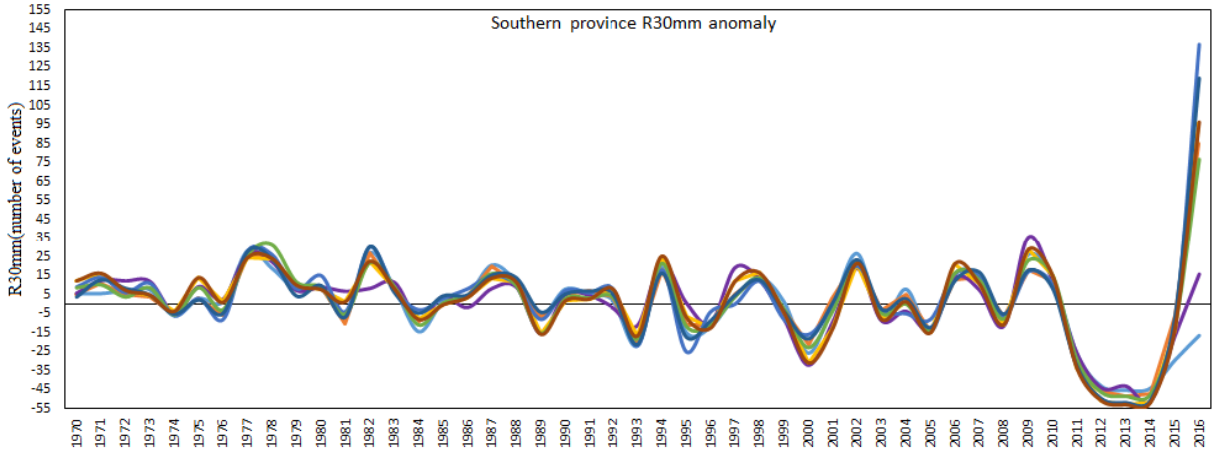


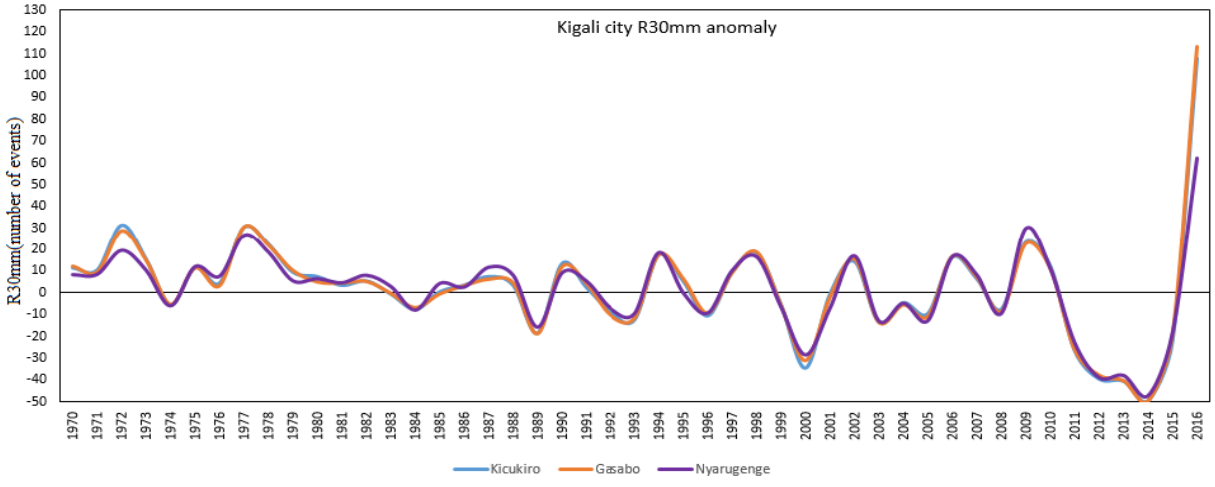
Climatology of Annually Anomalies of Rainfall Events greater than 30 mm (R30 mm)

The climatology of rainfall events greater than 30 mm (R30 mm) indicates significant increase of rainfall amount from 2015 in all Rwandan provinces.



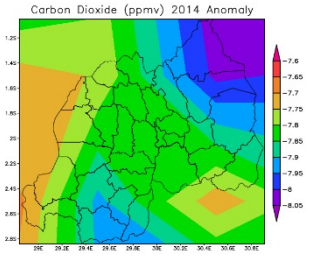

Western province R30mm anomaly
R30mm(number of events)
Karongi
Ngororero
Nyabihu
Nyamasheke
Rubavu
Rusizi
Rutsiro

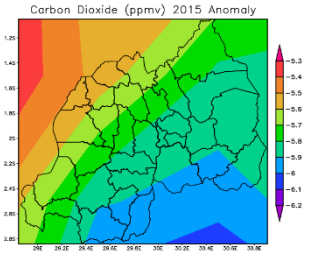

Southern province R30mm anomaly
R30mm(number of events)

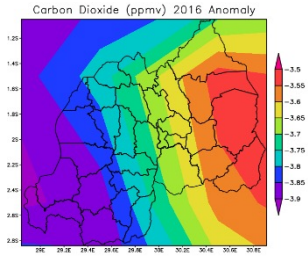

Kigali city R30mm anomaly
R30mm(number of events)
Kicukiro
Gasabo
Nyarugenge

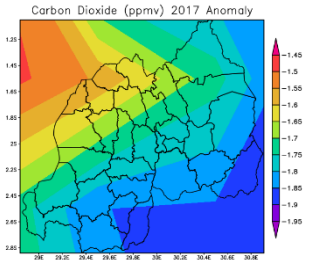
Carbon Dioxide Anomaly across Rwanda

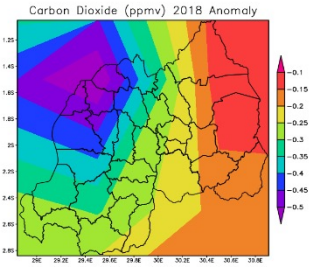
It is important to monitor the greenhouse gases due to their effects on cloud micro-macrophysics leading to weather and climate change. The CO_2 anomaly data indicates an increase of CO_2 from 2019 across Rwanda. The high and low CO_2 concentration is found in regions with low and high rainfall respectively due to the rainout processes.

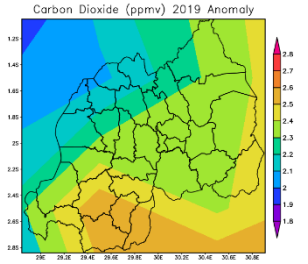


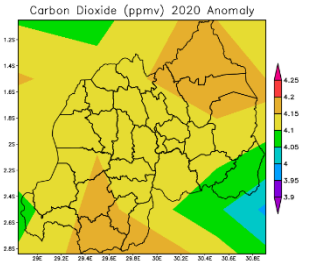


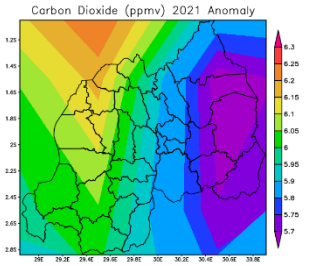


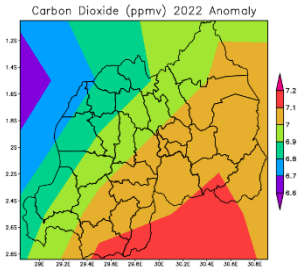






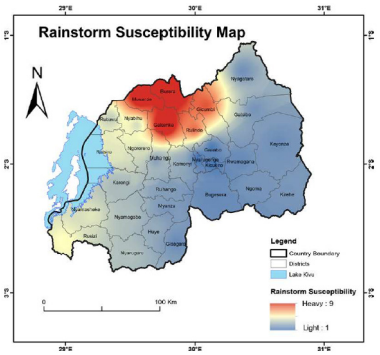


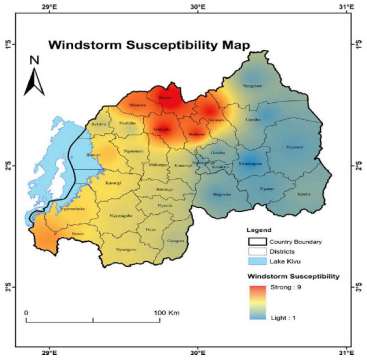


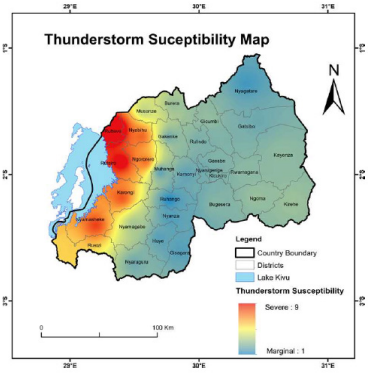


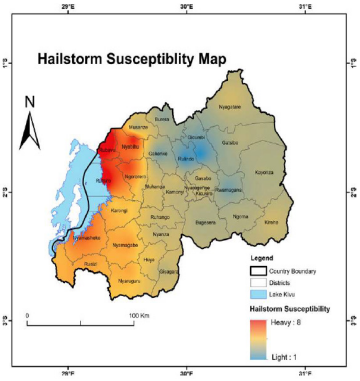
Early Warning Systems Modeling for Rainstorms, Windstorms, Thunderstorms and Hailstorms

The climatology of meteorological parameters data are utilized to develop early warning systems models for hydro-meteorological hazards.



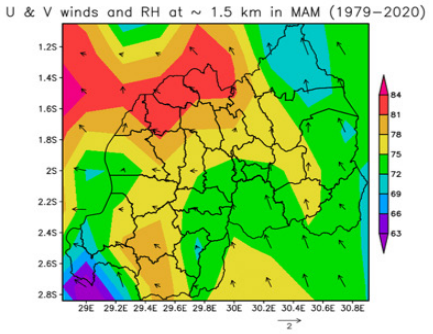


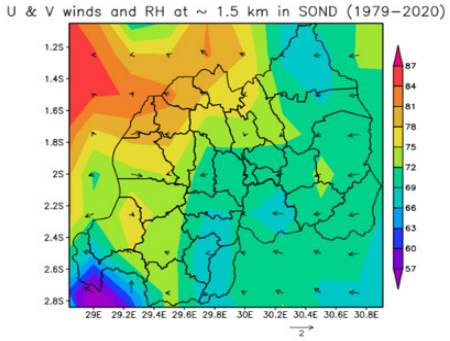


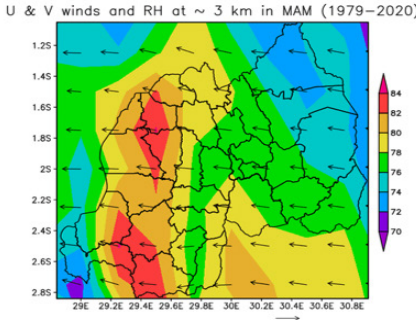


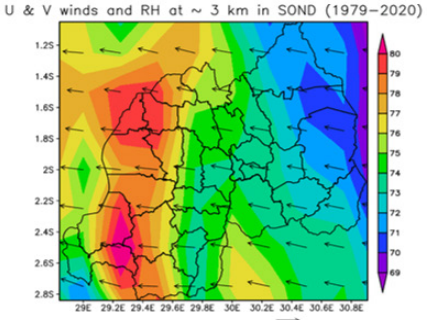
Zonal winds, Meridional Winds and Helicity for Climate Dynamics Prediction

The zonal winds, meridional winds and helicity data at different pressure levels are crucial for developing both weather and climate dynamics prediction models that can be used in disaster management and aviation sectors.



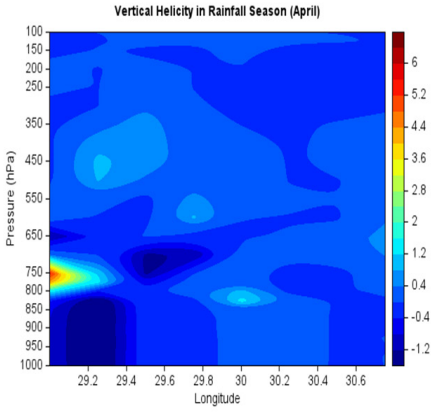


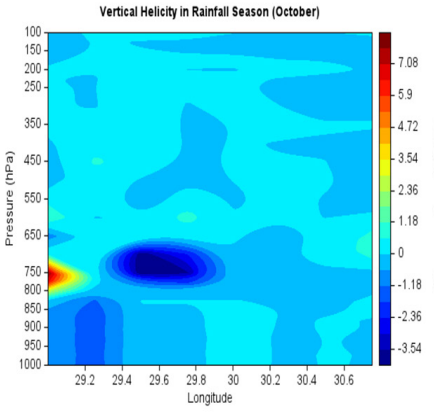


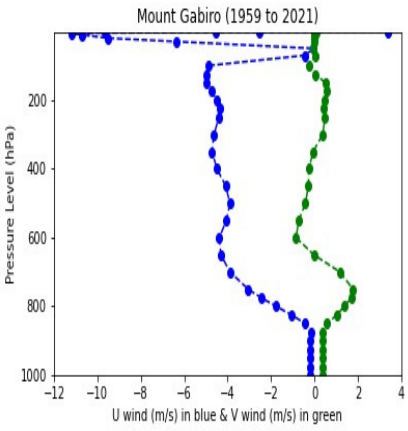


1. Climatology of wind vertical profile is a very important information that can be given to all Rwandan airports

2. Identify the wind direction & speed and their roles on transportation of clouds that can result to rainfall.







In addition to supporting data driven policy making, below is a table summarizing the benefit of the GeoHub to key sectors of the country:

Sectors	Benefits
Agriculture	• Capability to monitor the status of the Agriculture throughout the year • Capability to monitor crop health • Capability to estimate the yield • Enhance access to finances for farmers
Urban planning	• Capability to enforce the implementation of the master plan • Capability to map out key infrastructure and improve the planning for infrastructure deployment
Disaster Management	• Have a multi-hazard Early Warning System • Improved capability for Disaster relief
Mining	• Map out all potential mining sites • Monitor illegal mining • Enforce an environmental friendly mining
Environment	• Monitor illegal deforestation • Protection of green zone • Protection of water bodies and riparian zones • Monitor Greenhouse gases

Table 1: Benefits of the GeoHub for Key sectors

As we are in the process of acquiring new and robust infrastructure, RSA has already started supporting Government institutions in the utilization of satellite imagery. Below are some of the applications and services that were provide to Government Institutions in this fiscal year;

Establishment of a Teleport and a satellite ground station

The African region has a big gap in satellite ground infrastructure. This affects the quality of satellite services provided in Africa for broadband and voice communication and frequency in reception of satellite images that are critical to the development of the continent.

RSA saw an opportunity to address this gap and initiated a project to establish a World Class Satellite Teleport and a satellite Ground Station in Mwulire-Rwamagana. The Teleport of Rwanda will be providing the following services:

Ground Station as a Service (GSaaS)

The satellite ground station will be leased to different satellite operators for Telemetry, Tracking and Command (TT&C), downloading satellite images and controlling space vessel during the launching phase.

Teleport services

In case a satellite operator or a space actor wishes to use their own antenna, they will have a space where they can host it within the Rwandan Teleport and pay a monthly fee

Figure 2: Design of the antenna that RSA is in process of acquiring

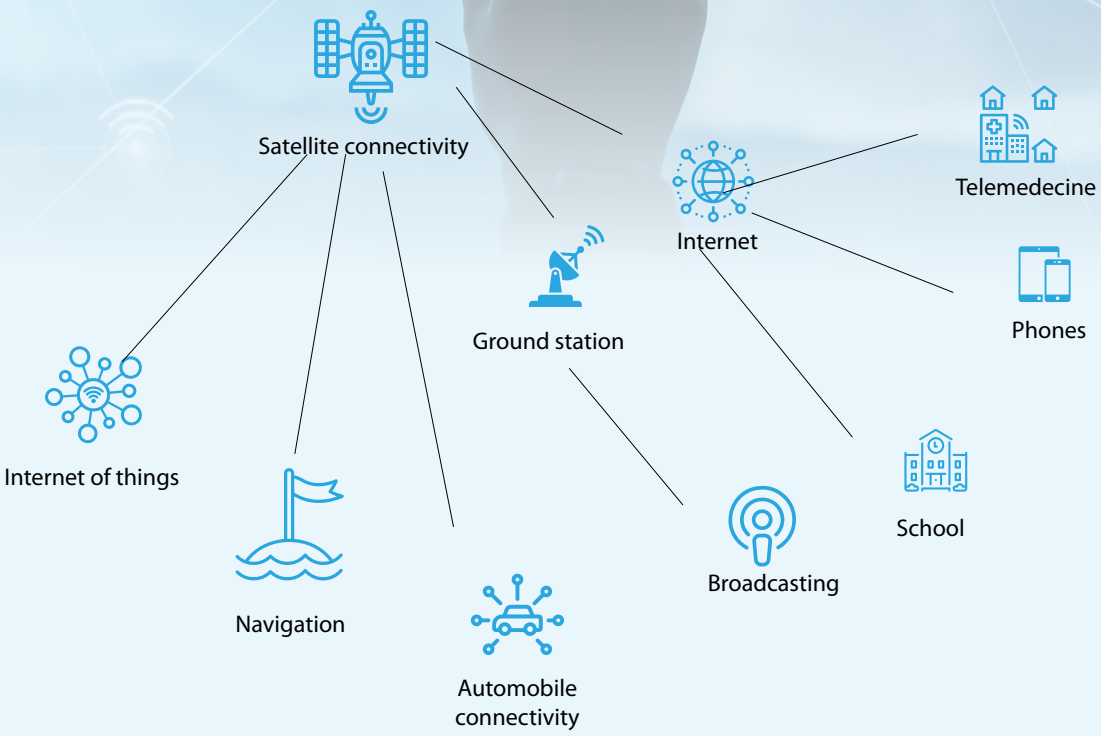
Figure 3: Progress of work for the construction the Rwandan Teleport

The business model was conducted on a 10-year horizon since the depreciation of Ground Station infrastructure is very low. It shows a clear viability of the project with an IRR estimated to 14%.
Beyond the financial viability, Rwanda will benefit from other strategic benefits, including but not limited to:

- Position Rwanda as a continental Hub for satellite ground infrastructure
- Attract international investment in satellite ground infrastructure
- Improve the quality of satellite services provided in Rwanda
- Position Rwanda's thought leadership in space diplomacy

7. RWANDA SPACE AGENCY INFRASTRUCTURE PROJECTS

As the world evolves toward a digital inclusive realm. Both demand and supply escalate, enhanced connectivity becomes increasingly pivotal across the human ecosystem. Every sector, whether education, health, or industrial evolution, requires robust connectivity. The leverage of space technology emerges as a vital alternative for communication, especially when compared to terrestrial approaches. Connecting through space-based technologies not only strengthens the network on Earth but also encompasses a wide variety of applications, ranging from direct broadcasting and internet delivery to navigation, weather forecasting, and global monitoring.



Moreover, space technology provides advantageous solutions for connecting isolated areas, such as remote regions. The use of satellites, communication connectivity extends over vast distances, linking remote and inaccessible regions to the global network.

Since 2022, Rwanda has been leveraging space technology by providing internet access to 50 schools through the Starlink internet network and is planning to initiate additional projects aimed at boosting the digital economy. These endeavors will drive Rwanda towards achieving its Vision 2050 of creating smart infrastructure.

8. SPACE DIPLOMACY

RSA Membership

RSA is a member of:
International Astronautical Federation

Signatories

Partners

UNOOSA
United Nations Office for Outer Space Affairs

unitar
United Nations Institute for Training and Research

UNOSAT

GSOA
GLOBAL SATELLITE OPERATORS ASSOCIATION

smart africa
CONNECT. INNOVATE. TRANSFORM

RCMRD

german cooperation
DEUTSCHE ZUSAMMENARBEIT

Implemented by giz

Digital Transformation Center Rwanda

AFD
AGENCE FRANÇAISE DE DÉVELOPPEMENT

JICA
Japan International Cooperation Agency

Digital Earth AFRICA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