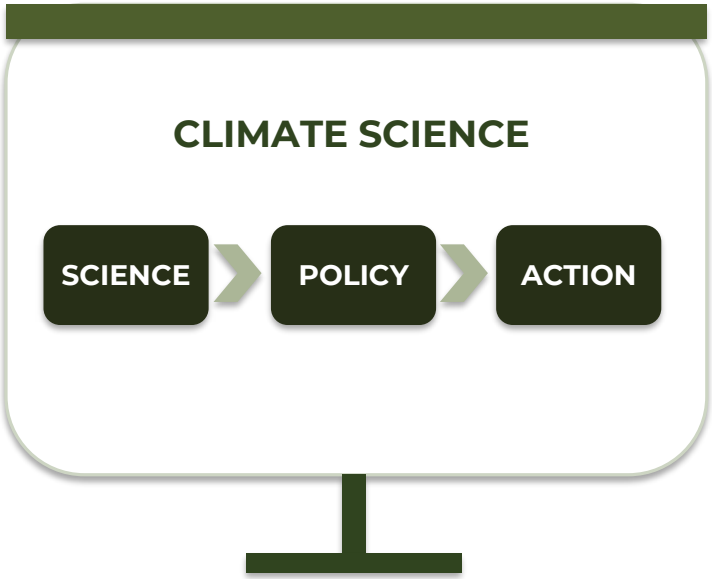
PLENARY PRESENTATIONS

A collection of plenary presentations delivered during the 2nd Rwanda Climate Science Symposium.

Explore the presentations that framed the symposium's science-to-policy dialogue.



Republic of Rwanda

Ministry of Environment

RWANDA CLIMATE SCIENCE NETWORK (RCSN)

Membership, Achievements, Next Steps

2nd RWANDA CLIMATE SCIENCE SYMPOSIUM - 22–23 September 2026 • Kigali, Rwanda

PRESENTERS

Jean Pierre Nizeyimana
Green Economy Specialist, Ministry of Environment

Olivier Niyompuhwe
Advisor for Climate Science & Research, GIZ Rwanda

Janet Umuhoza
Advisor for Climate Science & Research, GIZ Rwanda

RCSN: ABOUT & MEMBERSHIP

A proposed national coordination mechanism connecting climate research, data, policy and implementation.

Why RCSN exists

- Growing climate research community
- Fragmented research, data & policy engagement
- Need to translate science into usable advice

Membership is designed to be broad but institutionally anchored

Government agencies

Research & academia

Private sector & industry

Civil society & youth

Development partners & international organisations

How the network has evolved

2023

RCSN first proposed at a WCRP Open Science Conference 2023 in Kigali

MAY 2025

RCSS 2025 recommended formalizing and expanding the network

2026

Governance design

Why Joining the Network

Beyond the symposium itself, membership is intended offer concrete, ongoing value to every institution involved.

Visibility
Institution & research visibility

Connection
Network of climate science peers

Voice
Collective voice to policymakers & donors

Access
Shared climate data & findings from other members

How to engage

Contribute data, research & findings → **Access the RCCP** → **Shape policy briefs & the Annual Report**

Membership is intended to have practical value: it connects an institution directly to Rwanda's climate research and policy process, not just symbolic participation.

Why RCSS / RCSN Matters for National Strategies

The value is not simply producing more research; it is creating a repeatable route from evidence to decisions.

Climate science & data
- Research
- Observations
- Modelling
- Risk evidence

→

The gap
- Evidence may exist, but remain hard to find or use
- Interpretation and accessibility remain key gaps

→

RCSN / RCSS
- Coordination
- Synthesis
- Dialogue
- Climate Intelligence

→

Policy & planning
- Priorities
- Sector plans
- Budgets
- Standards

→

Investment & action
- Implementation
- Finance
- Anticipatory action

Where evidence needs to connect

NDC 3.0

Implementation and progress evidence

National Adaptation Plan

Risk and adaptation evidence

GGCRS

Low-carbon, climate-resilient development

NST2 - 2024–2029

Sector planning and transformation

Climate & Nature Finance Strategy - 2024–2030

Investment readiness and climate finance

ACHIEVEMENTS

1ST Rwanda Climate Science Symposium 2025

13–14 MAY 2025

32
Speakers

31
Scientific presentations

4 Research streams

- Measurement and Reduction of GHG Emissions
- Observation and Modelling of Climate Change
- Impacts of Climate Change and Risk Assessment
- Climate Action: Adaptation to and Mitigation of Climate Change

9,072
YouTube views

7,700+
Unique viewers

All Participants offered certificates

Participation

120+ PARTICIPANTS

GENDER INCLUSION 38.3% women

Speaker line-up was 43.7% women (14 of 32)

Knowledge products

Book of Abstracts archived online

Oral presentations and posters archived

Photo gallery and symposium series website

Recommendations

The 2025 symposium recommended:

- Formalizing and expand the RCSN
- Strengthen the Rwanda Climate Change Portal
- Continue the symposium as a recurring/annual national platform

ACHIEVEMENTS

2nd Rwanda Climate Science Symposium (RCSS) 2026

22–23 SEP 2026

The second edition broadens reach, deepens policy engagement and introduces an outcome-oriented Resolution.

900+
Registrations received

200+
CONFIRMED IN-PERSON

600+
CONFIRMED VIRTUAL

INTERNATIONAL REACH
~300 (33%) from abroad

112 abstracts submitted



5 Thematic research streams

- Agriculture & Food Systems
- Climate Data & Monitoring Systems
- Urbanization, Infrastructure & Energy
- Nature-Based Solutions & Ecosystems
- Health-Climate Nexus

Access & delivery

- **MoE YouTube livestream**
- **Sign-language interpretation**
- **Hybrid participation**
- **Website programme**

Strategic shift

2025 built the platform. 2026 is structured to generate policy takeaways, commitments and a follow-up Resolution, moving the symposium from exchange toward continuity and accountability.

Reviewers & Technical Committee

RCSS 2026 is coordinated through multi-institutional scientific and technical structures.

Reviewers

12 experts guiding scientific quality, abstract review and programme direction

AIMS RIC	3	AKADEMIYA2063	1
UR / CoEB	2	RSA	1
GIZ	2	REMA	1
NCST	1	Meteo Rwanda	1

Technical Committee

MoE-nominated structure supporting institutional coordination, implementation and follow-up

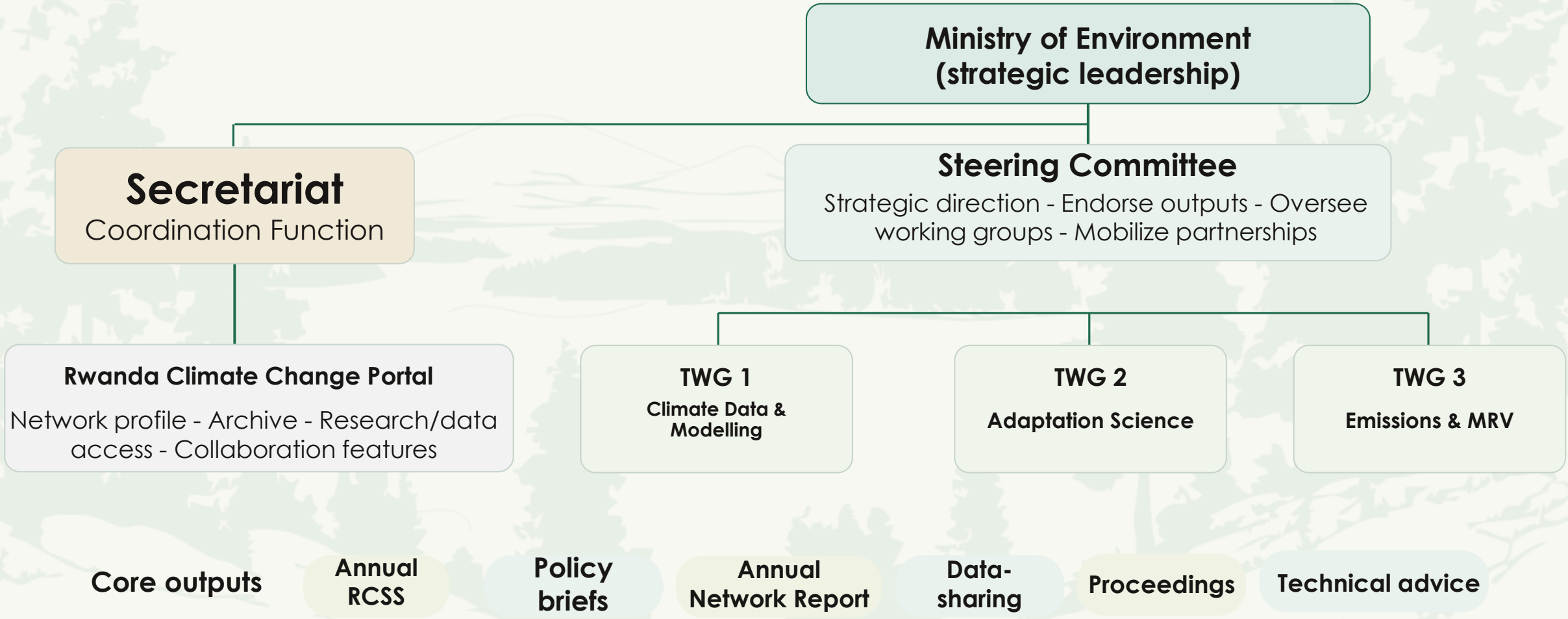
MoE	1	REMA	2
RGF	1	Meteo Rwanda	1
RFA	1	RSA	1
NLA	1	RWB	1

Together, the two committees create continuity between scientific quality and institutional ownership.

ONGOING / PLANNED INTERVENTIONS

Institutionalizing RCSN: Proposed Structure subject to formal adoption

A government-anchored structure designed to coordinate evidence



THE FUTURE OF RCSN (2026 AND BEYOND)

The network needs visible outputs between symposia, not only activity during the event.

RCSS is intended to continue as a recurring/annual platform, with future editions expanding its regional or continental scope

IMMEDIATE ACTIONS: 2026 → 2027

SEP 2026

RCSS 2026

- Symposium Resolution
- Five research streams → policy takeaways

2026/27

Immediate follow-up

- Public reference document
- RCCP integration work
- Policy-ready outputs

2027 →

Next RCSS Cycle

- Progress review
- Recurring national platform
- Regional / continental reach

FROM 2027 ONWARD • INSTITUTIONAL STRENGTHENING

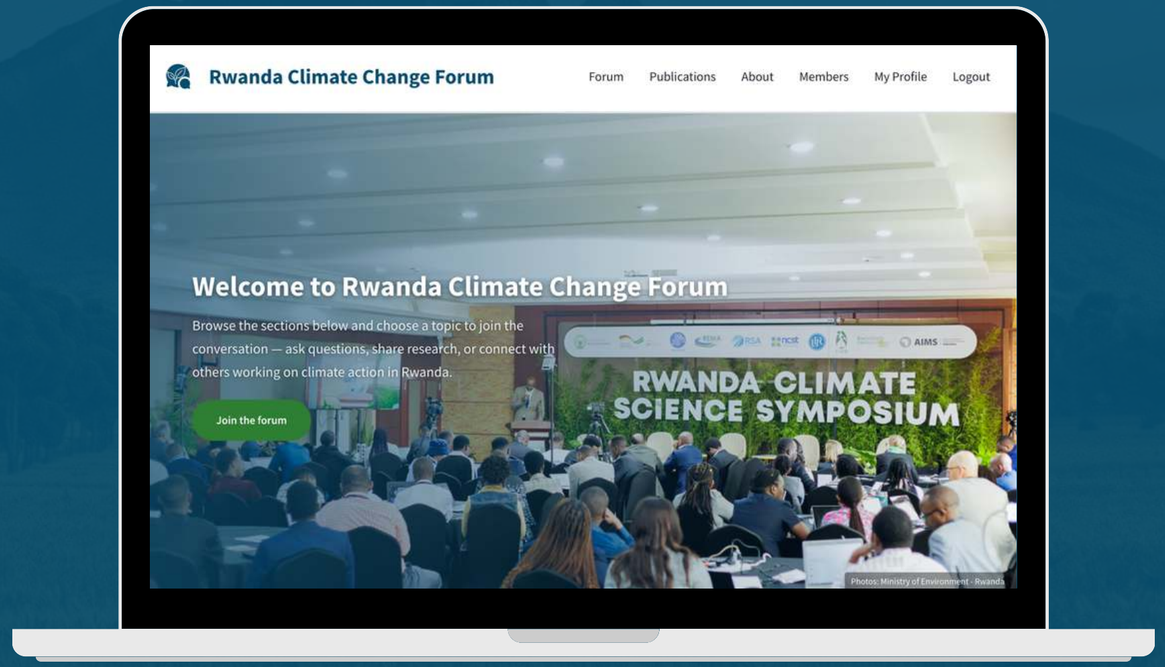
Governance refinement • Operating model • Working mechanisms • Sustainable resourcing

THANK YOU!

Rwanda **Climate Change** Forum

CONNECT. SHARE. COLLABORATE.

REMA
OUR ENVIRONMENT OUR FUTURE



Introducing the **Rwanda Climate Change Forum**

CONNECT. SHARE. COLLABORATE.

The forum is a digital space bringing together Rwanda and Africa's climate community to exchange knowledge, discuss emerging issues and strengthen collaboration.

Join the Forum:
www.climatechange.rw/forum

Rwanda **Climate Change** Forum

SCAN TO BECOME A MEMBER

Why a **Climate Change Forum?**

The Forum comes following last year's Symposium resolutions and provides a shared space to:

- Connect researchers, policymakers, practitioners and partners
- Share research, data, publications and lessons
- Discuss emerging climate issues and challenges
- Discover what others are working on
- Build new collaborations and partnerships
- Find Opportunities

What are the **Core Features?**

Ask Technical Questions

Ask questions, share expertise and get insights from peers and climate experts.

Share Research & Data

Share research, datasets, reports, tools and other useful climate resources.

Find Collaborators

Connect with researchers, institutions and practitioners for new collaborations.

Discuss Climate Science

Exchange ideas and perspectives on climate policies, plans and emerging issues.

Explore Climate Knowledge

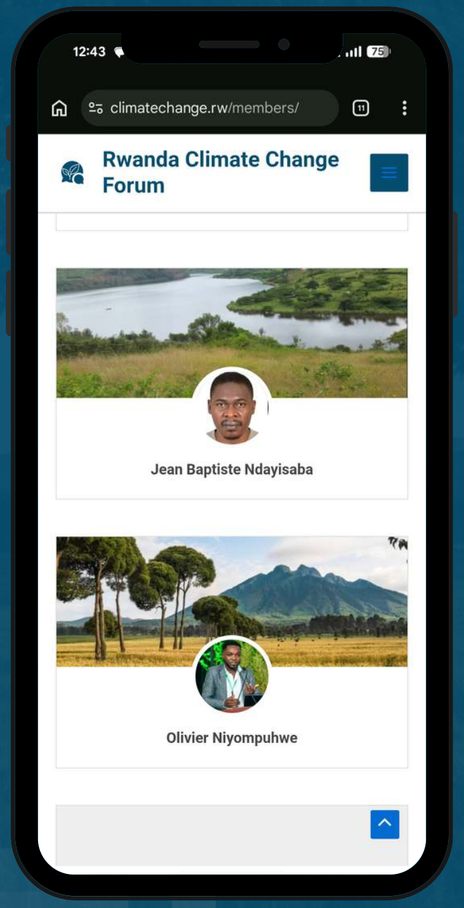
Discover research, resources, discussions and expertise from Rwanda’s climate community.

Connect Evidence + Action

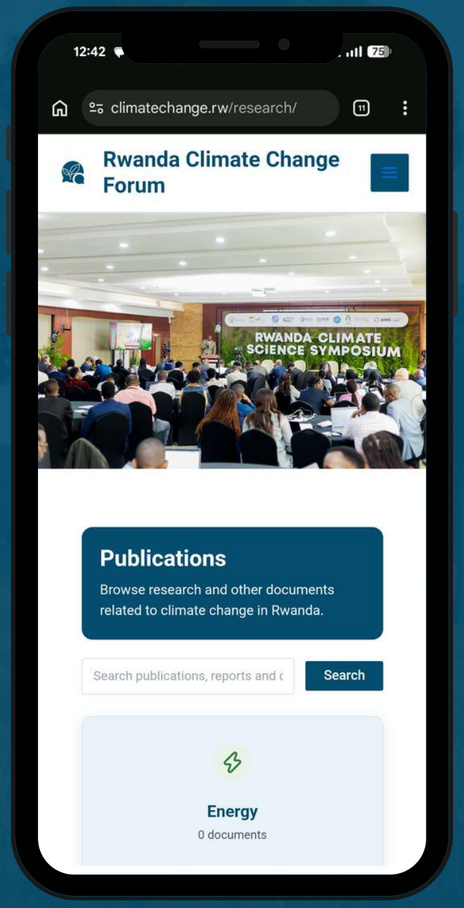
Bring climate science, practical knowledge and decision-making closer together.

How the Forum **works**

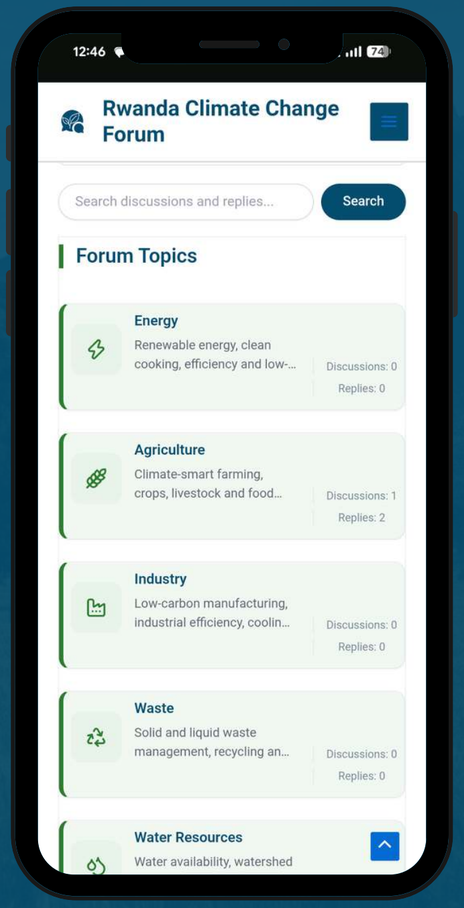
The Forum is designed to support information sharing, new initiatives, project ideas and connections between people working on climate change in Rwanda.



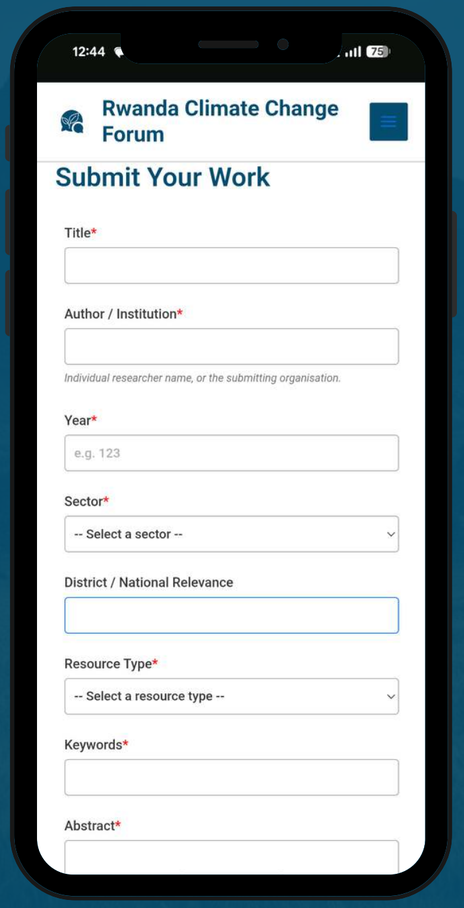
1 **Register to become a Member**



2 **Browse resources and documents**



3 **Contribute to the conversation**



4 **Upload your own research and documents**

Who is the **Forum for?**



- Researchers and academics



- Development partners



- Climate scientists and technical experts

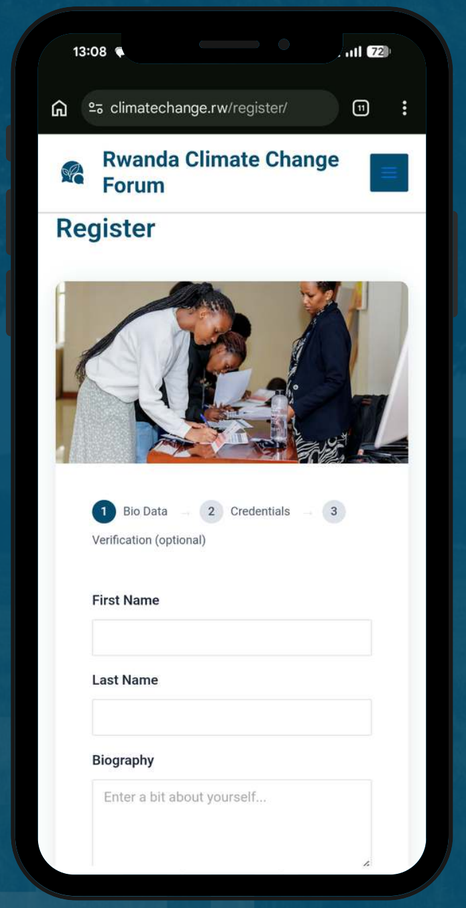


- Government institutions and policymakers



- Universities and research institutions

Joining the **Rwanda Climate Change Forum**



1 Register to become a Member

1. Visit www.climatechange.rw/register

2. Select “Register”

3. Create your account
   - Full name
   - Biography
   - Institution / Organisation
   - Username
   - E-mail Address
   - Password

4. Log in and join the conversation

SCAN TO BECOME A MEMBER

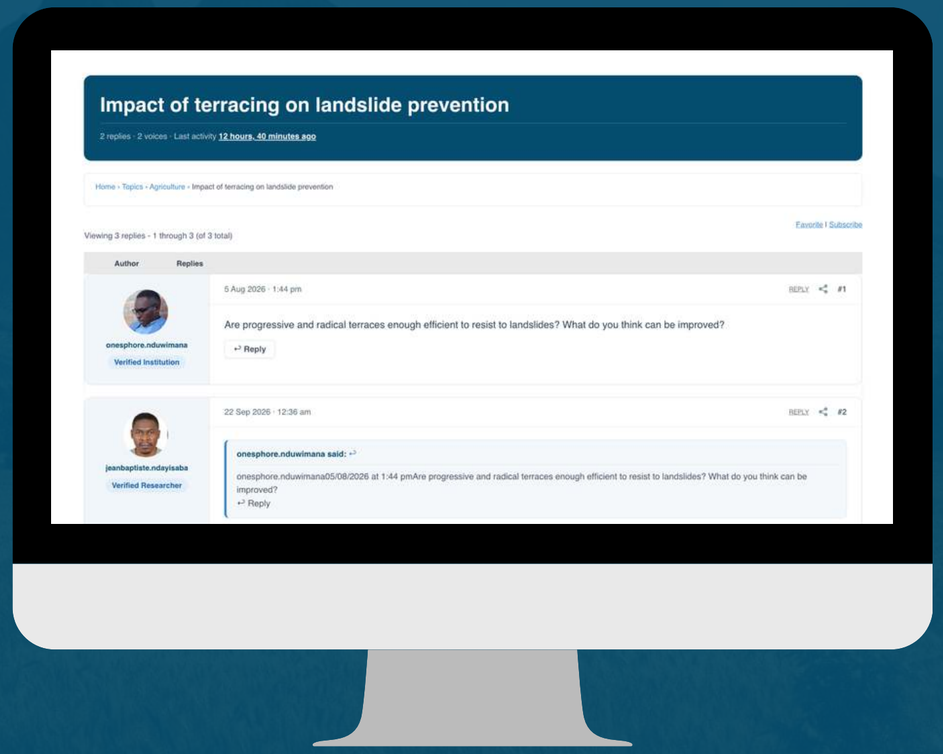
Join the **Discussion**

1. CLICK “FORUM”
Browse the discussions already taking place.

2. JOIN AN EXISTING DISCUSSION
Open a topic that interests you and click Reply to share your perspective, ask a question or add useful information.

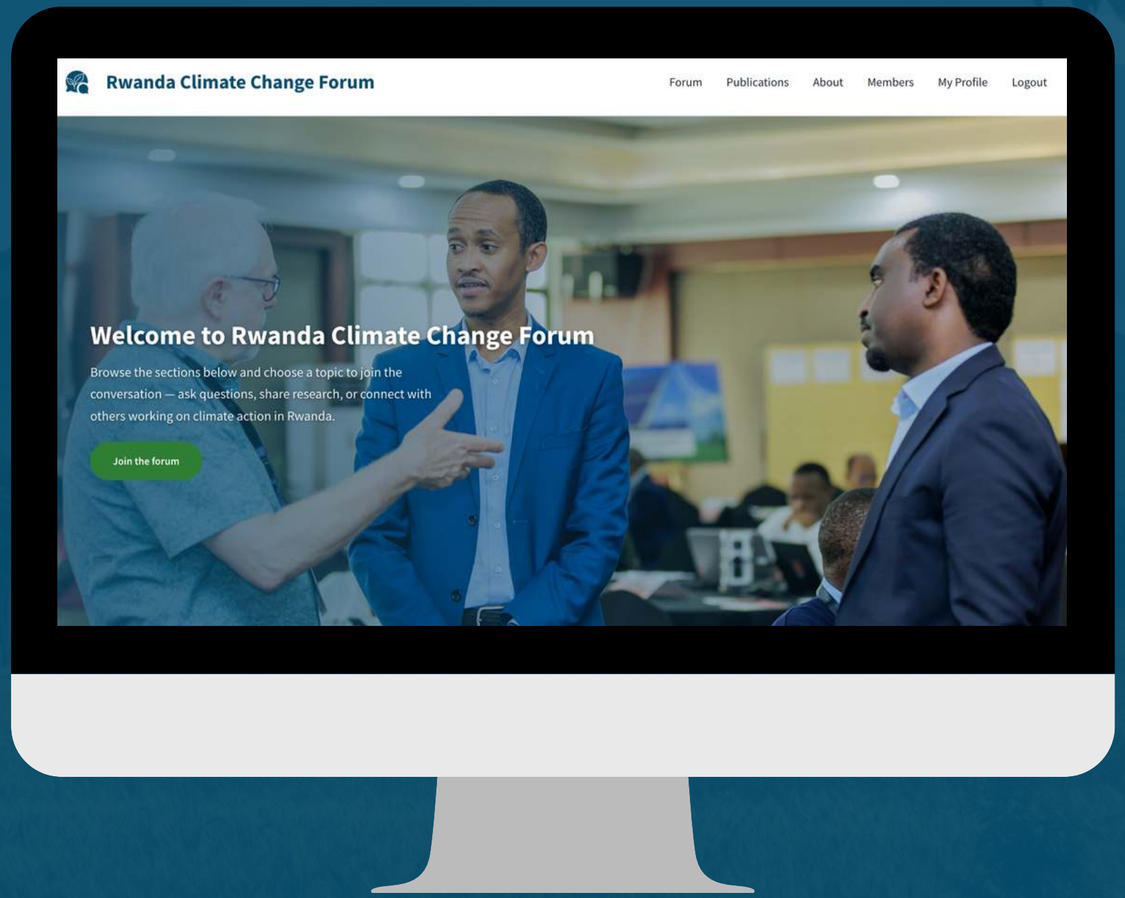
3. START A NEW DISCUSSION
Click Create Discussion to introduce a new topic, question, research finding or opportunity for collaboration.

4. KEEP THE CONVERSATION GOING
Respond to other members, share relevant resources and connect with people working on similar issues.



Rwanda **Climate Change** Forum

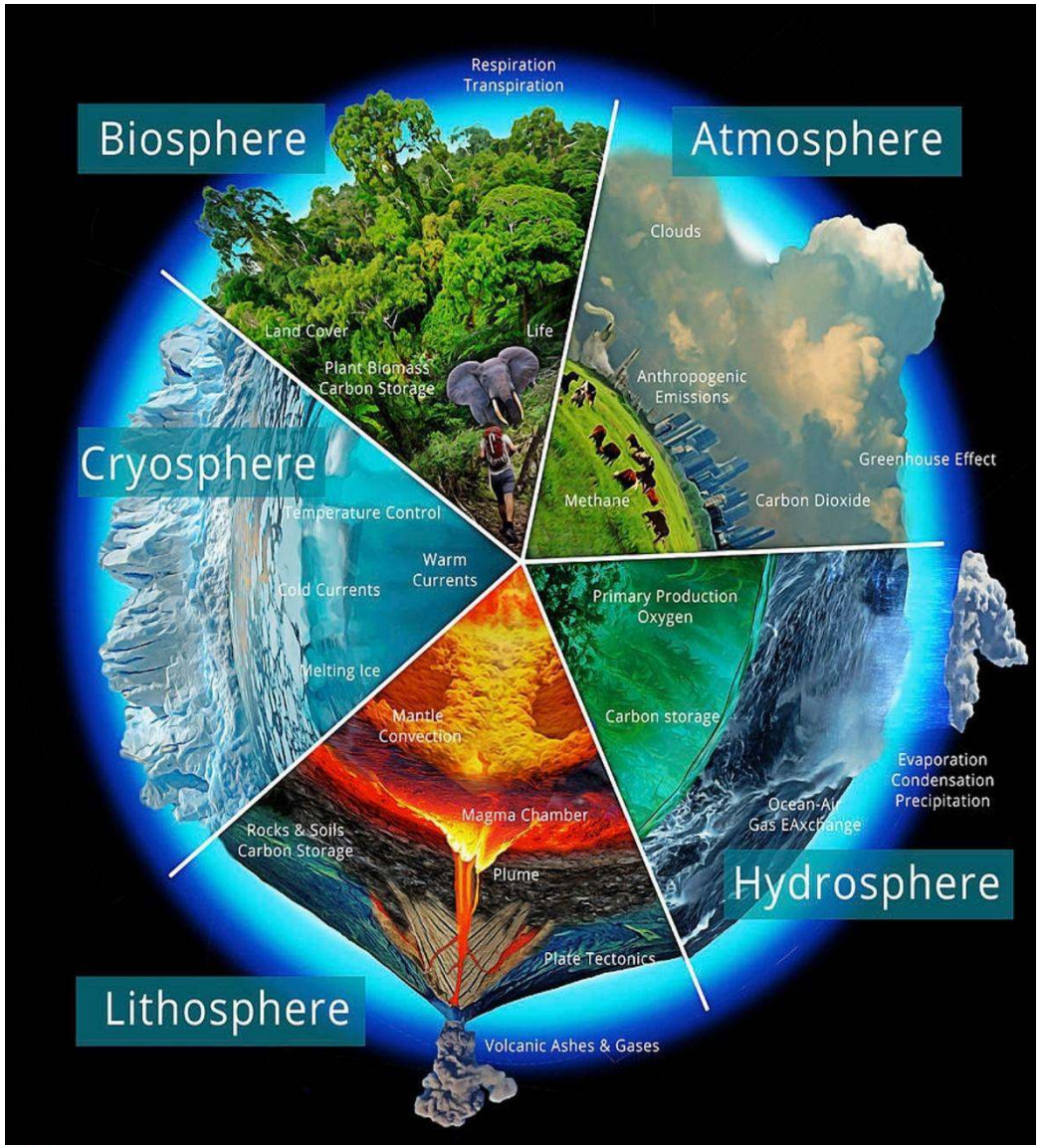
VISIT NOW



THANK YOU
MURAKOZE CYANE

Rwanda **Climate Change** Forum

CONNECT. SHARE. COLLABORATE.



Role of Remote Sensing and Weather Forecast Modelling for Effective Climate Decision and Policy Making

Presented by
Dr. Didier Ntwali
Division Manager of Earth and Space Sciences Division
Rwanda Space Agency

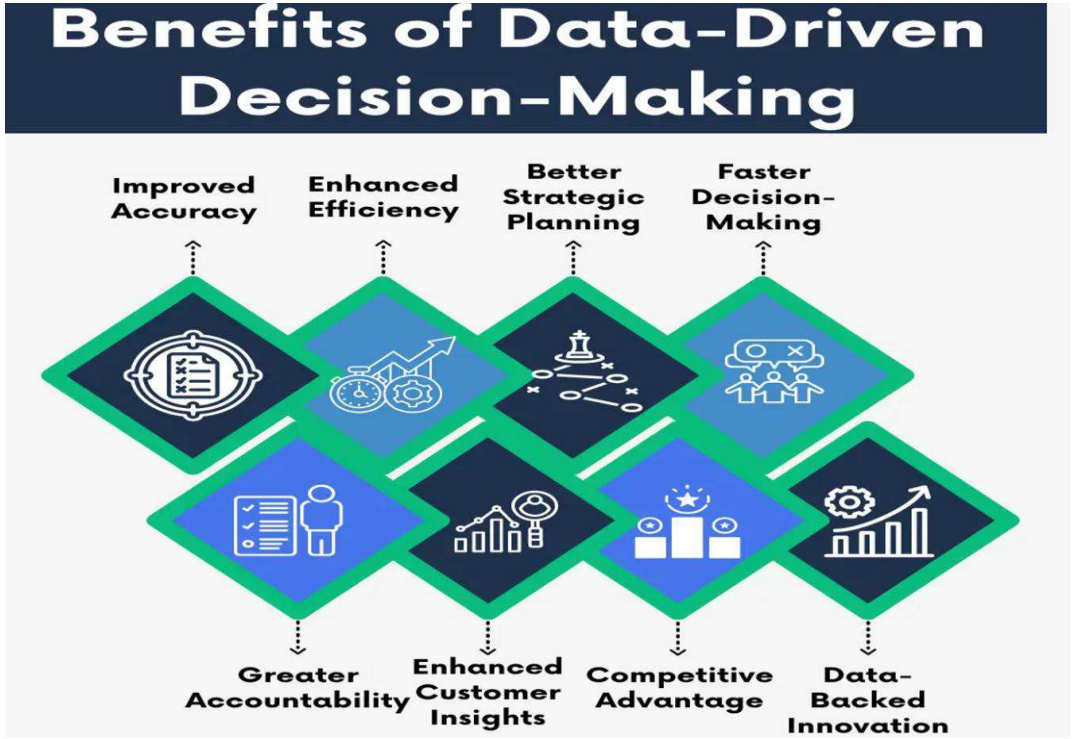
At the 2nd Rwanda Climate Science Symposium
22-23 September 2026

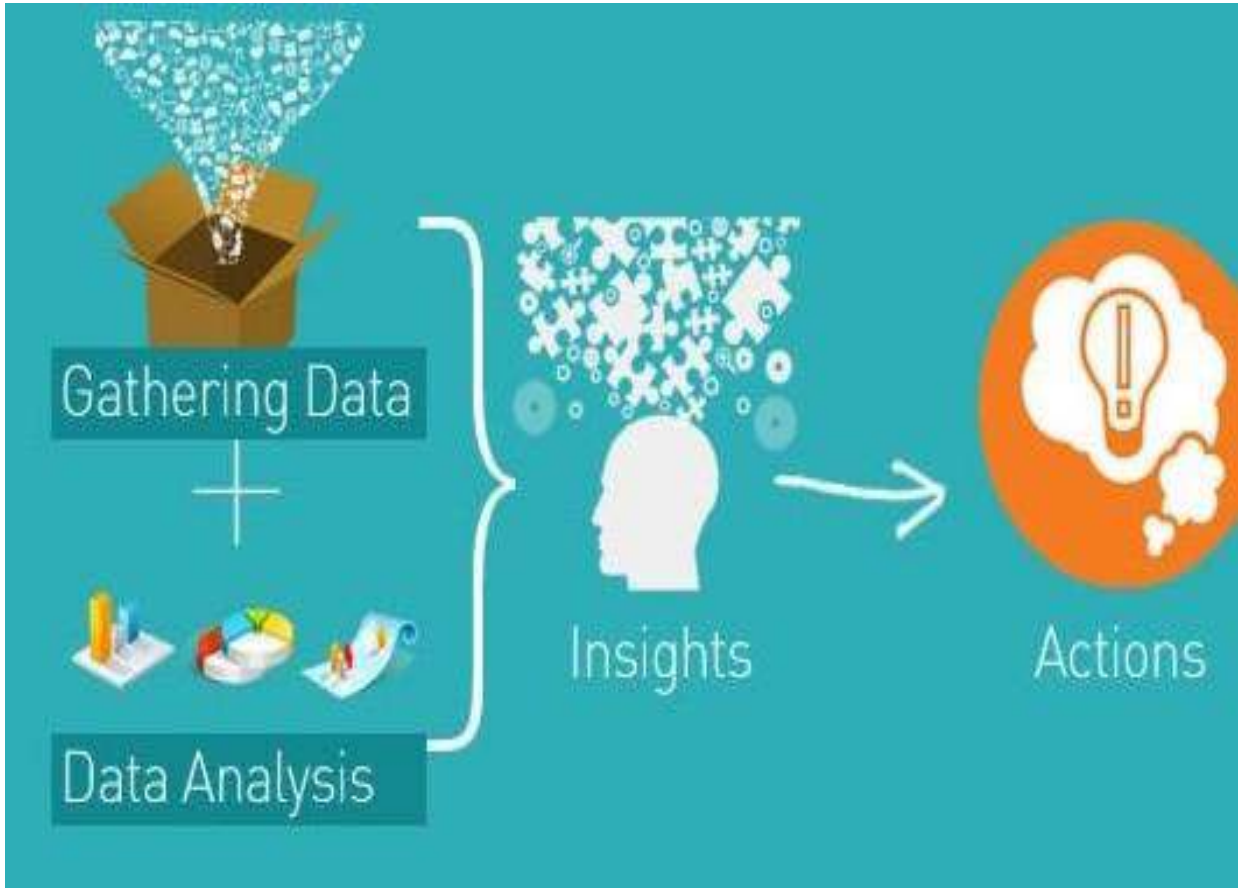
Outline

- Role of Data on Decision, Action, Regulation, Policy, Strategy
- Potential Sources of Climate Data/Climate Data is not only Temperature and Rainfall
- Applications in Weather Monitoring/Weather Nowcast & Weather Forecast
- Applications of Climate Insights in Agriculture Sector
- Applications of Climate Insights in Water Resources/Hydrology Sector
- Applications of Climate Insights in Environment – Air Quality
- Applications of Climate Insights in Urbanization
- Applications of Climate Insights in Forestry Sector
- Applications of Climate Insights in Disaster Management Sector
- Applications of Climate Insights in Health Sector

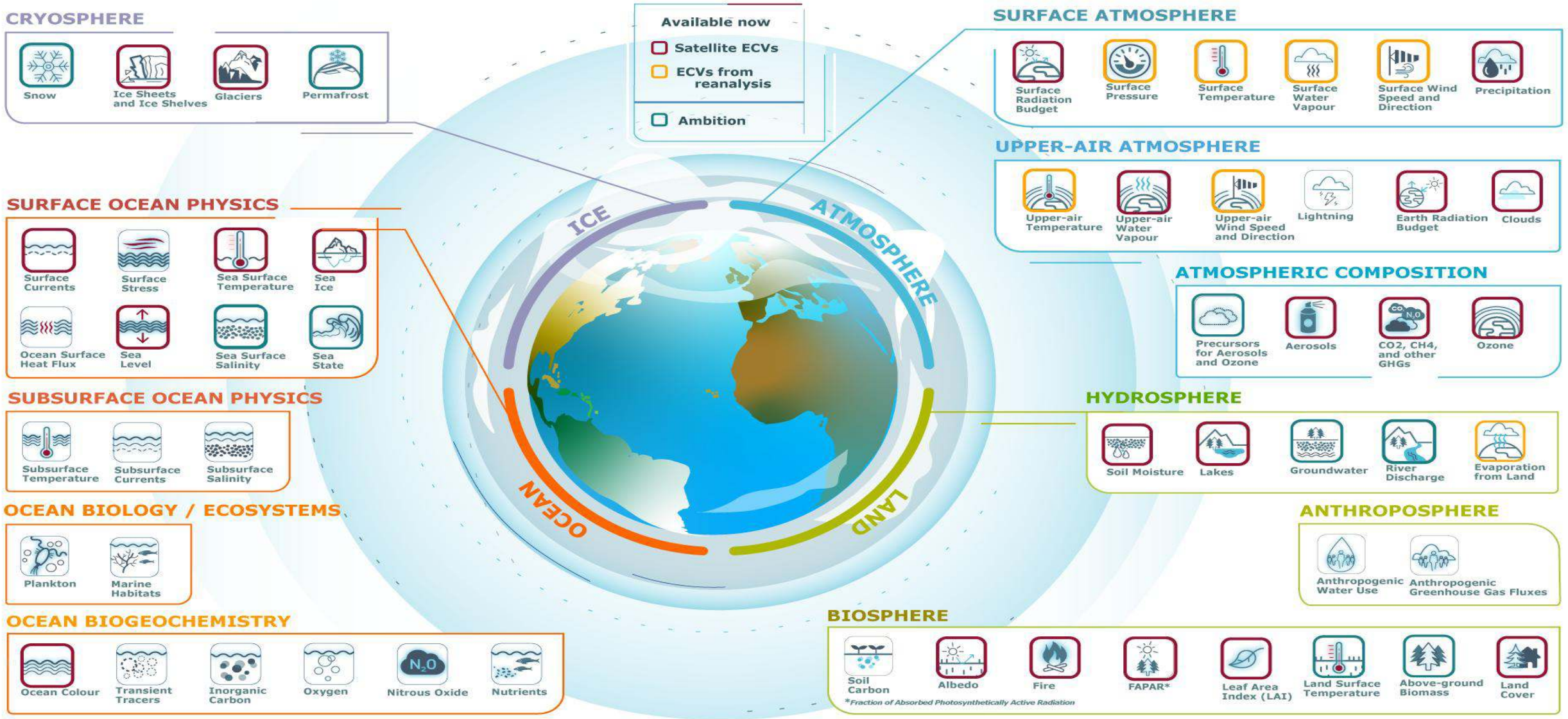
ROLE OF DATA ON DECISION – ACTION – REGULATION - POLICY – STRATEGY







CLIMATE DATA IS NOT TEMPERATURE AND RAINFALL ONLY!!



PROGRAMME OF THE EUROPEAN UNION

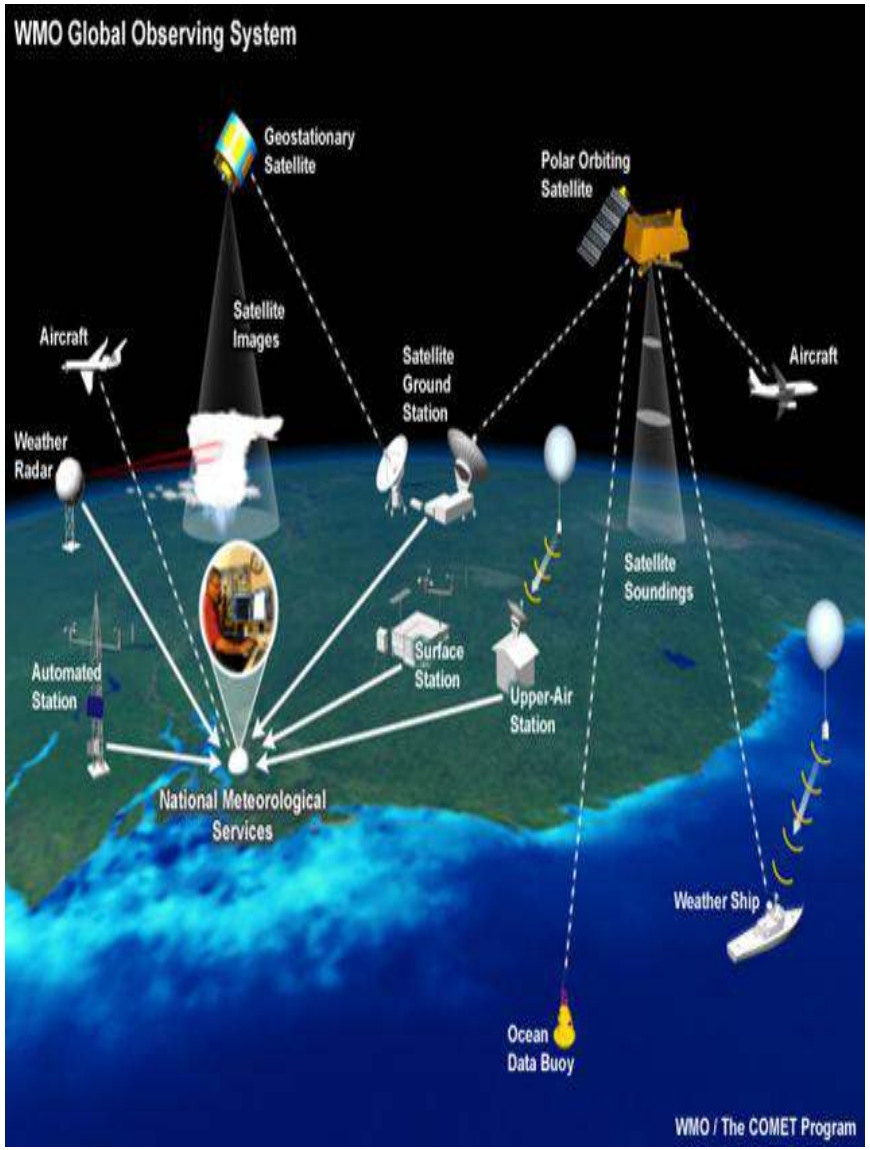
Copernicus Europe's eyes on Earth

IMPLEMENTED BY ECMWF

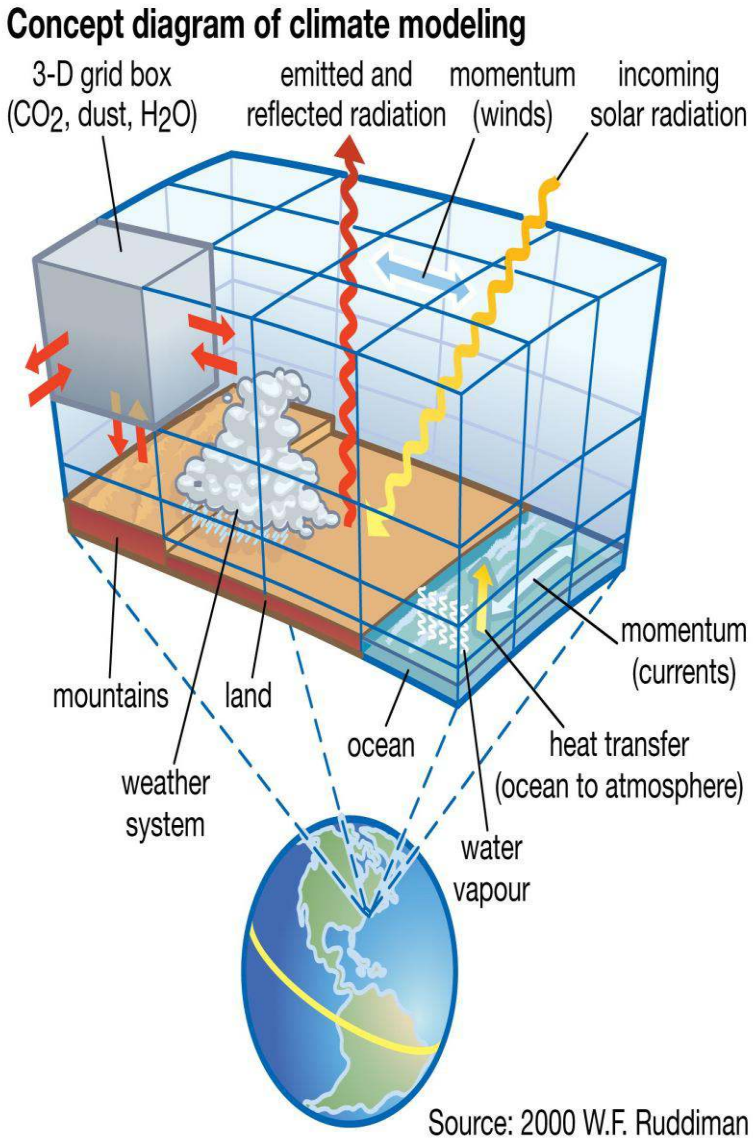
Climate Change Service

POTENTIAL SOURCES OF CLIMATE DATA

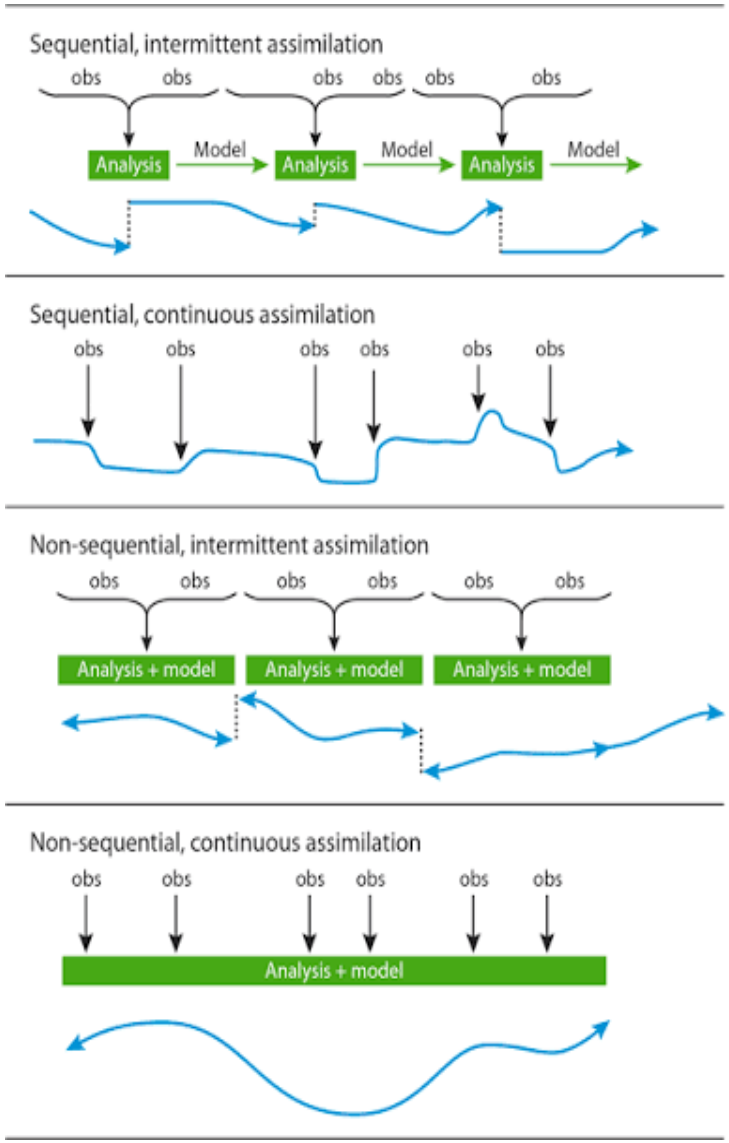
Observations



Model



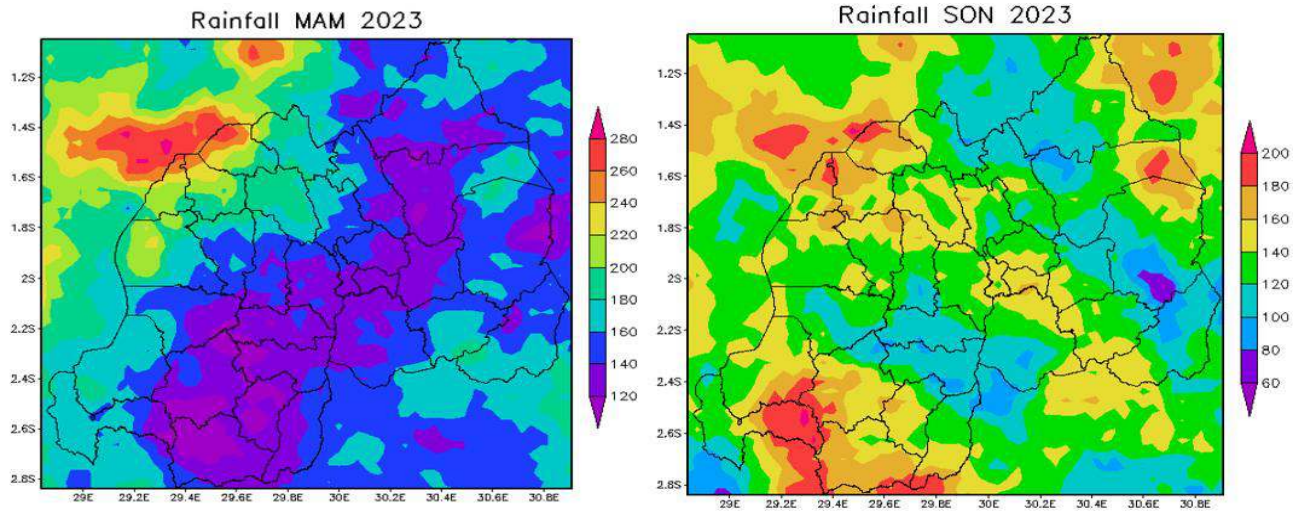
Reanalysis



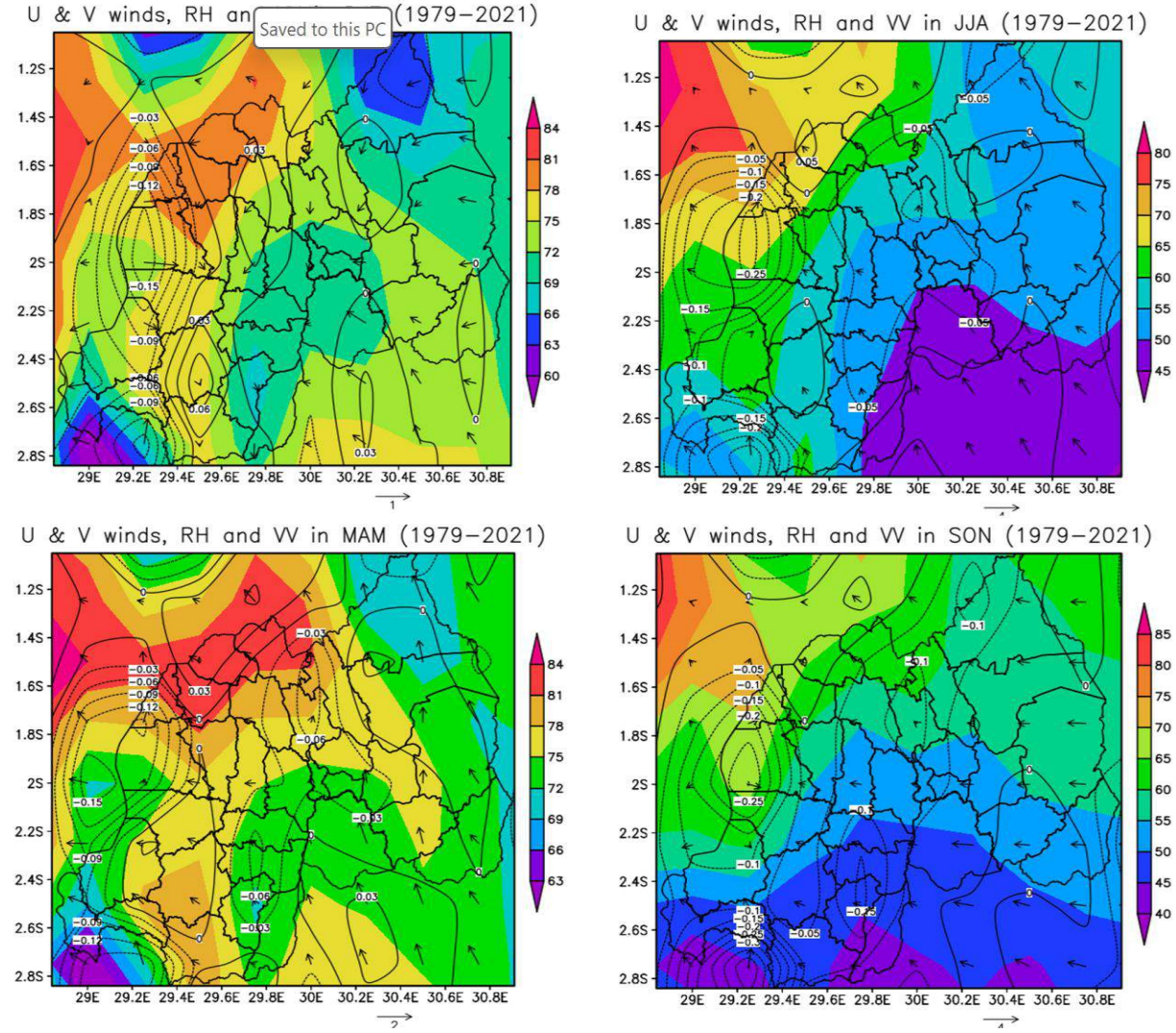
1. Applications in Weather & Climate Monitoring

Climatology of Rainfall, U, V, RH

Rainfall Variability in 1983 and 2023

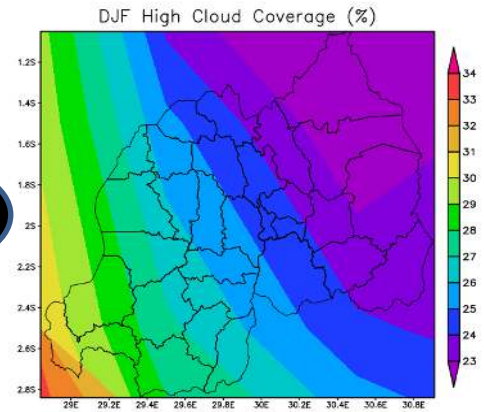


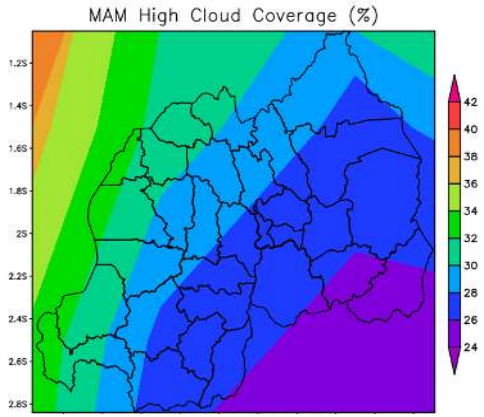
U & V & RH Climatology (1979 -2021)

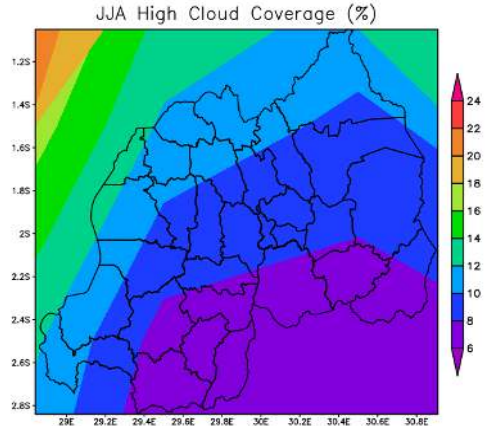


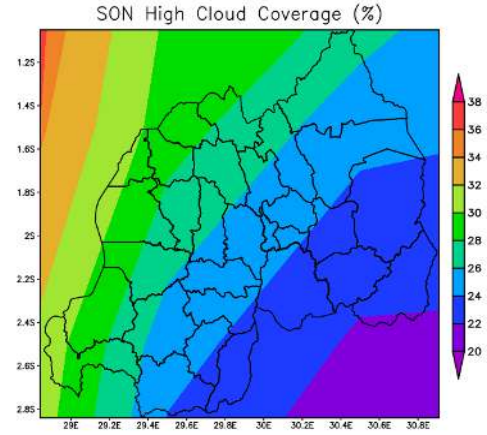
Climatology of high, middle and low cloud coverage

HC

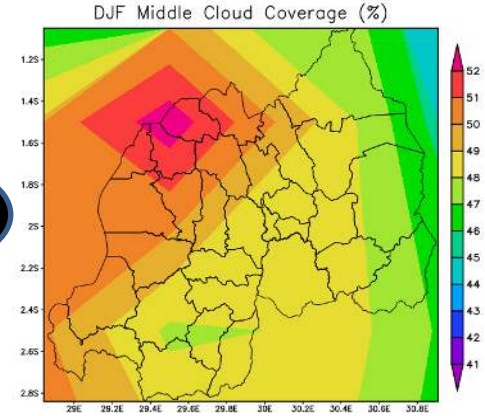


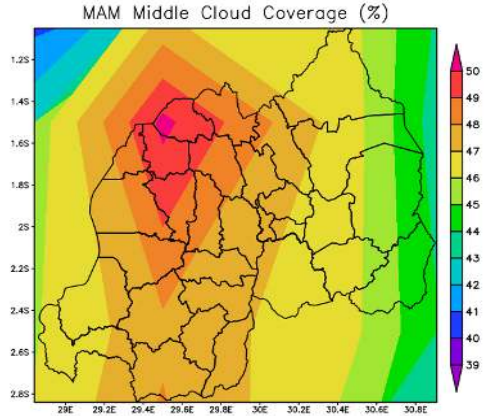


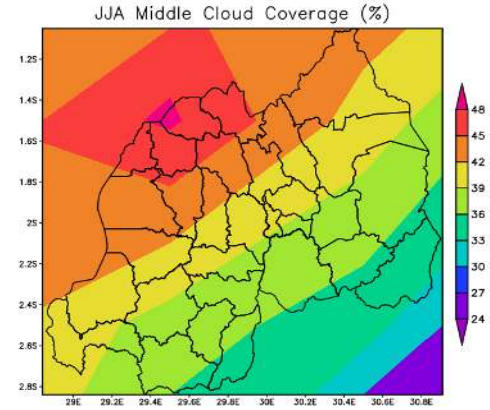


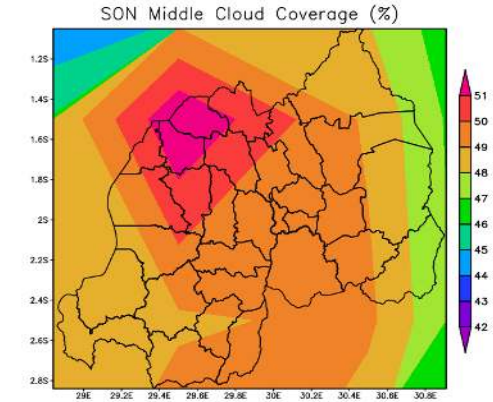


MC

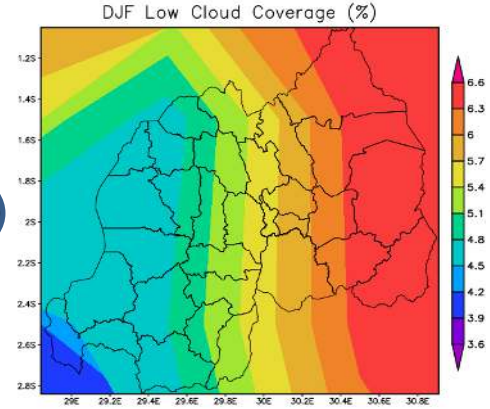


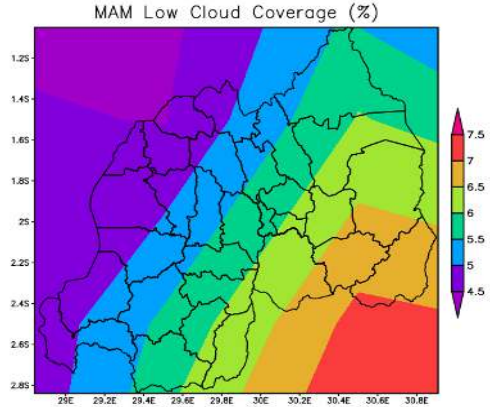


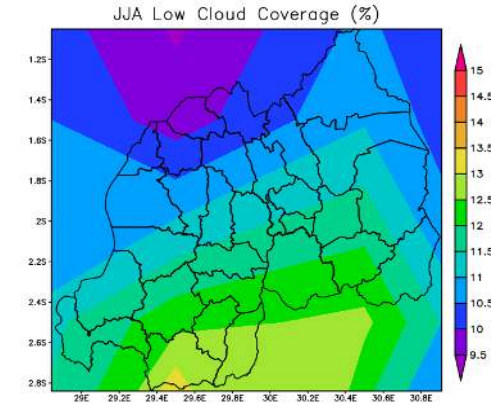


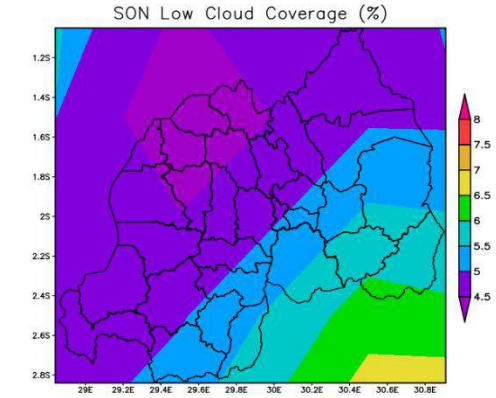


LC



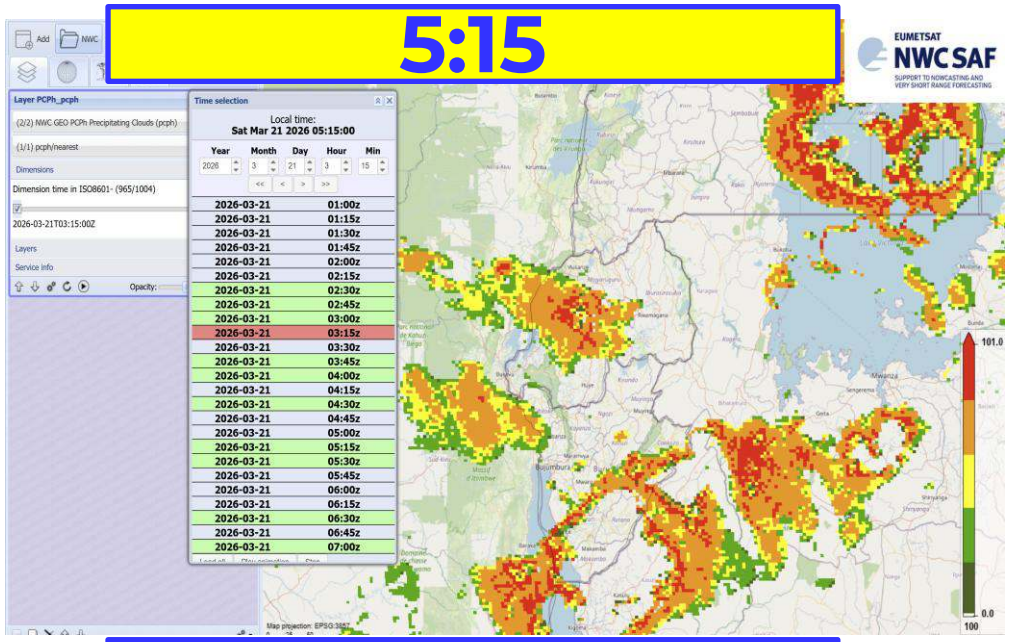




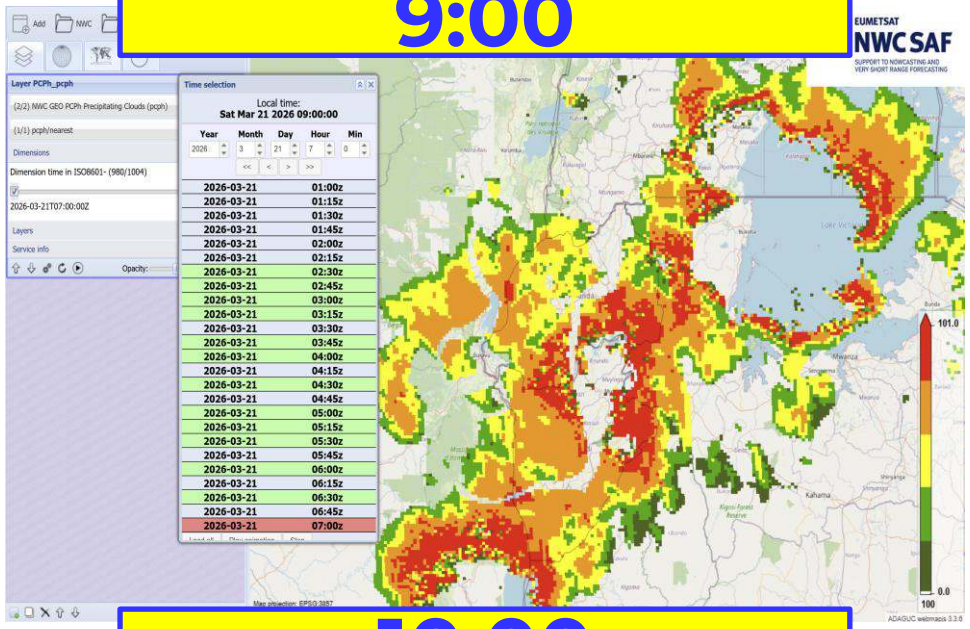


RSA WEATHER MONITORING OVER RWANDA BASED ON SATELLITE OBSERVATIONS

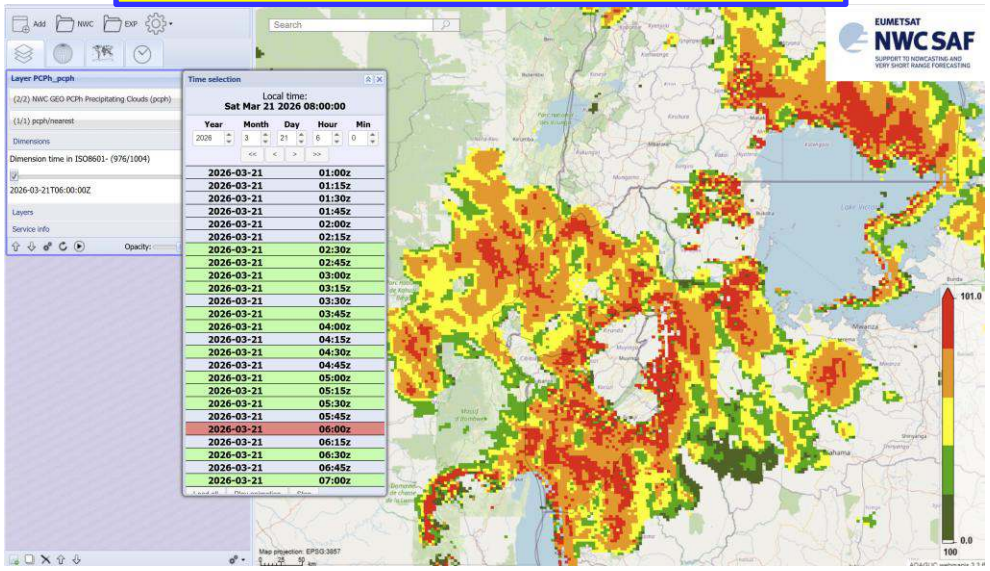
5:15



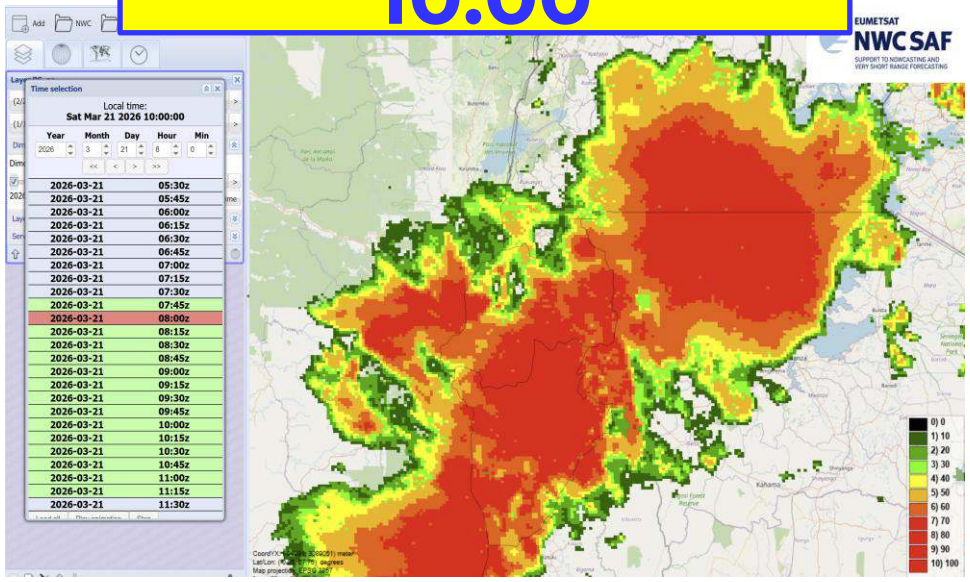
9:00



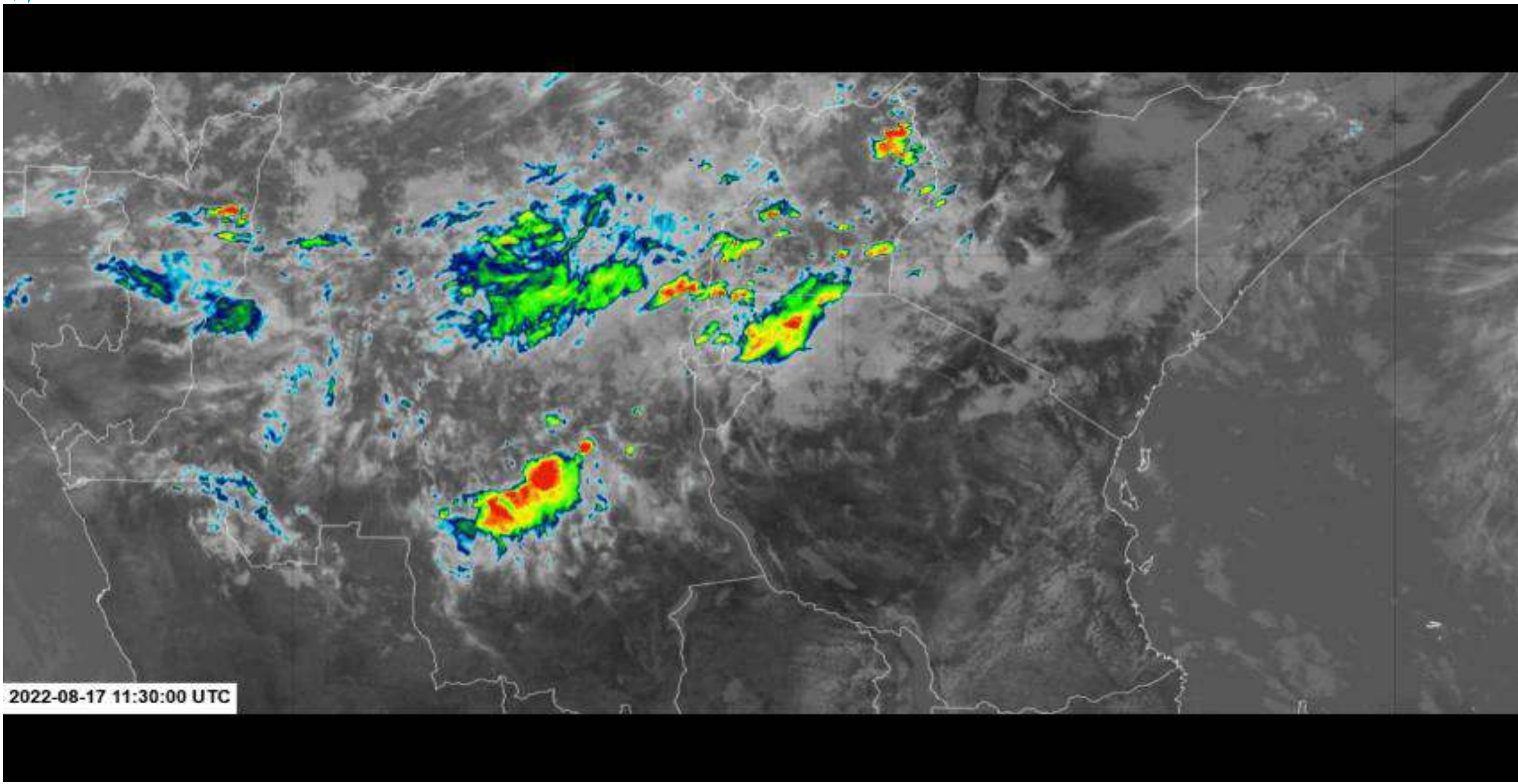
8:00



10:00



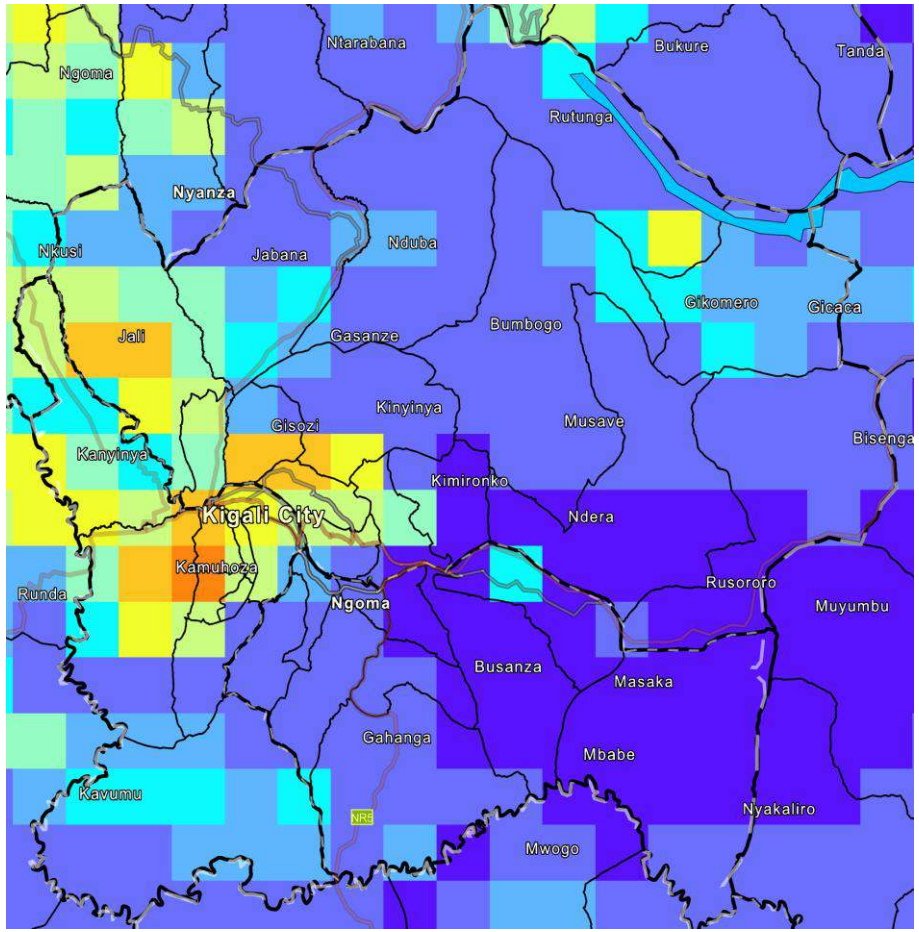
WEATHER MONITORING OVER RWANDA BASED ON SATELLITE OBSERVATIONS



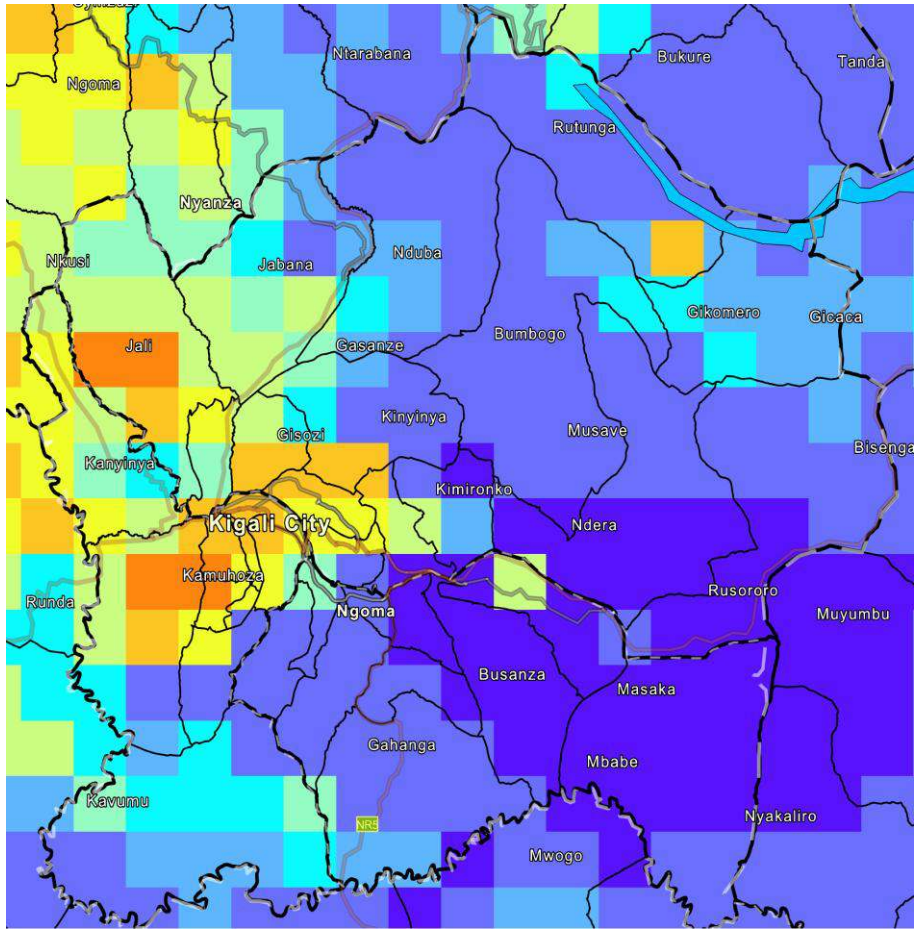
NECC Report & Model Forecast at Cell Level

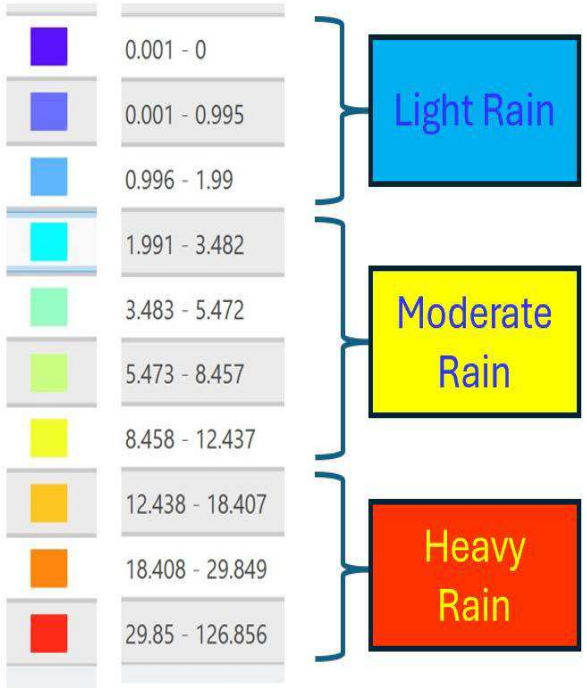
NECC Report: On 7 May 2026 at 17h30 Nyarugenge district, Nyarugenge sector, Agatare cell, Meraneza village heavy rain damaged the house belonging to Mukeshimana injured Byukusenge Djasumin 5yrs, the child was sent to Nyarugenge hospital for medical treatment; Nyamirambo sector, Rugarama cell, Rugarama village heavy rain damaged Miduha road, Police intervened to facilitate traffic mvt

WRF-ARW rainfall forecast at 17h00



WRF-ARW rainfall forecast at 18h00

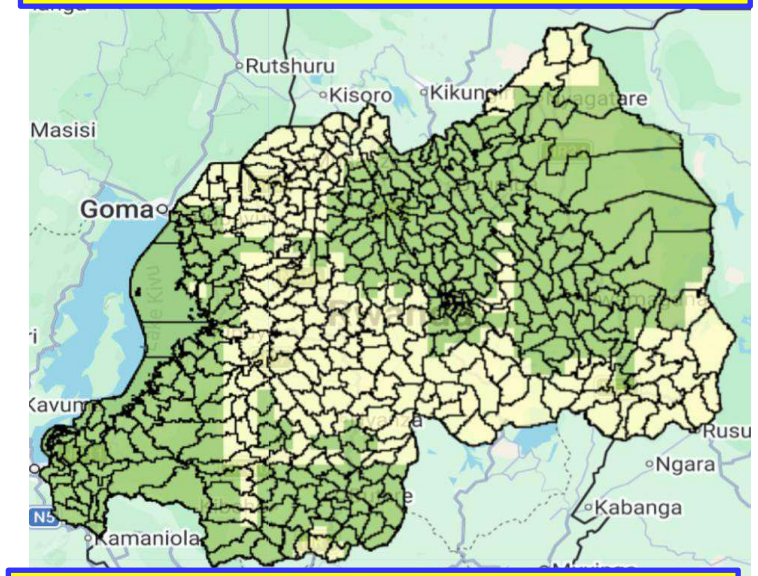




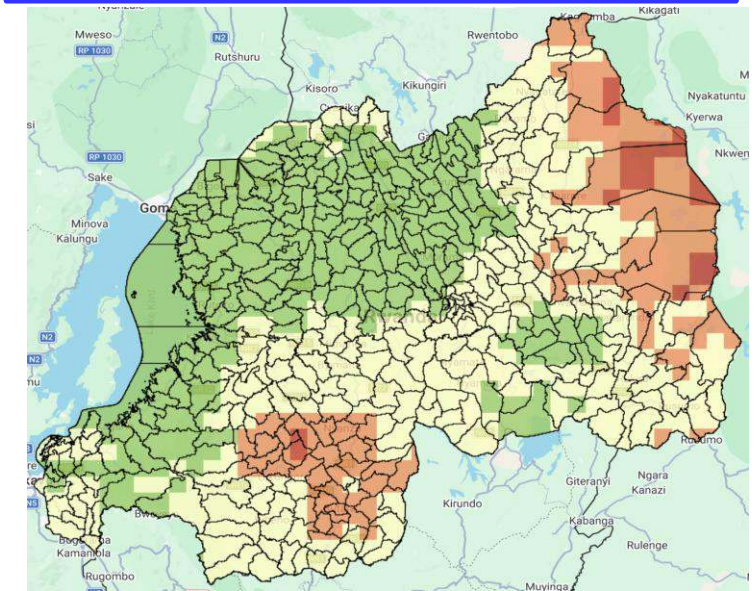
2. Applications of Climate Insights in Agriculture Sector

Drought

Year 1981

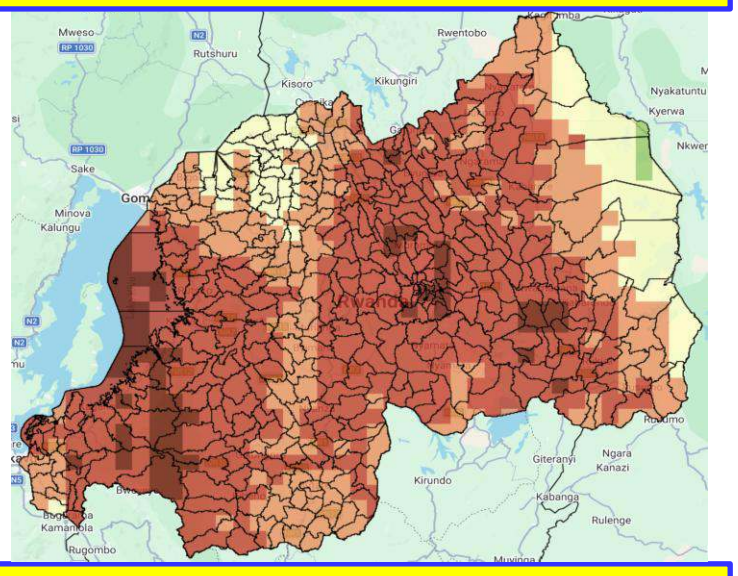


Year 1990

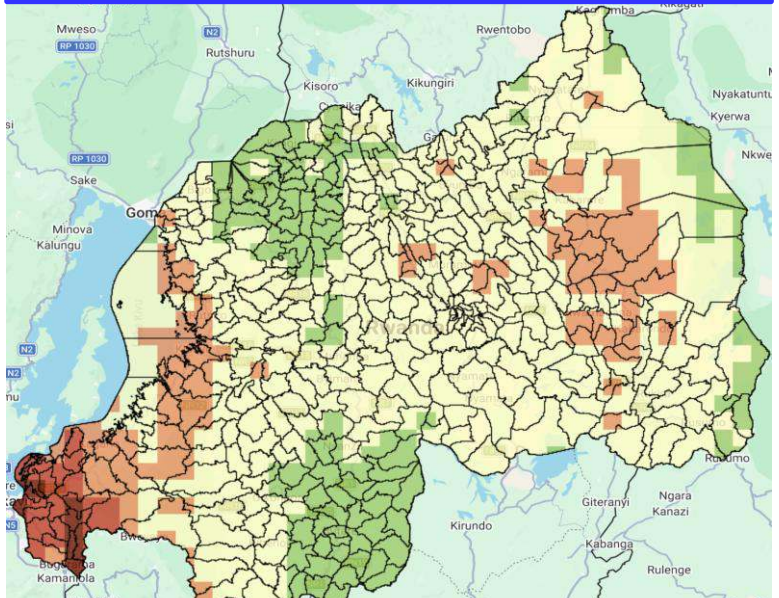


- Severe drought
- Moderate
- Mild
- Near-normal
- Wet

Year 2014

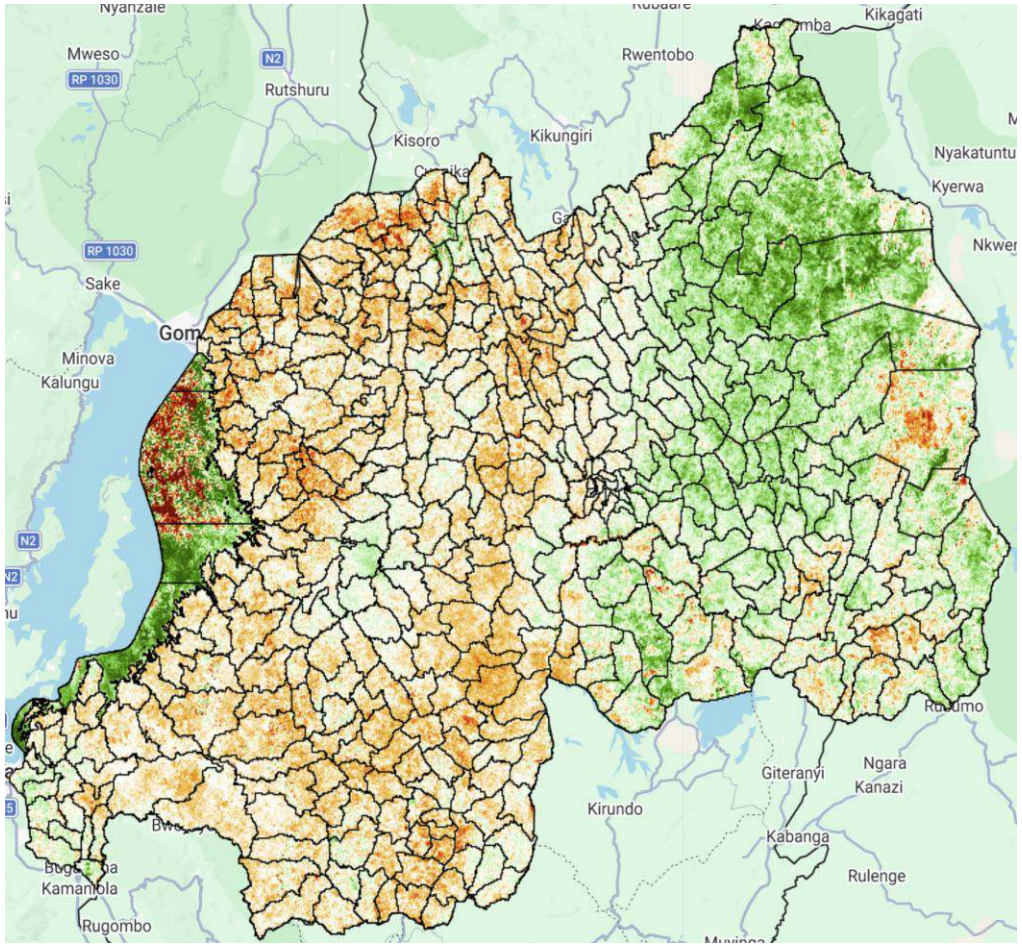


Year 2024



Agricultural Vegetation Change from 2005 to 2015 and 2015 to 2025

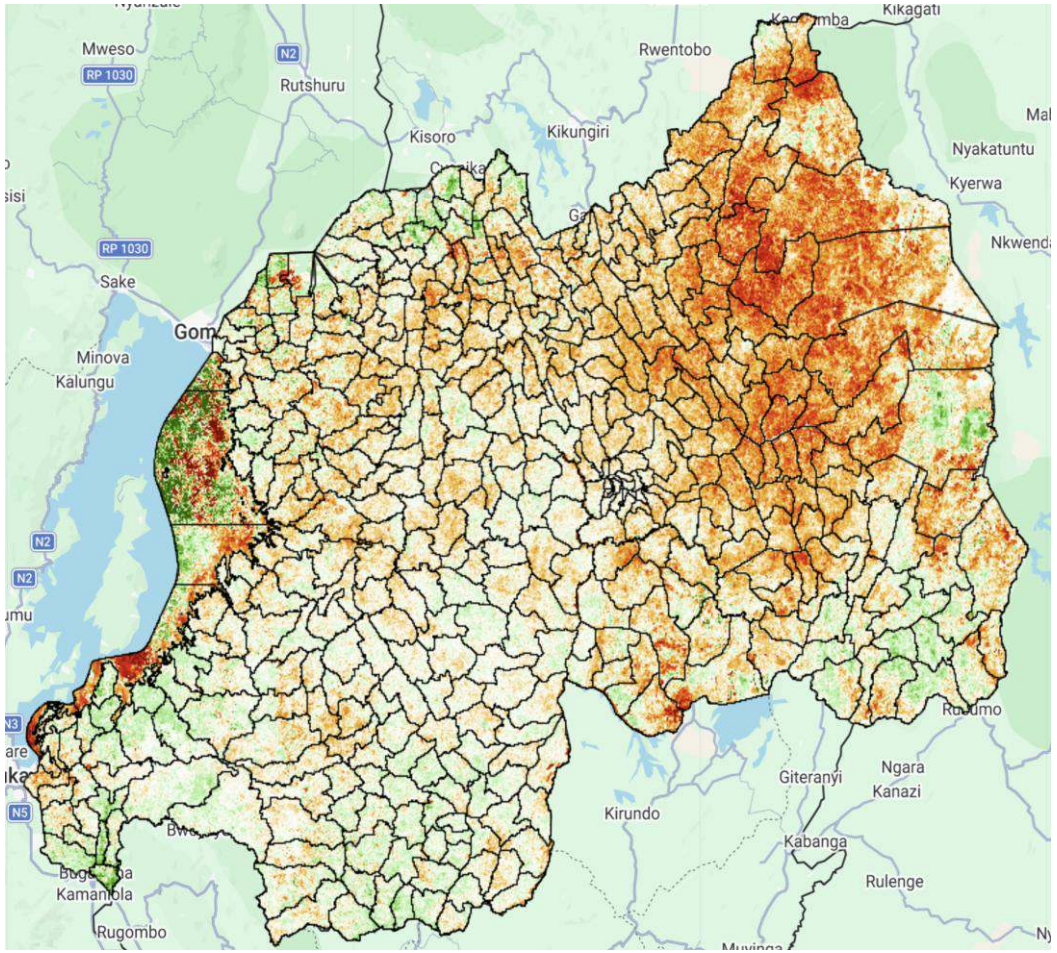
2022 NDVI – 2021 NDVI



Agricultural NDVI Change

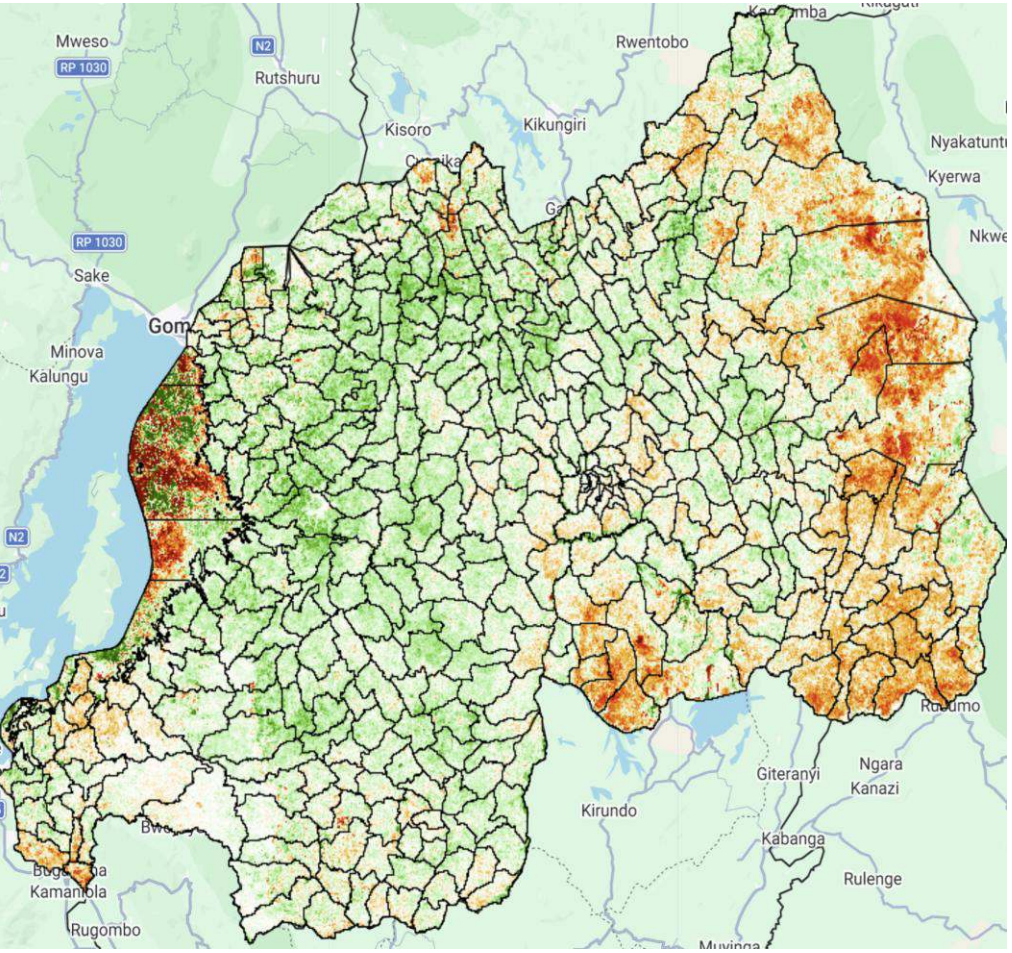
- < -0.20 | Strong agricultural vegetation decline
- -0.20 to -0.10 | Moderate agricultural vegetation decline
- -0.10 to -0.02 | Slight agricultural vegetation decline
- -0.02 to +0.02 | Stable agricultural vegetation
- +0.02 to +0.10 | Slight agricultural vegetation increase
- +0.10 to +0.20 | Moderate agricultural vegetation increase
- > +0.20 | Strong agricultural vegetation increase

2023 NDVI – 2022 NDVI



Agricultural Vegetation Change from 2005 to 2015 and 2015 to 2025

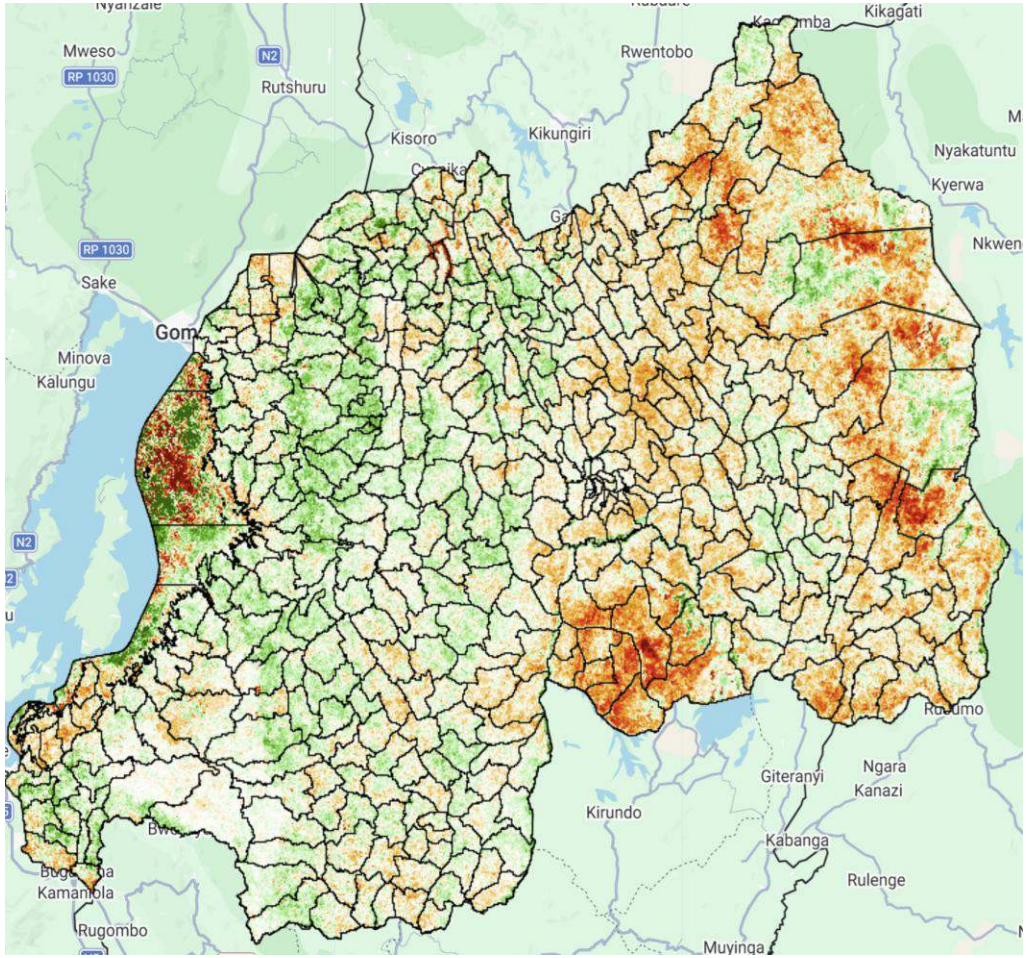
2024 NDVI – 2023 NDVI



Agricultural NDVI Change

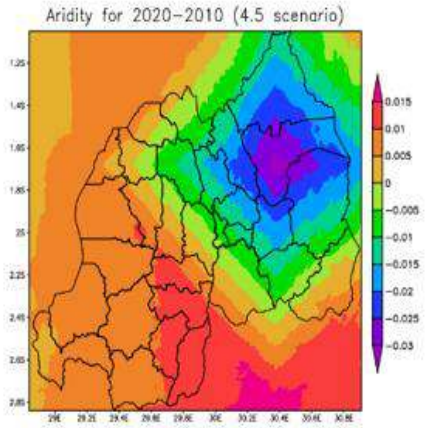
- < -0.20 | Strong agricultural vegetation decline
- -0.20 to -0.10 | Moderate agricultural vegetation decline
- -0.10 to -0.02 | Slight agricultural vegetation decline
- -0.02 to +0.02 | Stable agricultural vegetation
- +0.02 to +0.10 | Slight agricultural vegetation increase
- +0.10 to +0.20 | Moderate agricultural vegetation increase
- > +0.20 | Strong agricultural vegetation increase

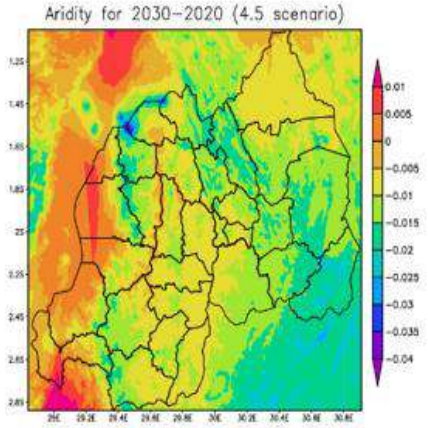
2025 NDVI – 2024 NDVI

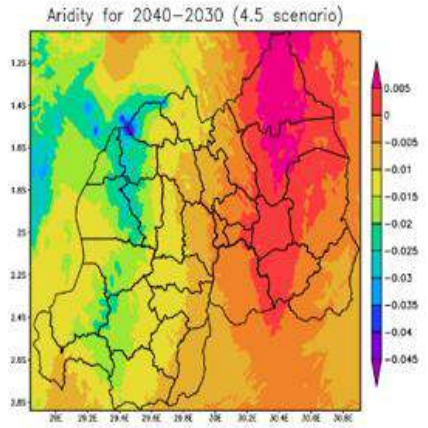


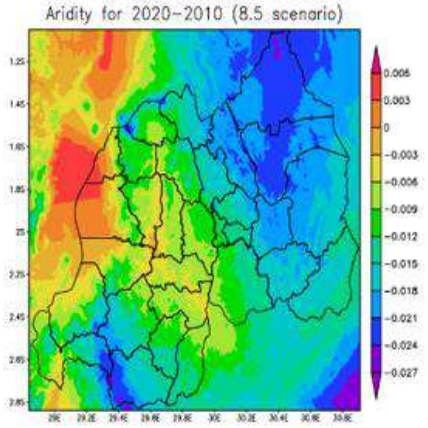
ESSD Activities: Climate Change - Climate Projections in Agriculture & Food Security and Water Resources Management

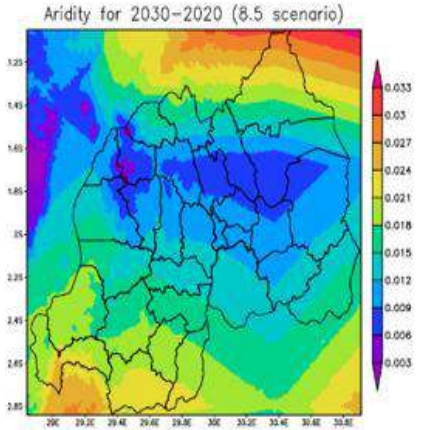
The use of climate projections to improve our policies on climate change mitigation and adaptation in agriculture and food security

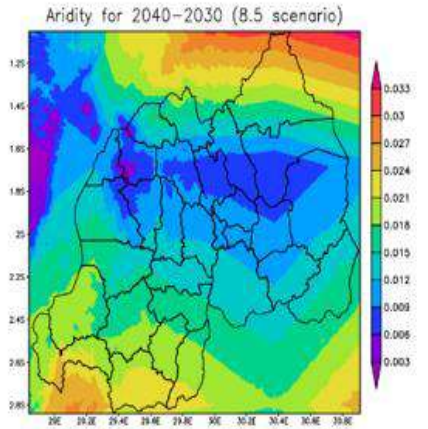


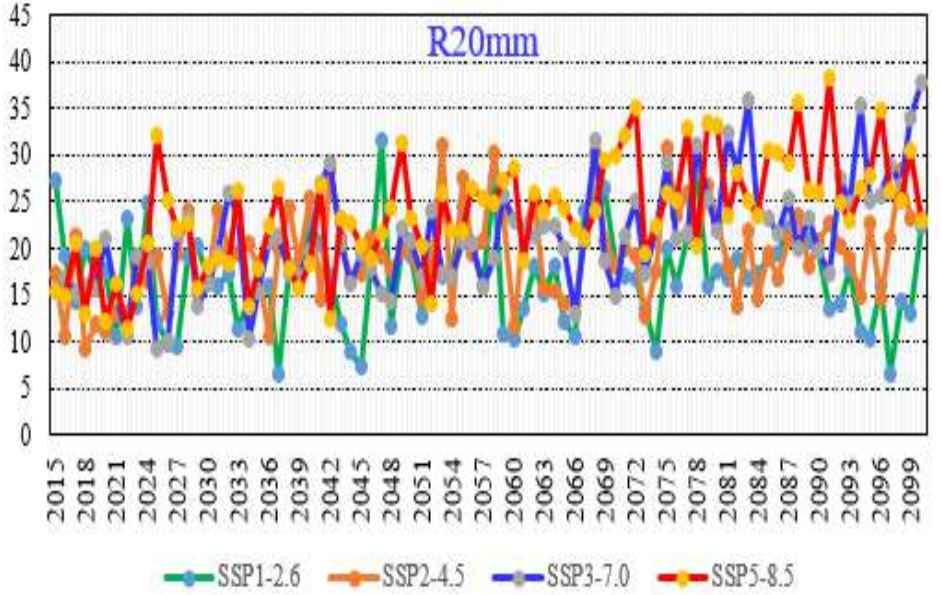


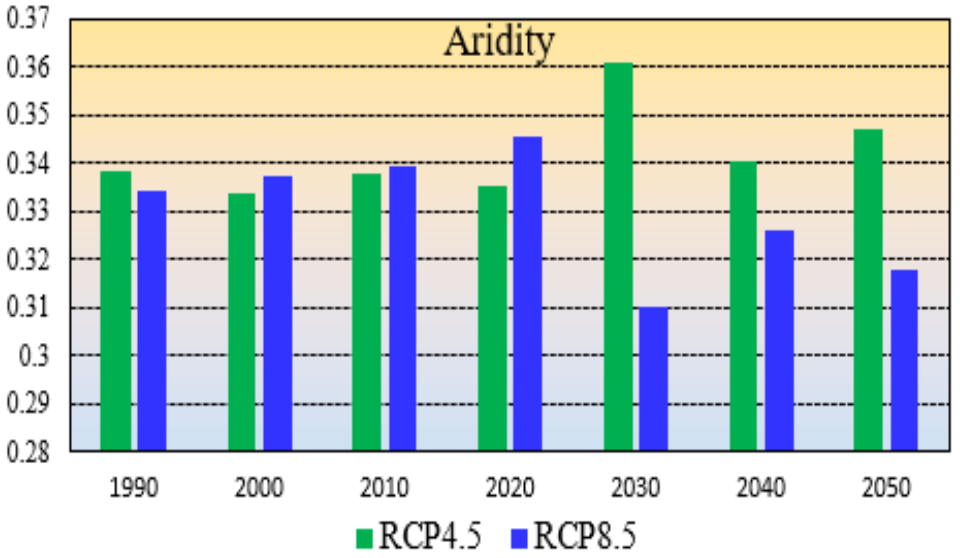






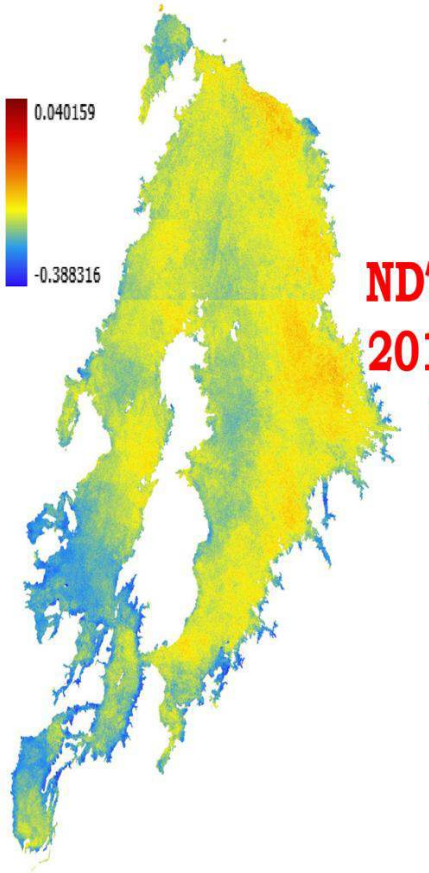






3. Applications of Climate Insights in Water Resources/Hydrology Sector

Water Quality



NDTI Mean from 2017 to 2024 at Lake Kivu

Surface Water Change

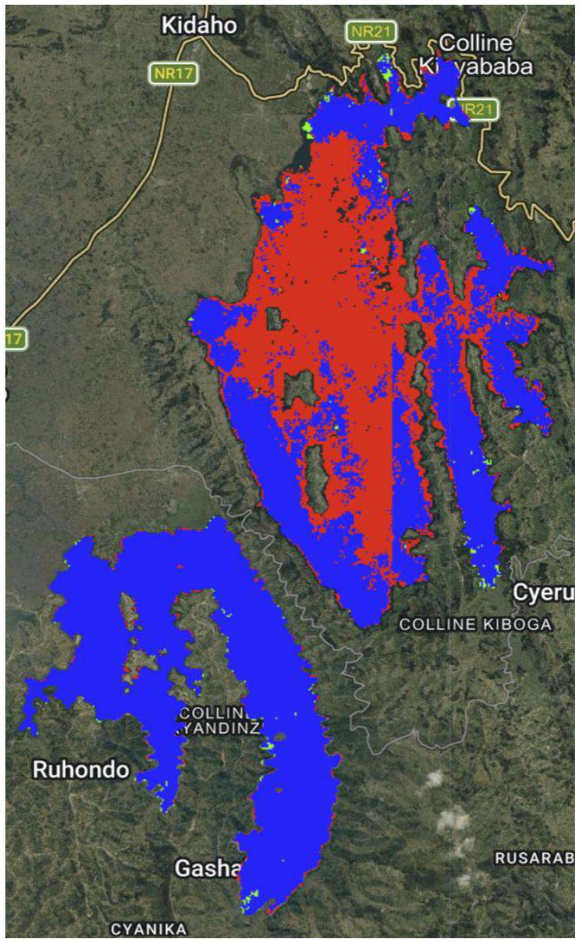
2018 → 2026

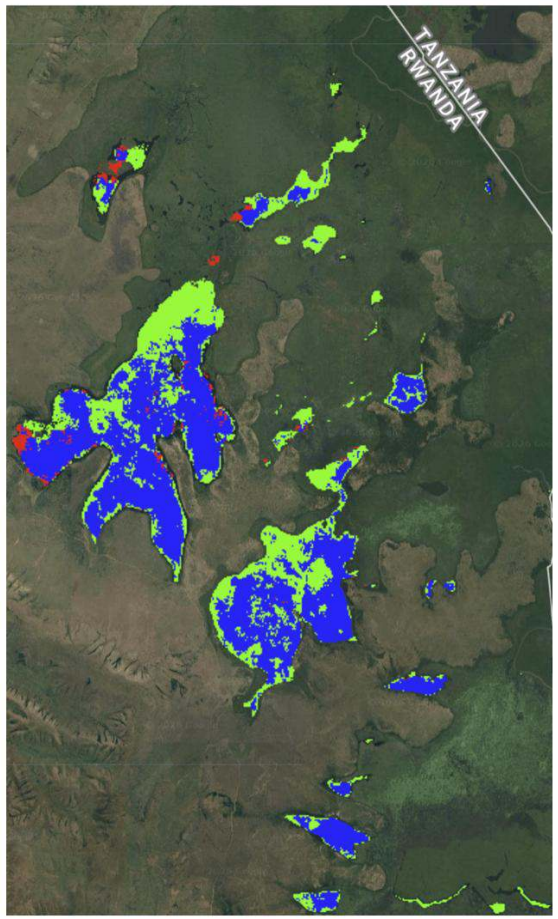
Blue = Water present in both years

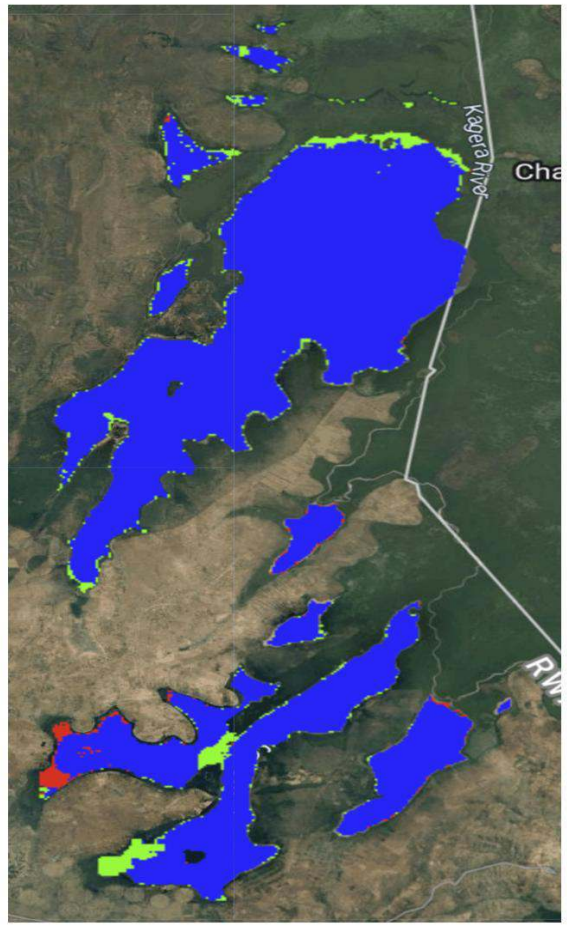
Green = Water expansion

Red = Water reduction





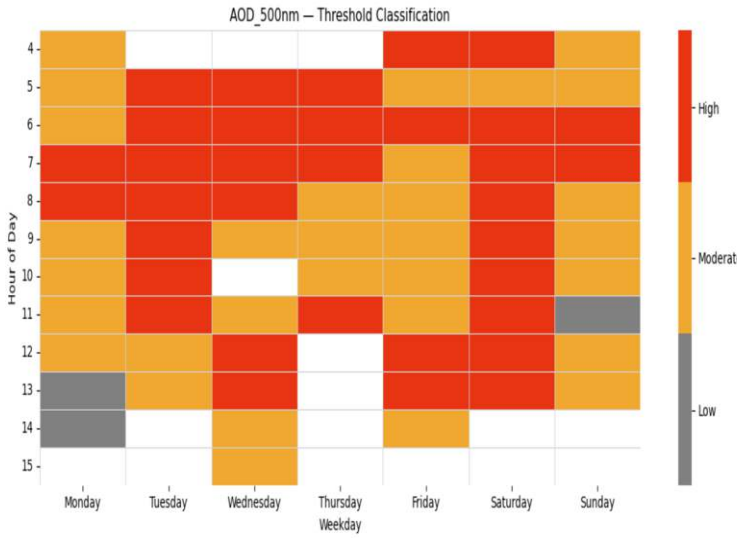


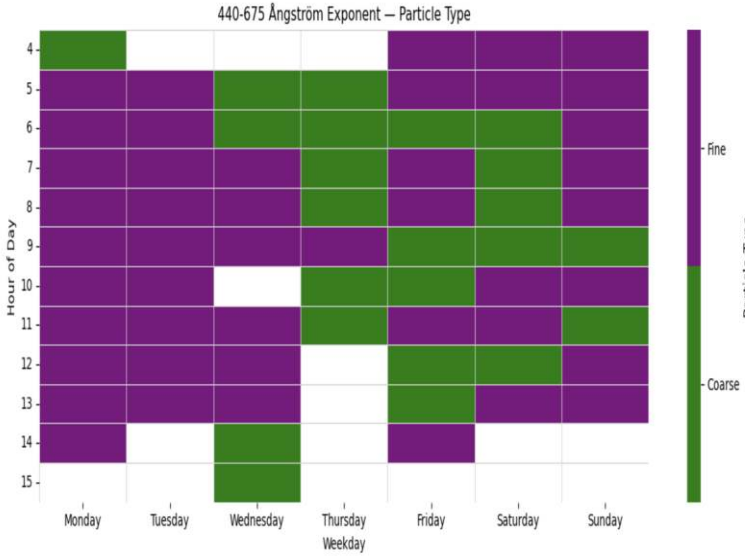


4. Applications of Climate Insights in Environment – Air Quality

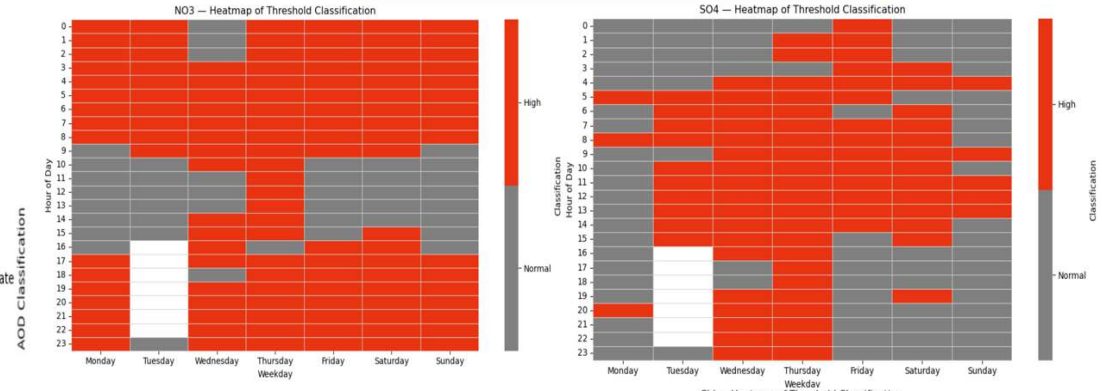
Air Pollutants Measurements

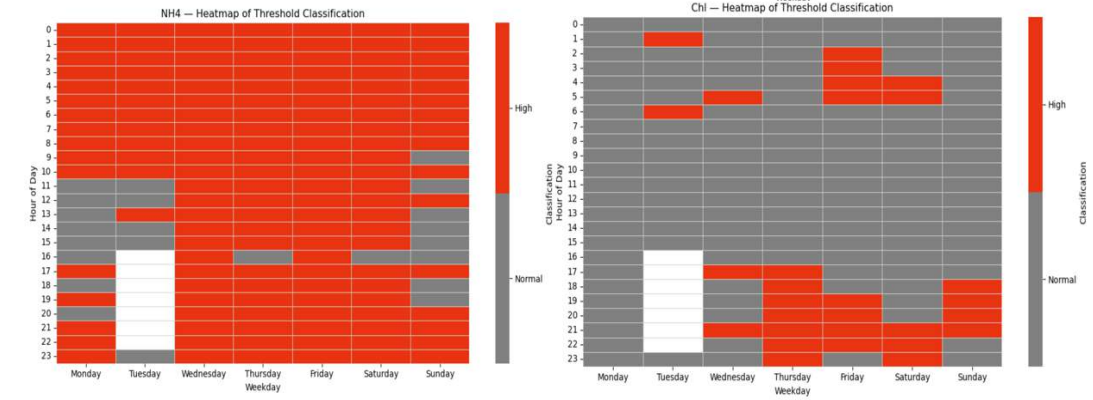
AERONET Cimel Sun Photometer Data Analysis

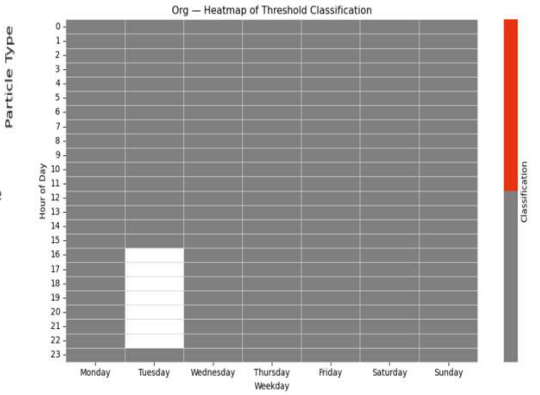




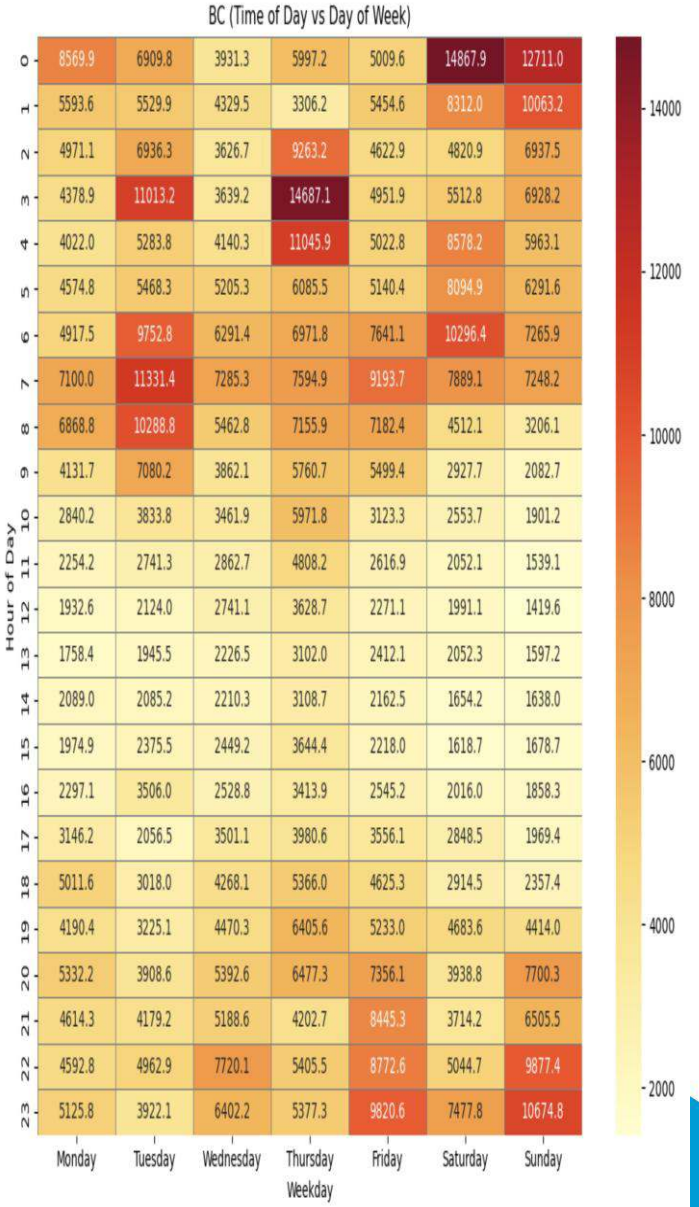
ACSM instrument data analysis







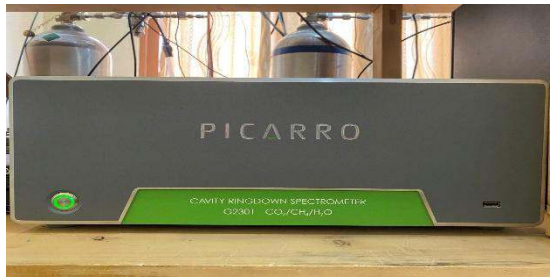
Aethalometer Data Analysis



RCO Activities at Mugogo station – Greenhouse Gases (GHG) Measurements based on PICARRO



Picarro G2401: $CO_2/CH_4/H_2O/CO$ measurements

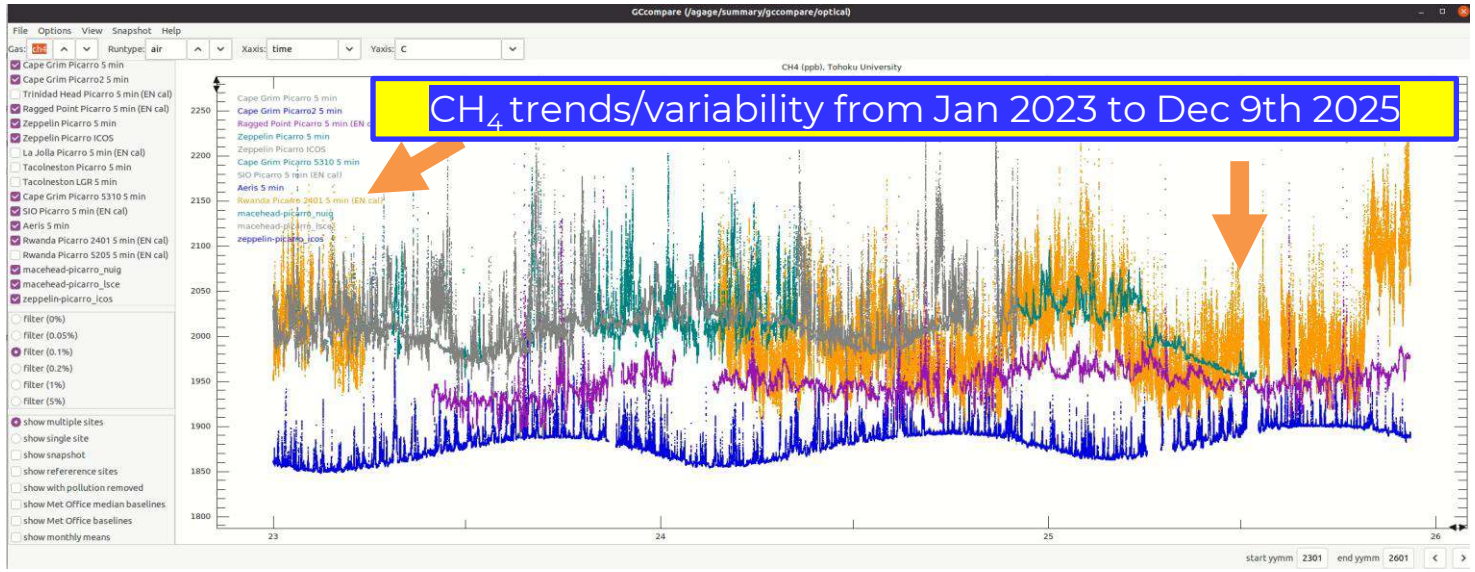


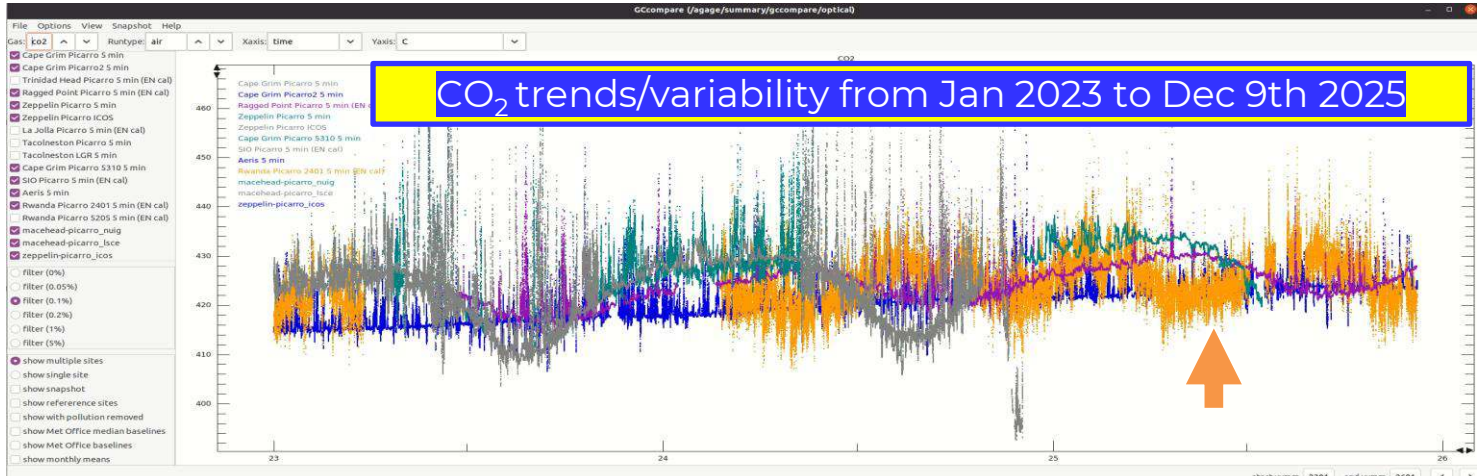
Picarro G2301: $CO_2/CH_4/H_2O$ measurements



Picarro G5105: N_2O/H_2O measurements

Picarro Data Analysis of GHG & Reports to contribute to effective national environmental policies





Rwanda's new NDC 3.0 action: mitigation target of 53% reduction in greenhouse gas emissions by 2035 compared to significant increase from the 38% target for 2030 under NDC 2.0.

Greenhouse Gases (GHG) Measurements based on Picarro G2401 and Picarro G2301 Instruments of RCO/RSA

Scientific Team: Dr. Didier Ntwali, Dr. Fabien Idrissa Nkurunziza

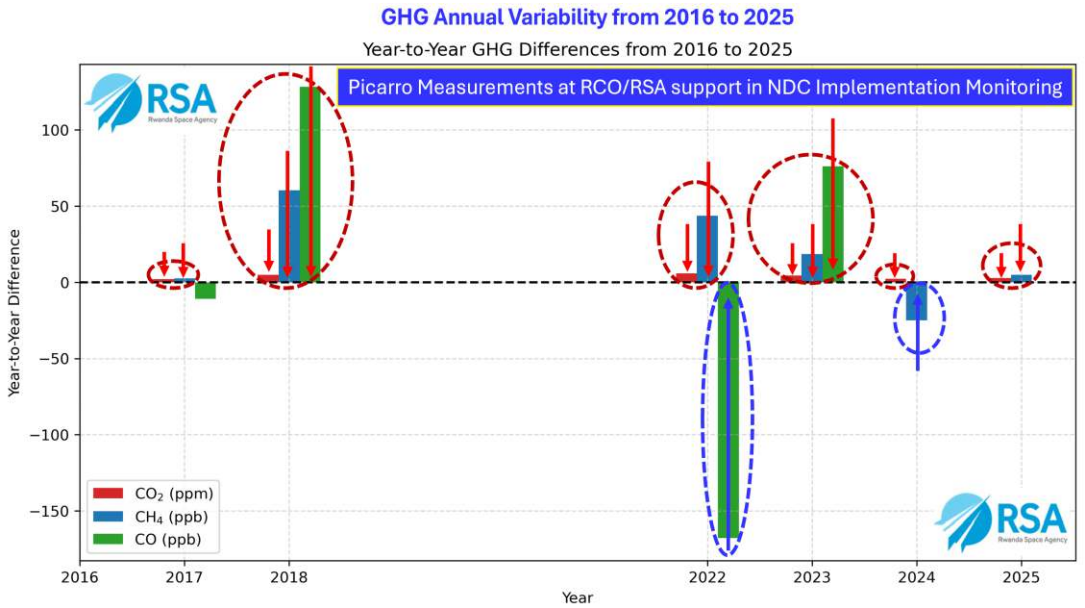
Technical team: Mr. Olivier Shyaka, Mr. Gaston Munyampundu, Mr. Eric Byiringiro, Mr. Jacques Nshuti

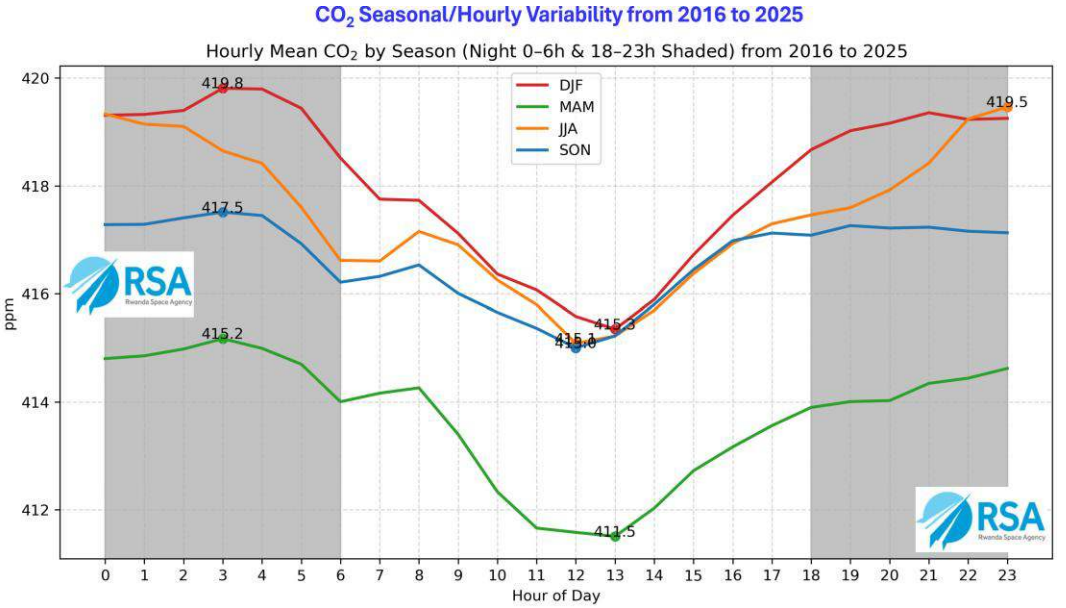


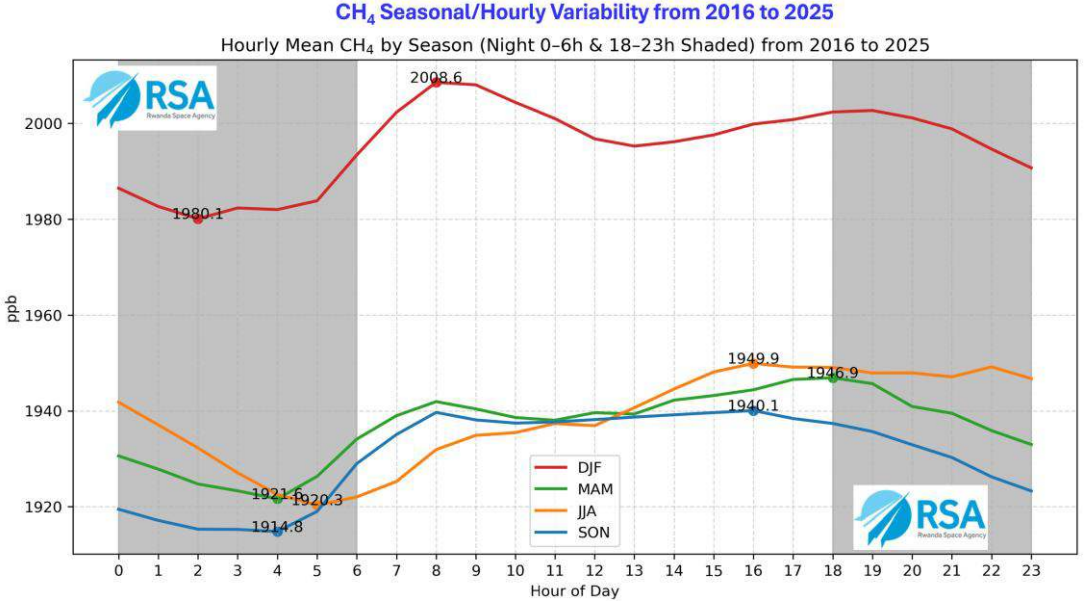
Picarro G2401: $CO_2/CH_4/H_2O/CO$ measurements

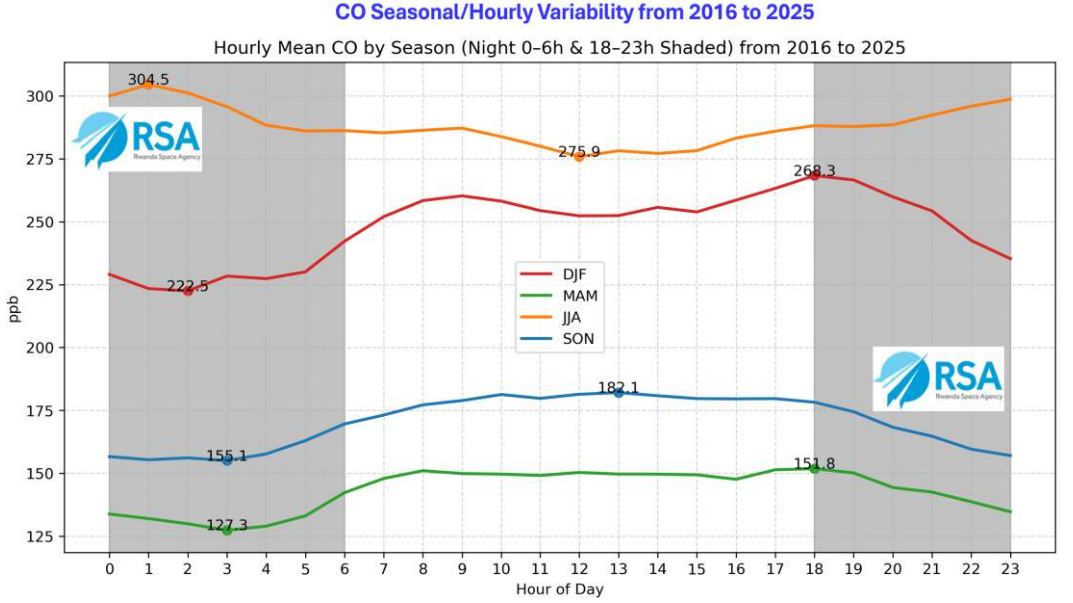


Picarro G2301: $CO_2/CH_4/H_2O$ measurements



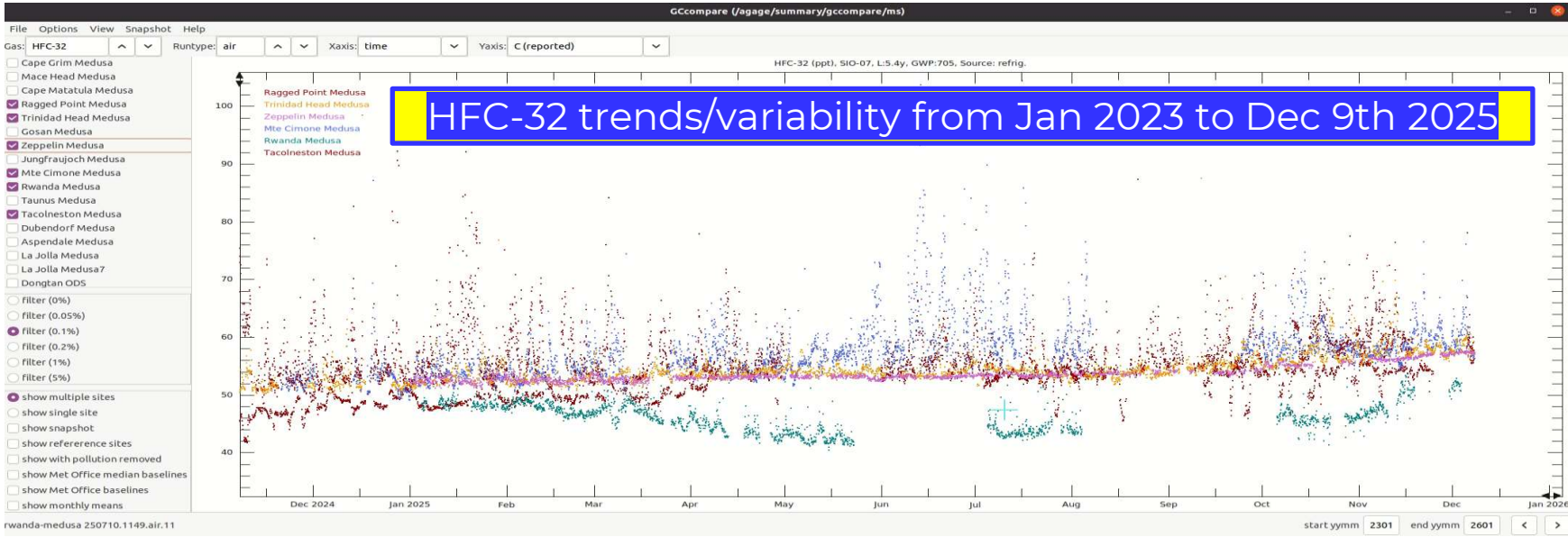


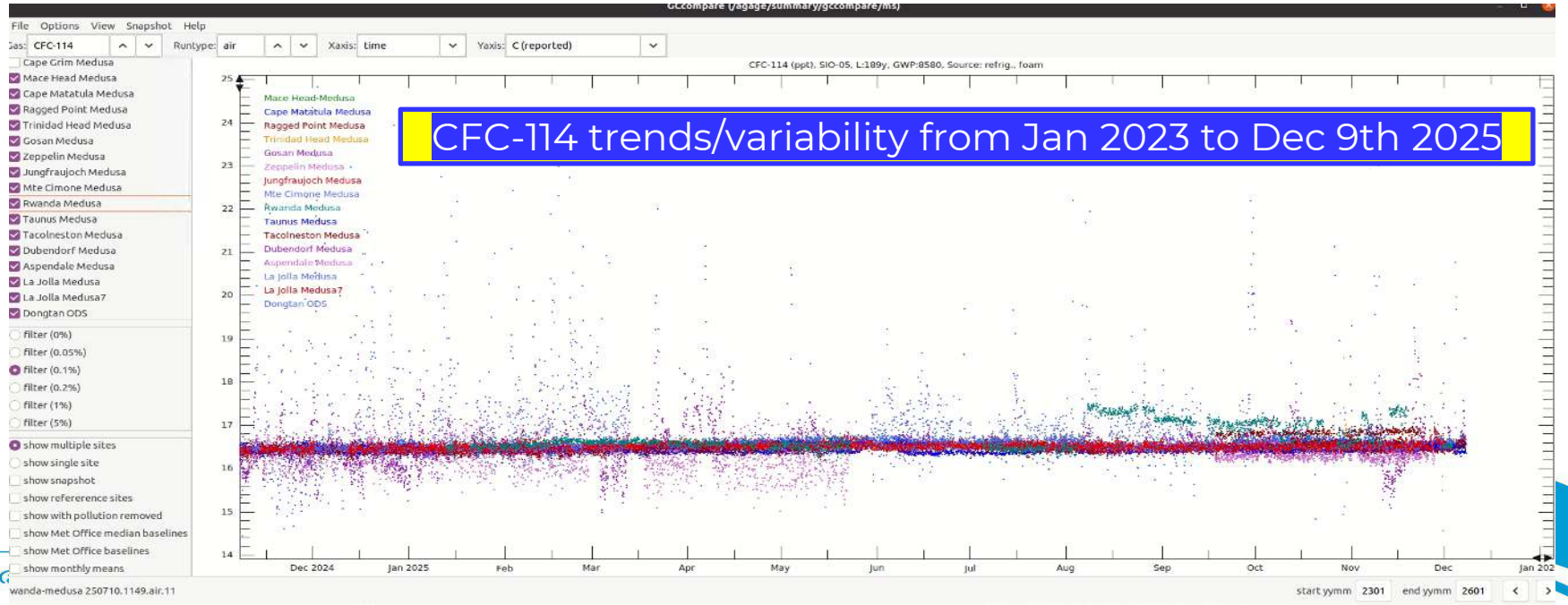




RCO Activities at Mugogo station: Ozone Depleting Substances Measurements based on MEDUSA

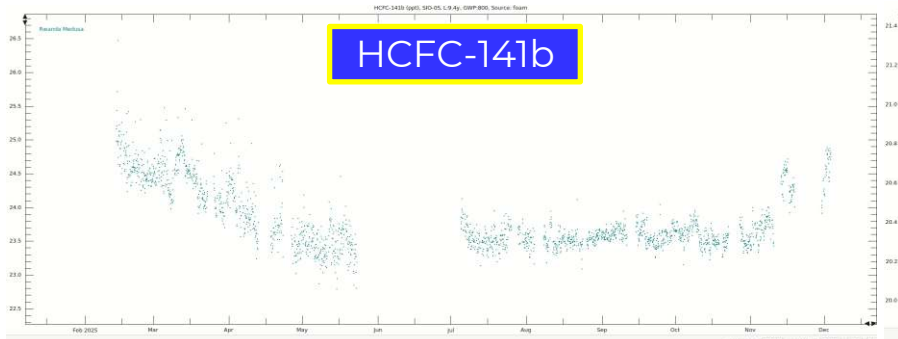


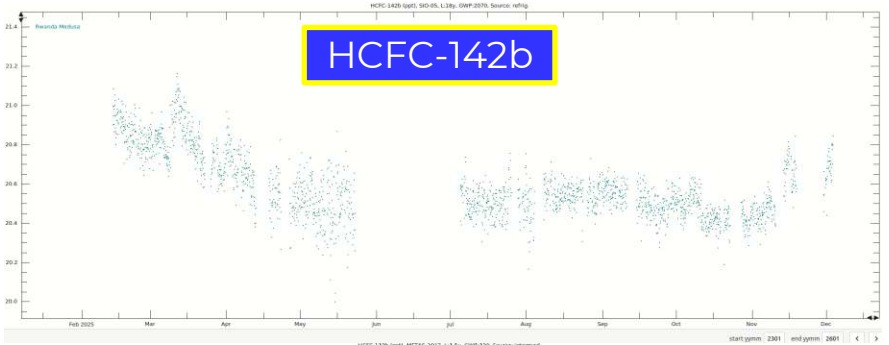


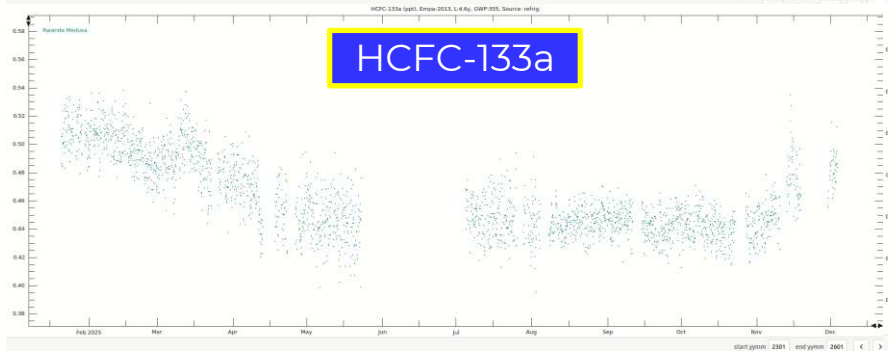


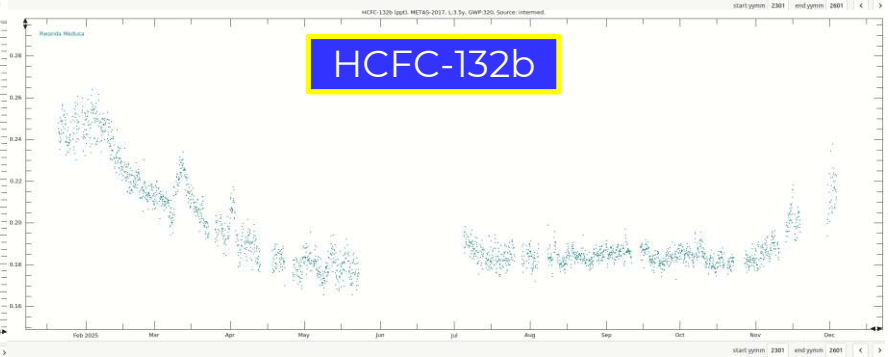
RCO Activities at Mugogo station: Ozone Depleting Substances Measurements based on MEDUSA

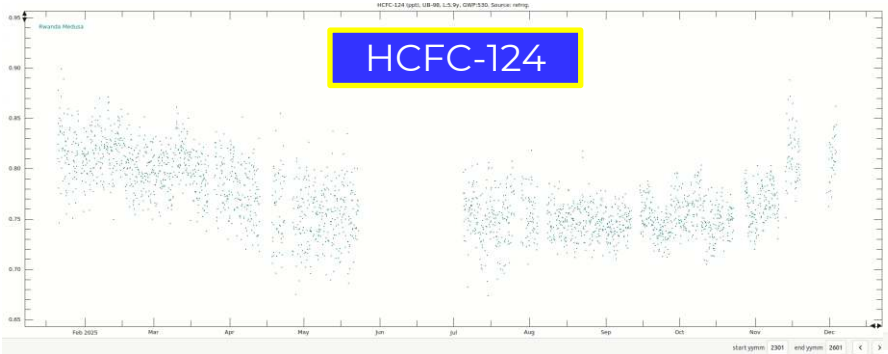


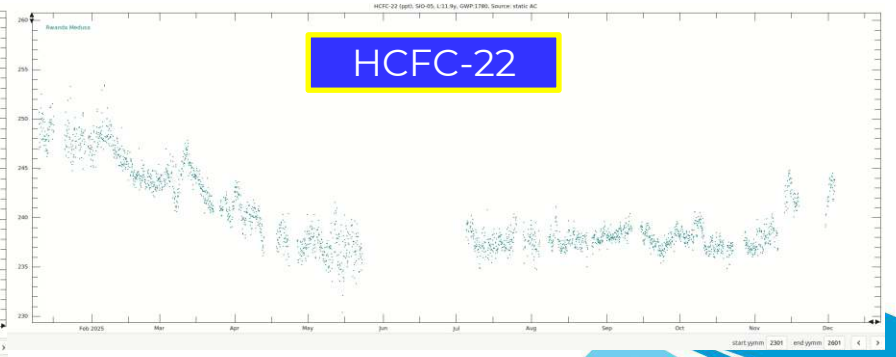






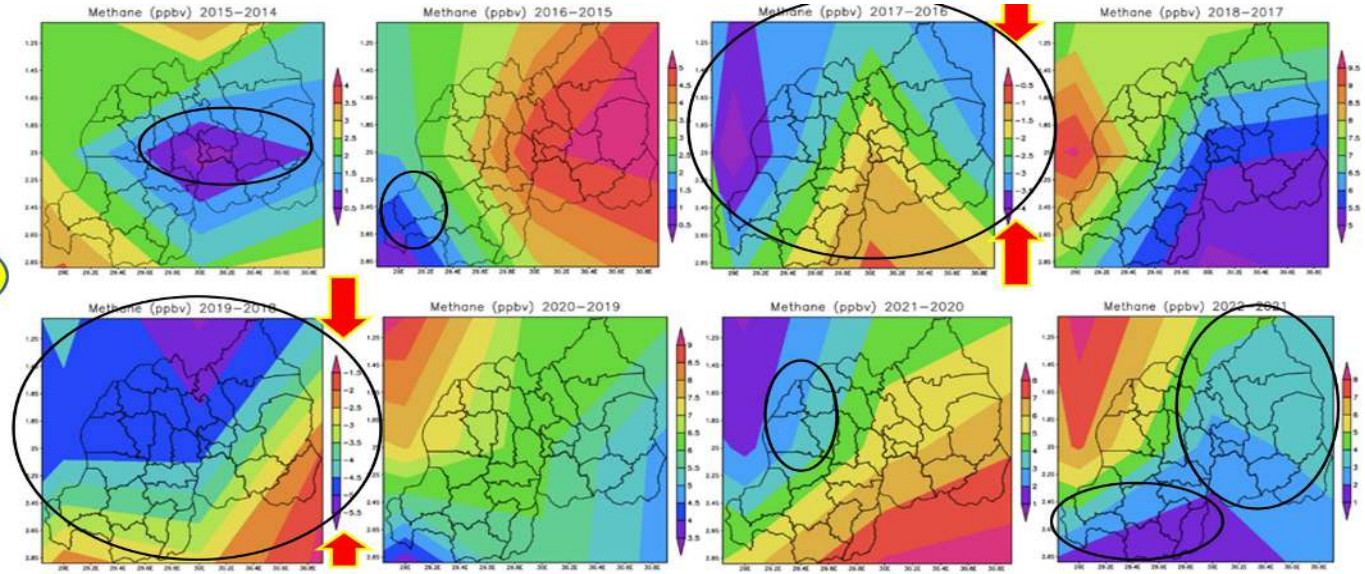




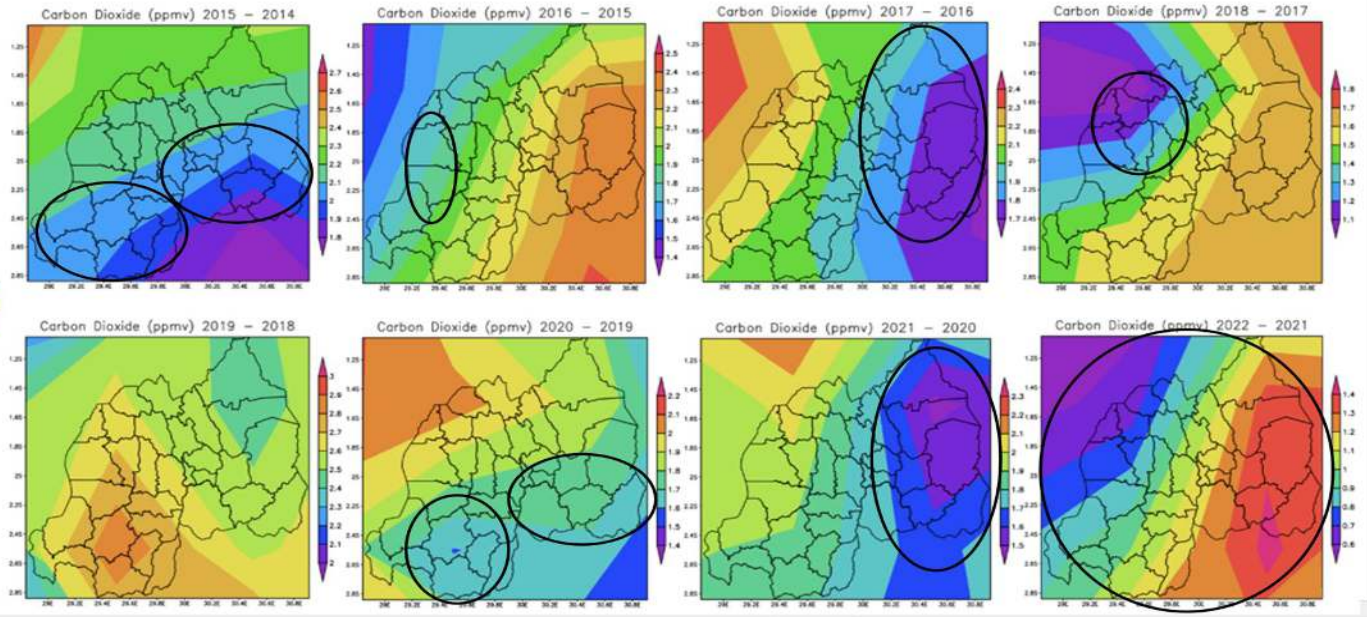


Evaluation of NDC Implementation based on Satellite Data: CO2 and CH4 Emissions

CH_4

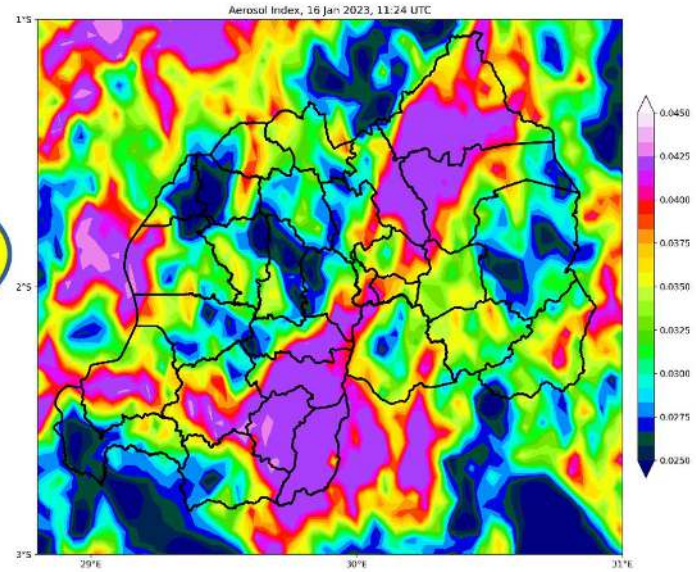


CO_2

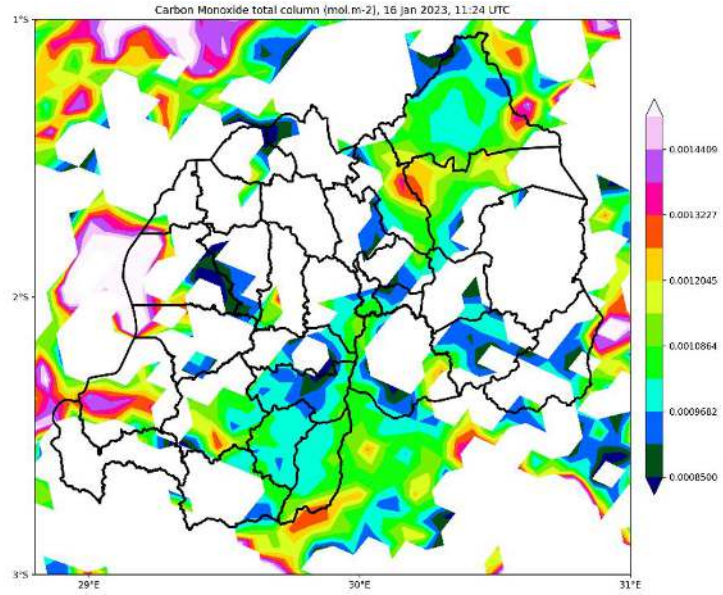


RSA
Rwanda Space Agency

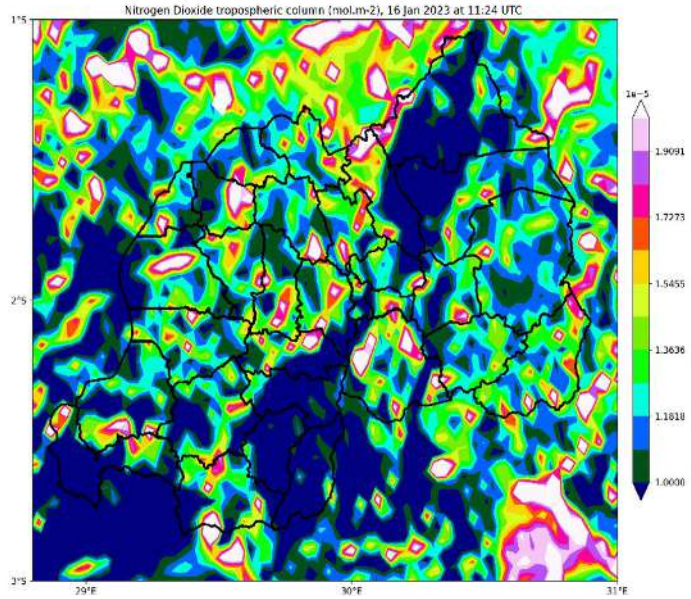
Aerosol Index



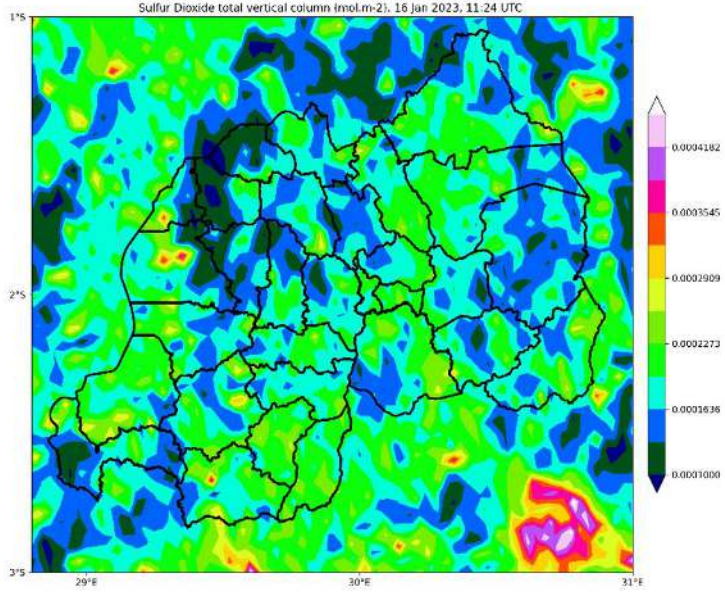
CO



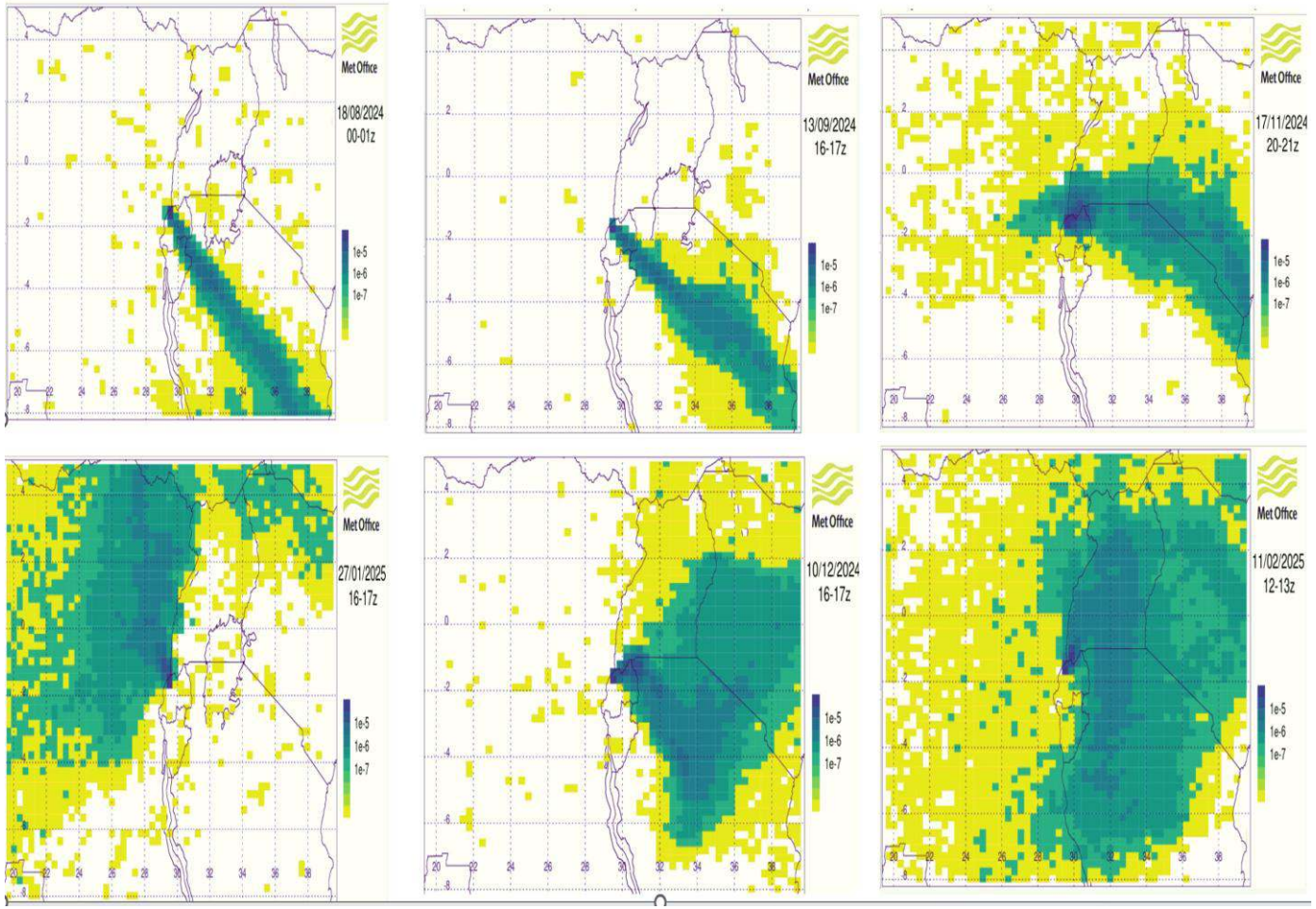
NO_2

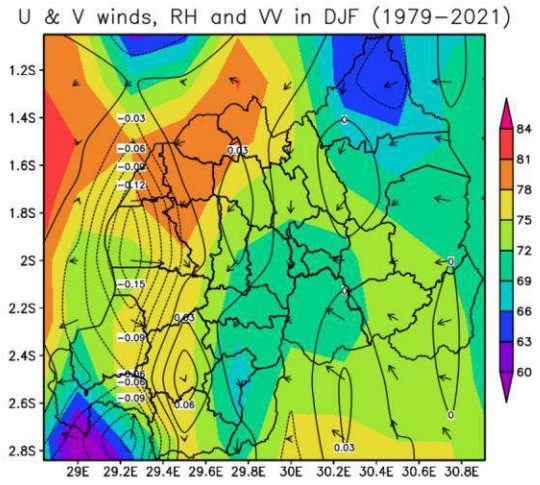


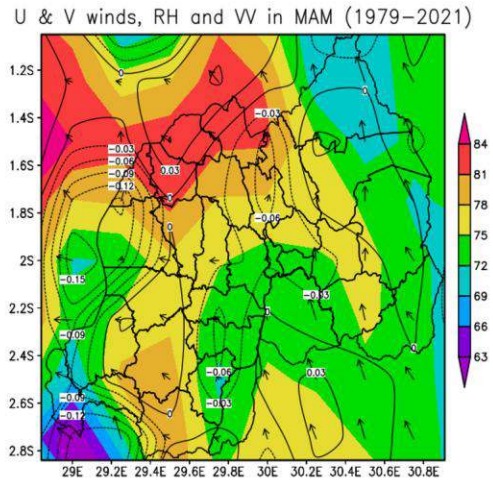
SO_2

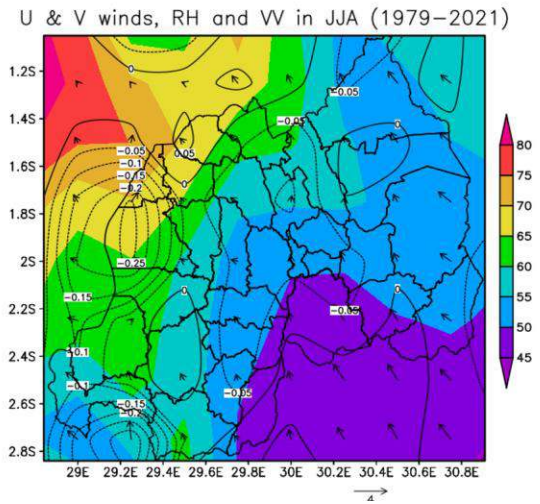


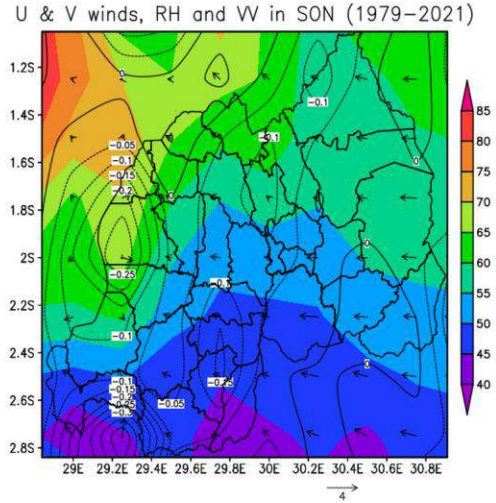
Regional Impacts:
Role of weather dynamics & weather physics in transporting/distributing GHG & ODS & Short-lived Air Pollutants towards Rwanda









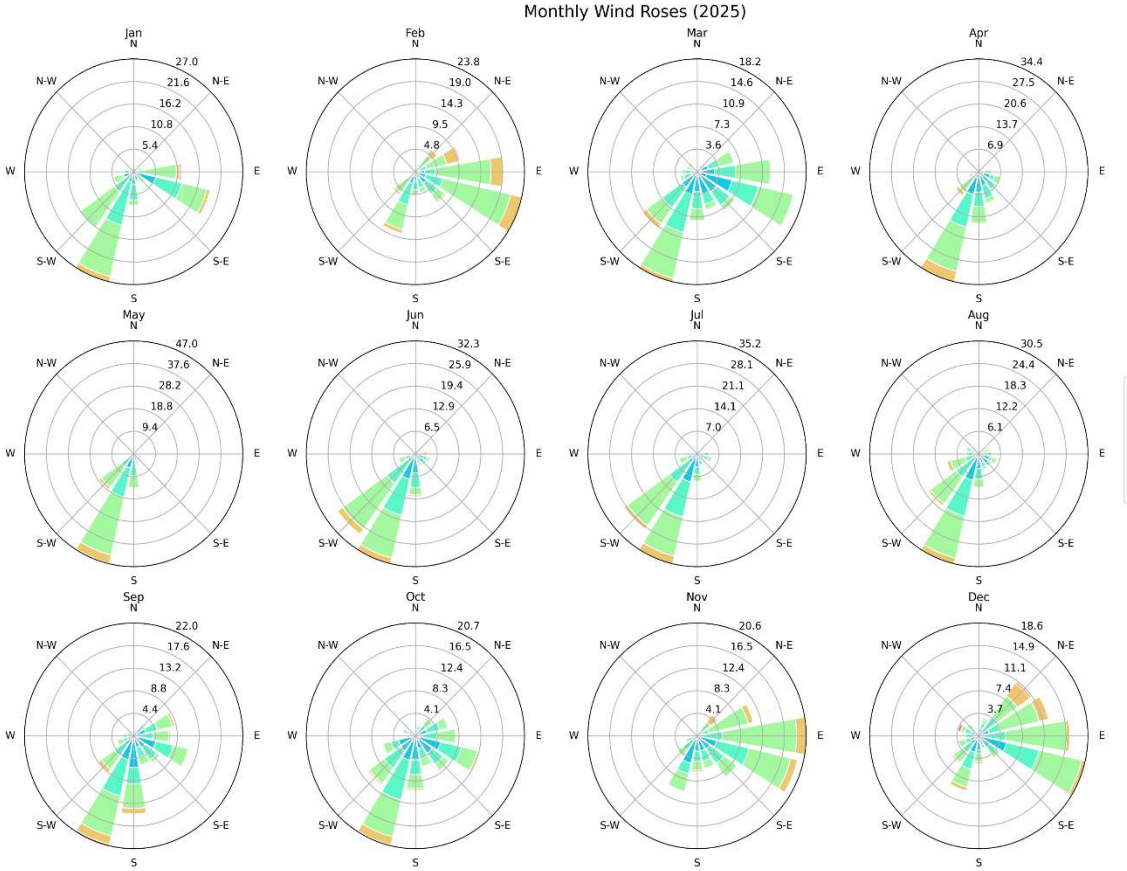


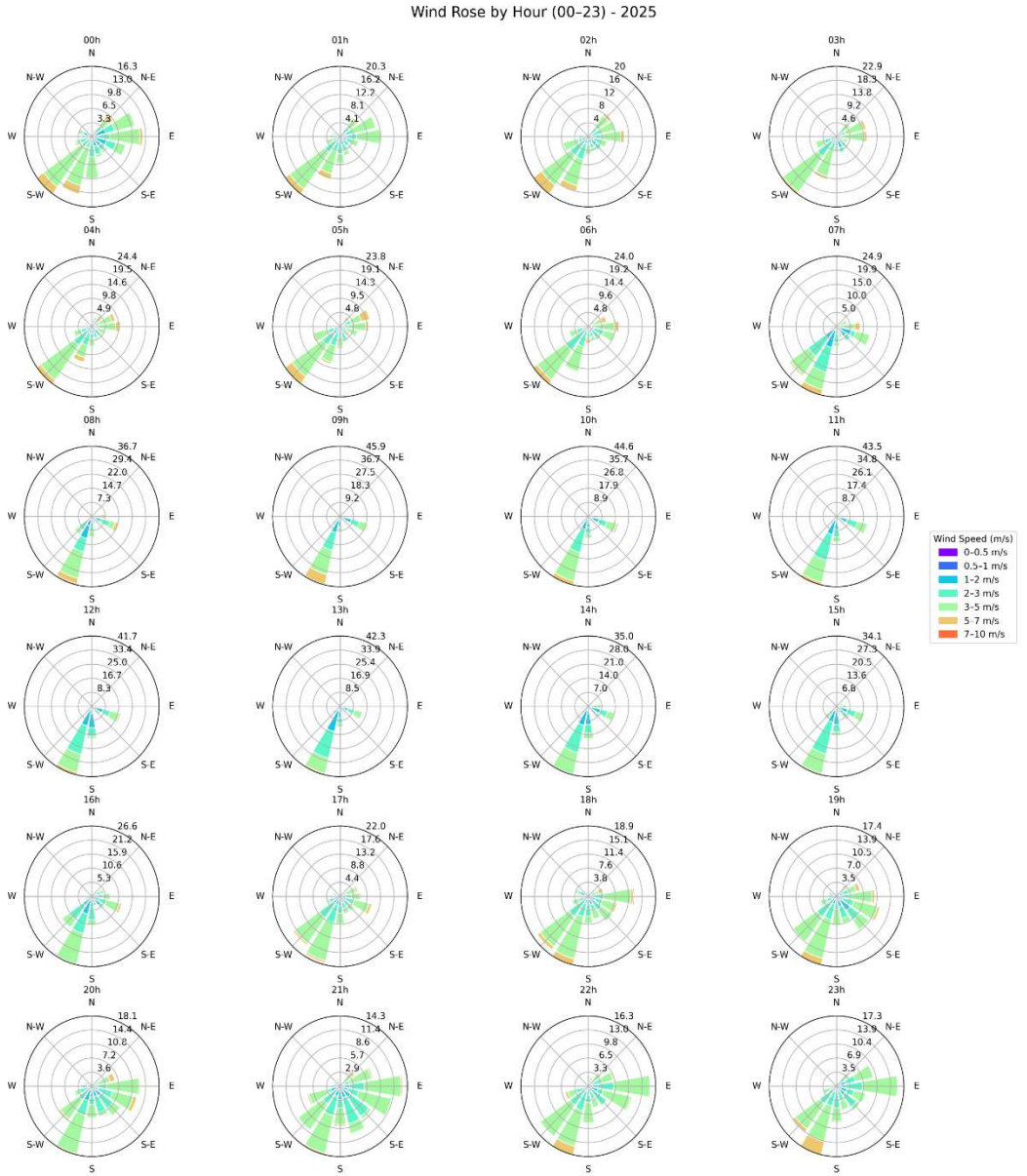
Wind Direction and Wind Speed based on Automatic Weather Station Instrument of RCO/RSA

Scientific Team: Dr. Didier Ntwali, Dr. Fabien Idrissa Nkurunziza

Technical team: Mr. Olivier Shyaka, Mr. Gaston Munyampundu, Mr. Eric Byiringiro, Mr. Jacques Nshuti



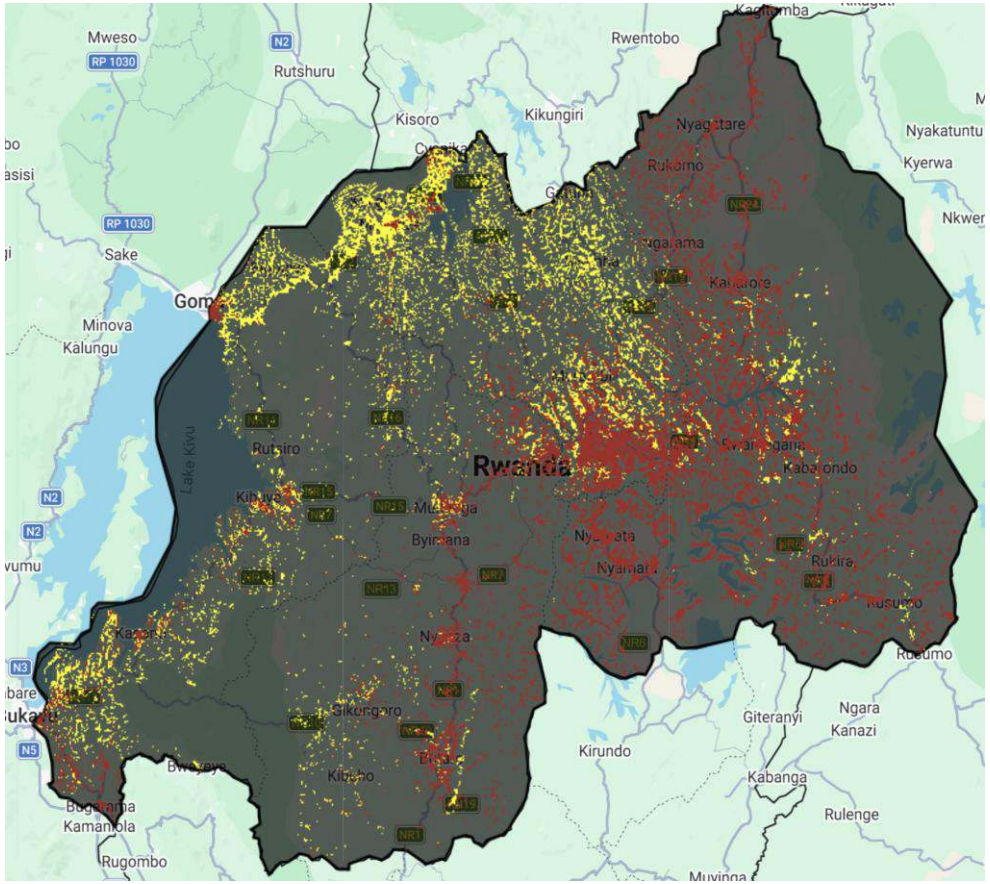




5. Applications of Climate Insights in Urbanization

Heat & Urbanization

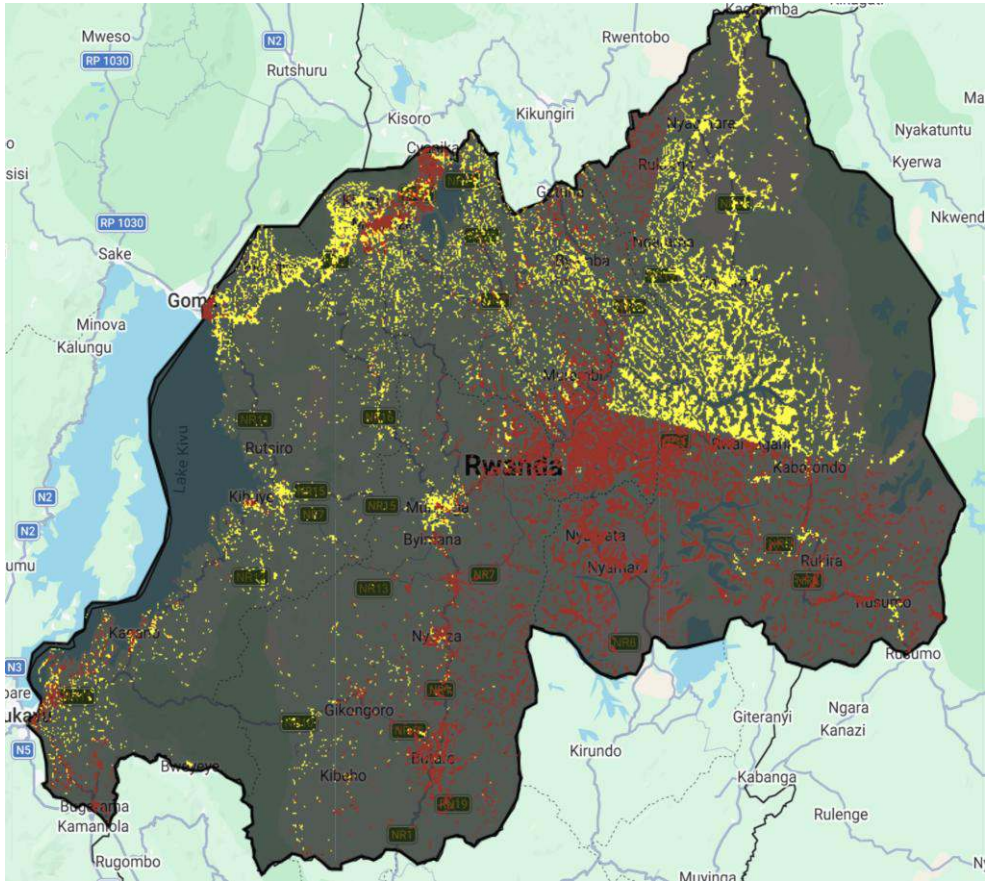
Year 2020



Urban Heat Island (UHI) Classes

- 1 Weak (0 – 0.005)
- 2 Moderate (0.005 – 0.010)
- 3 Strong (0.010 – 0.015)
- 4 Very strong (0.015 – 0.020)
- 5 Extreme (> 0.020)

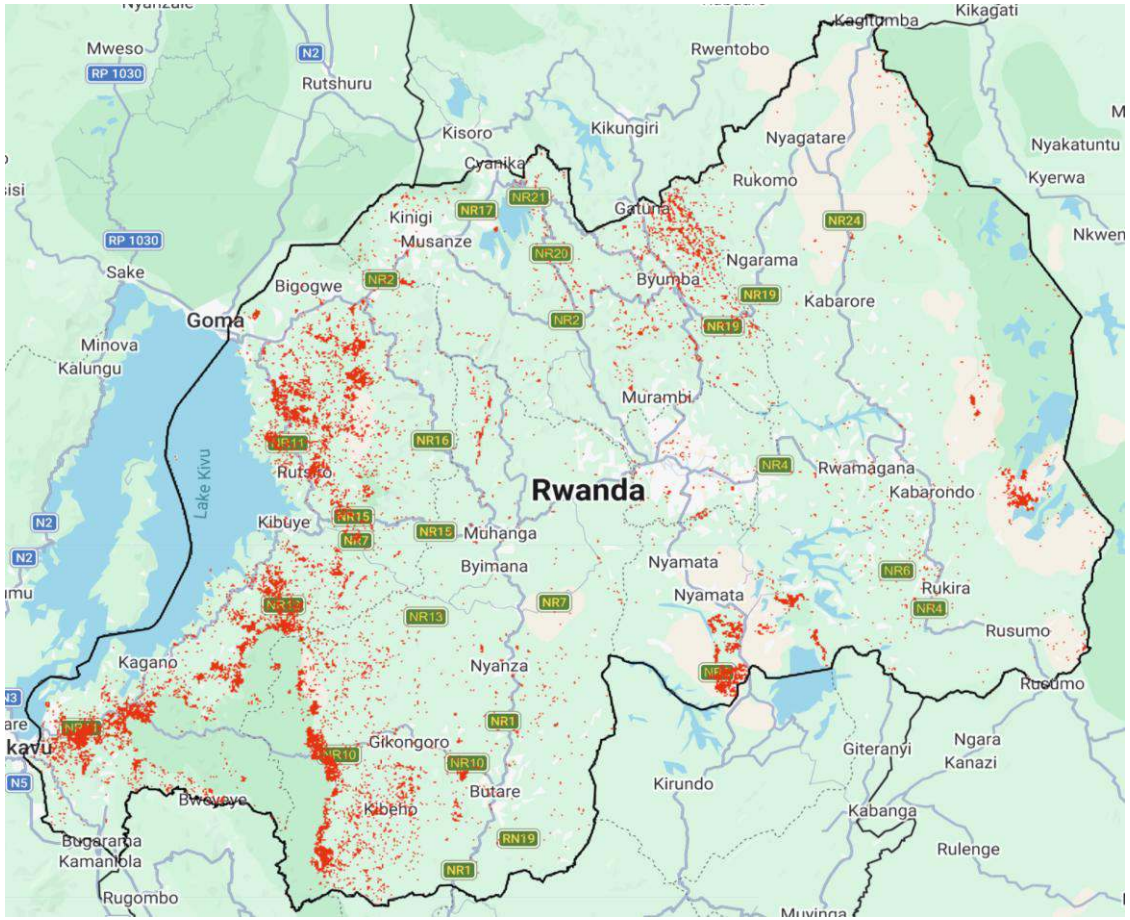
Year 2025



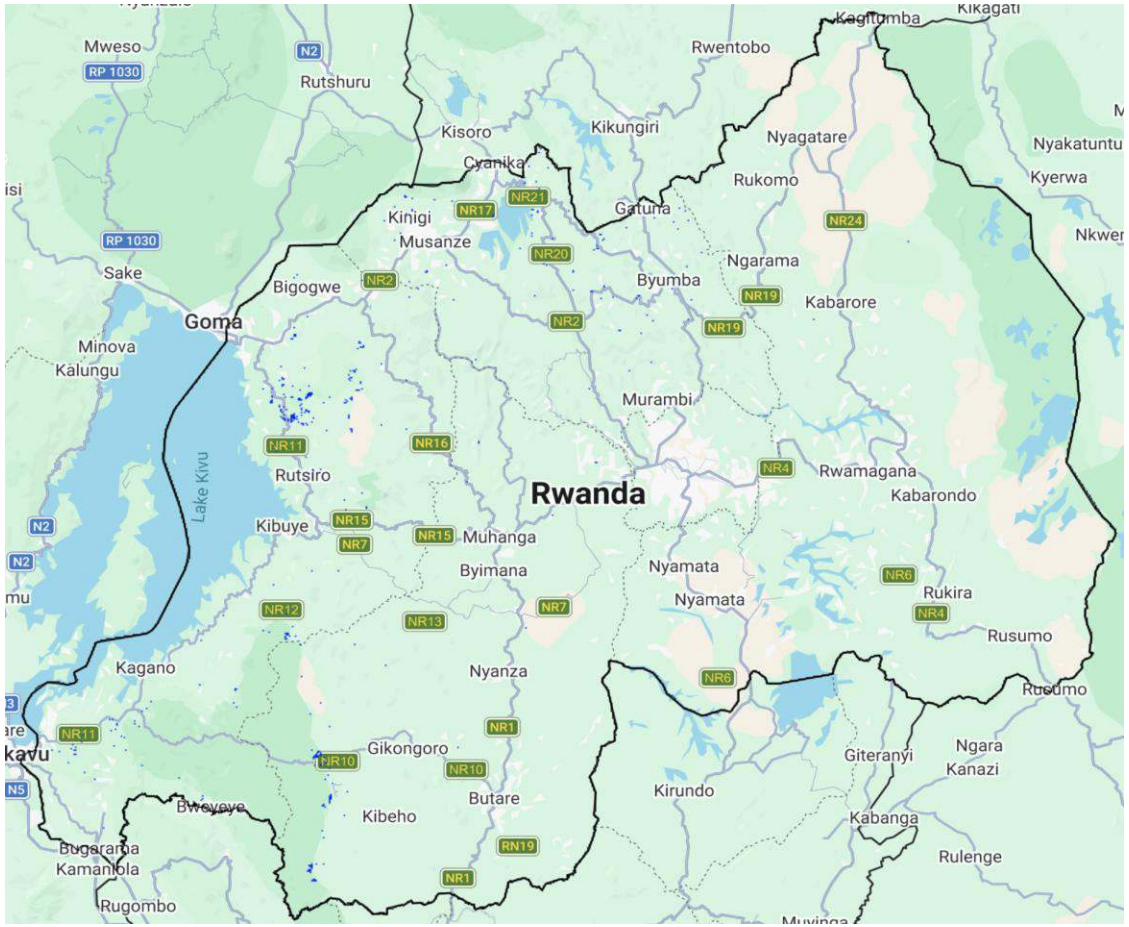
6. Applications of Climate Insights in Forestry Sector

RSA
Rwanda Space Agency

Deforestation (red)



Afforestation (blue)



7. Applications of Climate Insights in Disaster Management

https://svs.gsfc.nasa.gov/31243/

Scientific Visualization Studio

Galleries Help Search...

31242: Landsat 8 and 9 Composite of Rwanda

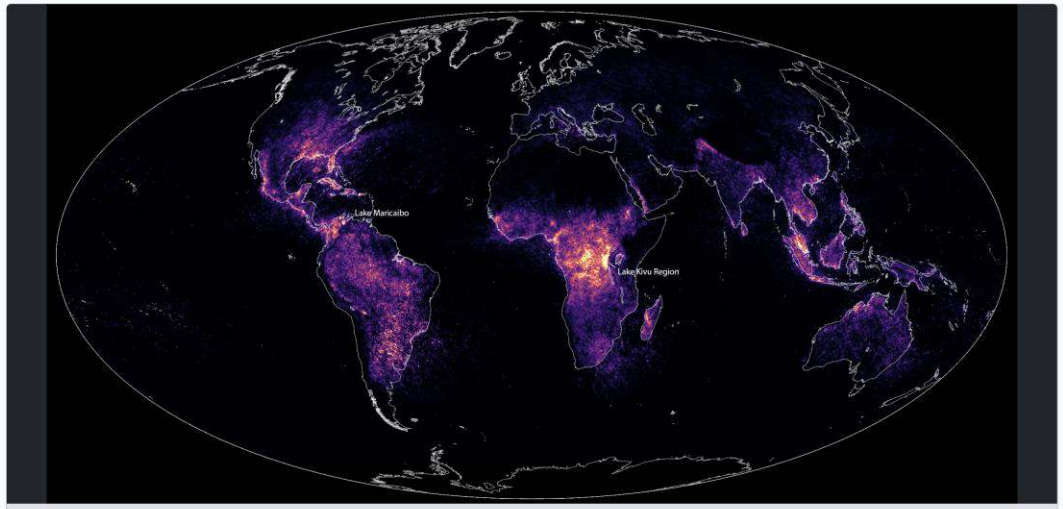
31309: GEOS-FP May 2024 US Tornado Outbreak

A New Look at Earth's Lightning

Released Monday, September 23, 2024

ID: 31243

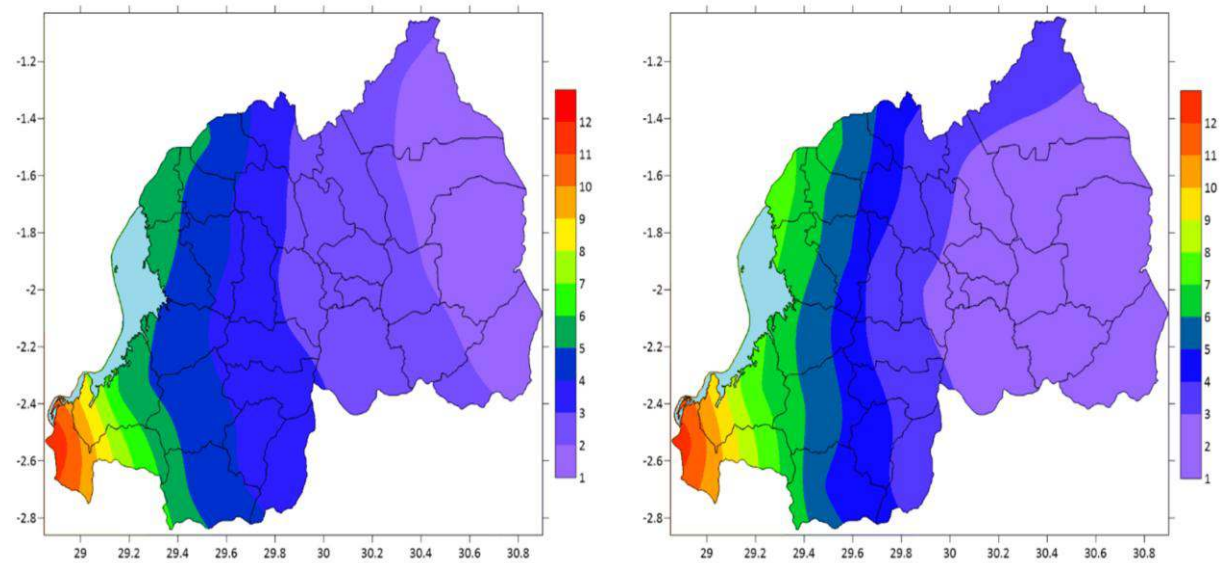
View full credits



Map of lightning frequency showing Lake Maracaibo in northern Venezuela and Lake Kivu between Rwanda and Democratic Republic of Congo are the places with the most lightning.

Download

Lightning flashes from 1981 to 2013



THUNDERSTORMS DEVELOPMENT MONITORING

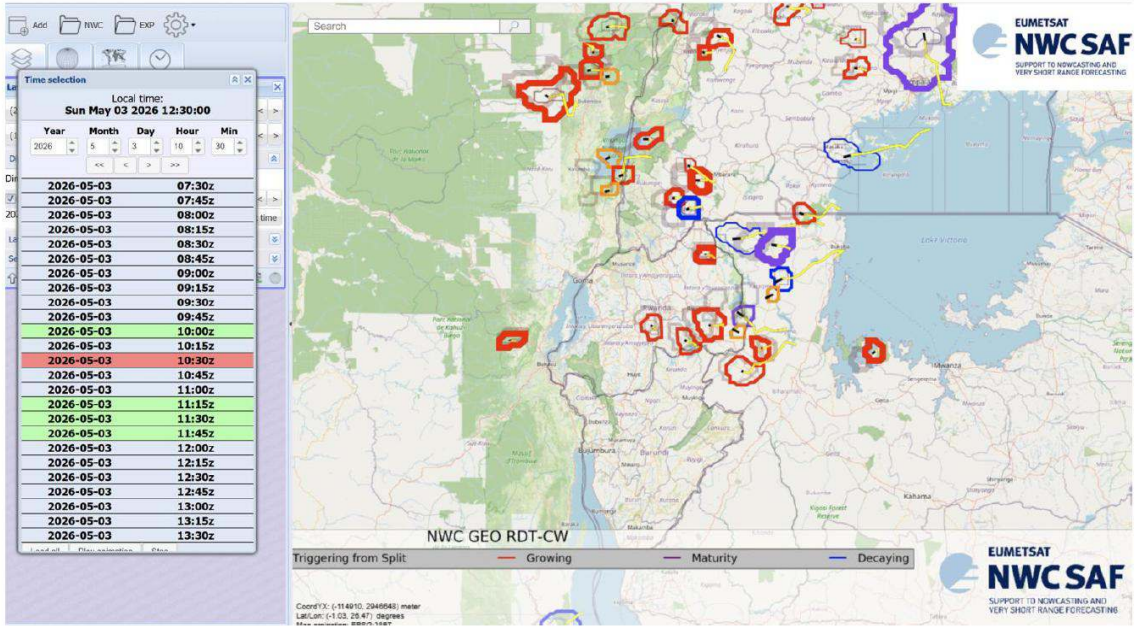
DISASTERS ON 3 MAY 2026

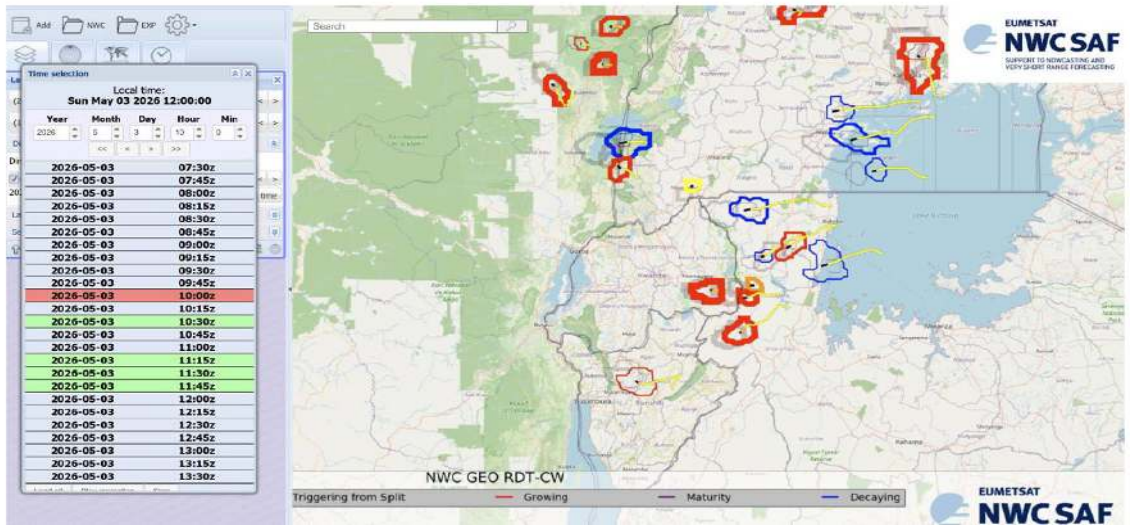
HEAVY RAINFALL ON 3 MAY 2026 AROUND 13:30 IN KIREHE DISTRICT

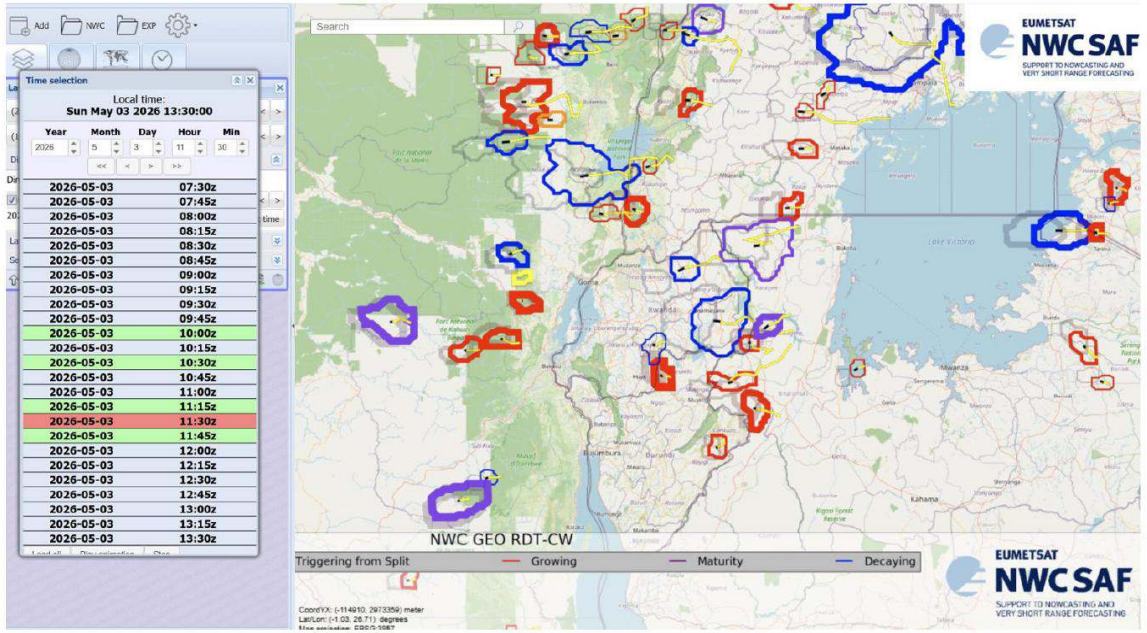
RadioTv10 Rwanda @Radiotv10rwanda · 12h

Imvura idasanzwe yaguye ahagana saa 13h30 muri @KireheDistrict mu Murenge wa Mpanga ,Akagari ka Bwiyorere , inkuba yakubise Inka 15 n'intama 18 zose zihita zipfa , zose zari muri Farm ya Mutarambirwa Patrick w'Imyaka 52. @RwandaEmergency @RwandaLocalGov @RwandaEast





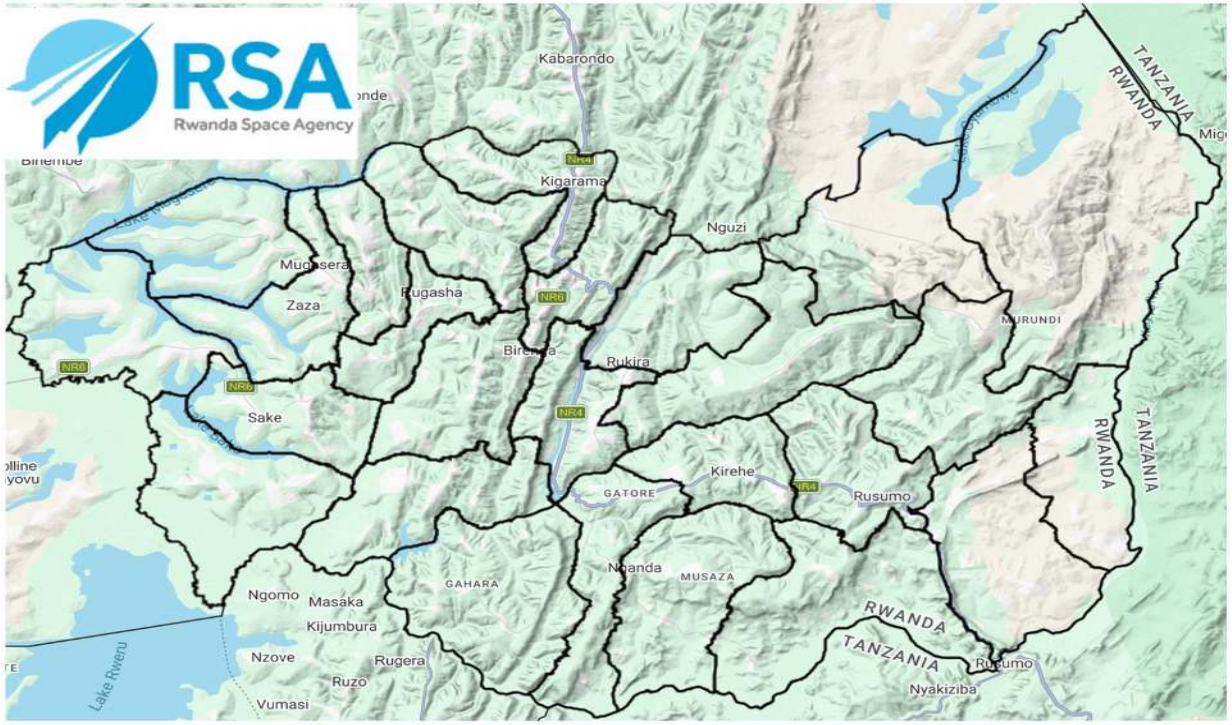




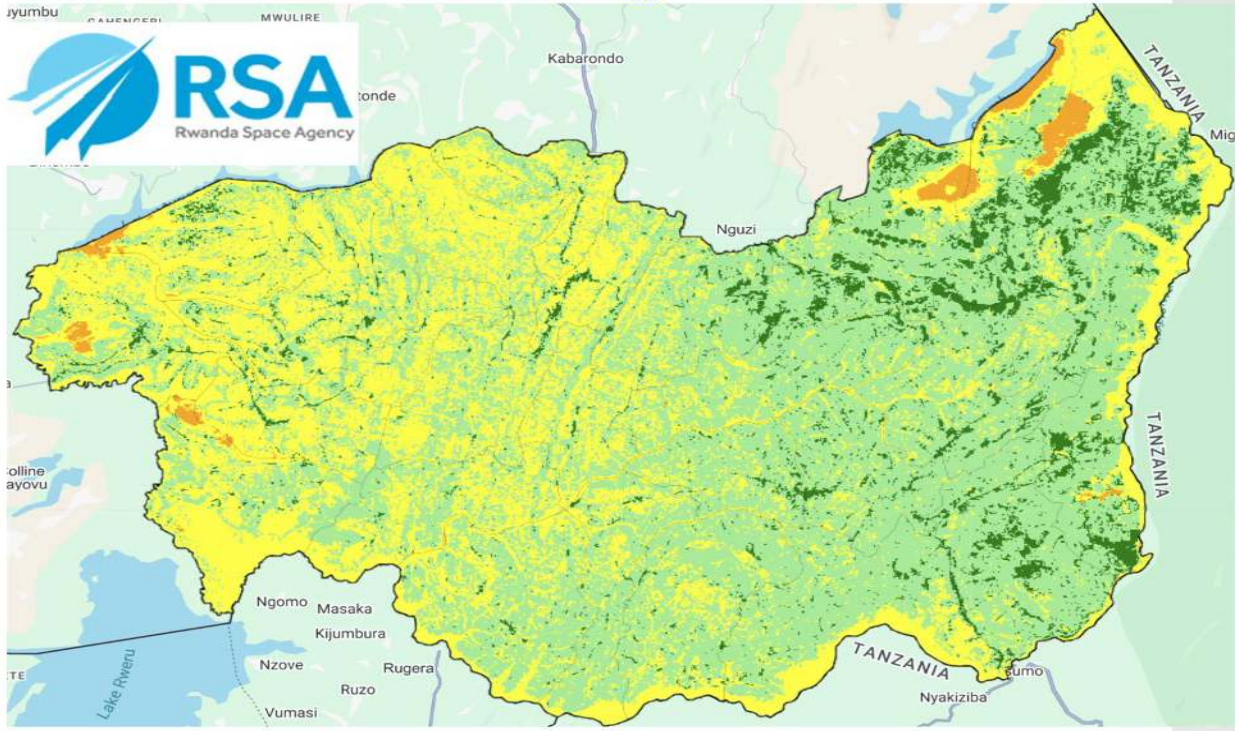
8. Applications of Climate Insights in Health Sector

Monitoring of Environmental Fever Risk in Ngoma District and Kirehe District based on Satellite Observations of Water & Vegetation Indicators to support in Fever Outbreak Surveillance during MAM 2026

Ngoma District and Kirehe District



Environmental Fever Risk Categories in Ngoma and Kirehe Districts during MAM 2026



Environmental Fever Risk Categories

- 0 - No Risk (0 drivers)
- 1 - Very Low Risk (1 driver)
- 2 - Low Risk (2 drivers)
- 3 - Medium/High Risk (3 drivers)
- 4 - Very High Risk (4 drivers)
- Severe Risk (Score ≥3)

Risk Drivers: NDVI >0.5 = Vegetation NDWI >0.2 = Water availability NDMI >0.2 = Humidity/moisture MNDWI >0 = Surface water

Research Project: Integrated Early Warning and Response System (IEWRS) for Health in the context of Climate Change in Rwanda

Climate Related Parameters

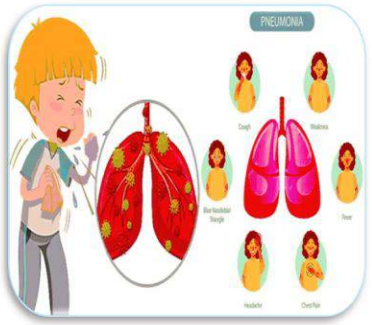
Data Category	Climate Related Variables
Meteorological Parameters (19)	Minimum Temperature (Tmin)
	Maximum Temperature (Tmax)
	Land Surface Temperature at Day Time
	Land Surface Temperature Night Time
	Mean Radiant Temperature (MRT)
	Universal Thermal Climate Index (UTCI)
	Rainfall
	Relative Humidity (RH)
	Specific Humidity (SH)
	Zonal Wind (U)
	Meridional Wind (V)
	Vertical Velocity (W)
	Convective Available Potential Energy (CAPE)
	Surface Latent Heat Flux (SLHF)
	Surface Sensible Heat Flux (SSHF)
	Surface Thermal Radiation Downwards (STRD)
	Surface Solar Radiation Downwards (SSRD)
	Surface Pressure (SP)
	Standardised Precipitation-Evapotranspiration Index (SPEI)
Air Pollutants (6)	Particulate Matter (PM2.5)
	Carbon Monoxide (CO)
	Nitrogen Dioxide (NO_2)
	Ozone (O_3)
	Sulfur Dioxide (SO_2)
	Formaldehyde (HCHO)
Water and Vegetation Health Indices (5)	Normalized Difference Water Index (NDWI)
	Normalized Difference Vegetation Index (NDVI)
	Chlorophyll Index (CI)
	Enhanced Vegetation Index (EVI)
	Red-Edge Chlorophyll Index (RECI)

4 Diseases (Vector-borne Diseases/Water-borne disease and Respiratory diseases

MALARIA



PNEUMONIA



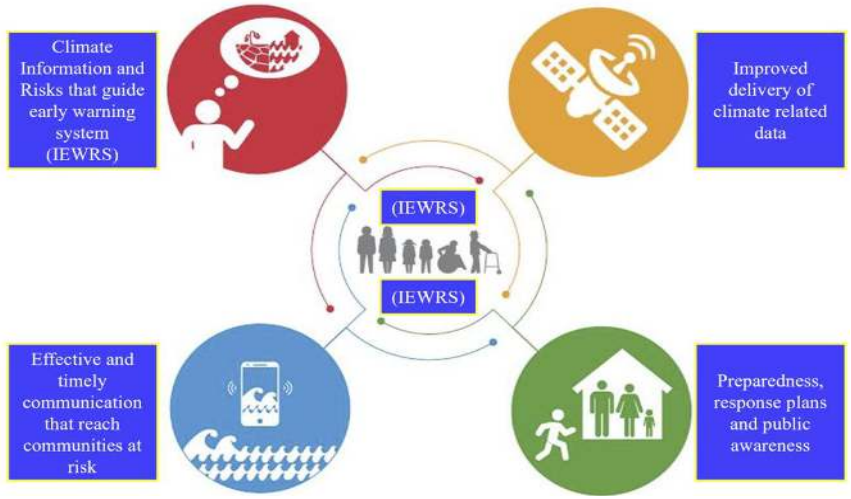
DIARRHEA



FLU



Predictions of Malaria, Flu Influenza, Pneumonia and Diarrhea 12 months ahead based on 30 climate related parameters across 416 sectors of Rwanda



Risk Knowledge

Climate information and risks that guide early warning system (IEWRS)

Monitoring & Warning

Improved delivery of climate-related data through continuous monitoring

Communication

Effective and timely communication that reaches communities at risk

Response Capability

Preparedness, response plans and public awareness for health emergencies

IEWRS PLATFORM: INTEGRATED EARLY WARNING AND RESPONSE SYSTEM

RSA Rwanda Space Agency

https://iewrs.streamlinexperts.com/app/forecast-map

IEWRS

Forecast Risk and Response Map

Search... ⌘K

SA Super Admin

OVERVIEW
- Dashboard

SURVEILLANCE
- Alerts
- Forecast Risk and Respons...
- Alert Detector

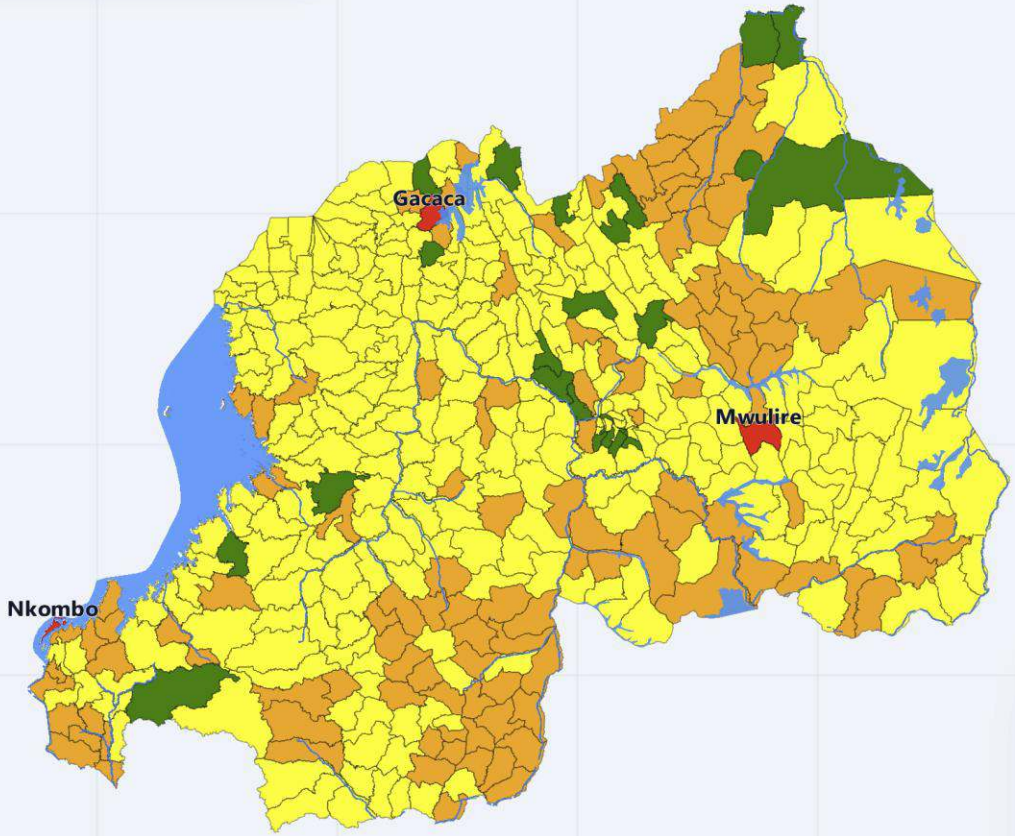
DATA & MODELS
- Data Intake
- Models
- Data Management
- Schema
- Analytics

ADMINISTRATION
- System Overview
- Audit log
- Settings

Malaria | Refresh | Focus sectors | Protocol Matrix

Malaria Forecast Oct 2026

416/416 sectors reporting



Live

‹ ❚❚ › Oct 2026 (416/416)

Forecast Risk and Response
(Number of Sectors)

Normal (No action)	(24)
Watch (Be aware)	(276)
Elevated (Be prepared)	(113)
Critical (Take action)	(3)

416/416 sectors reporting

THANKS FOR YOUR ATTENTION!

Climate Science for Resilient Development Rwanda, Africa and Global Perspectives

The future must not arrive untranslated

Prof Cecil Ouma

AIMS Research and Innovation Centre

Rwanda Climate Science Symposium 2026

Climate science can increasingly describe the future awaiting Rwanda. The question is whether that knowledge can travel far enough to help Rwanda shape that future.

The next frontier of climate science is not only improving how we model the climate. It is developing a rigorous science of how climate knowledge moves into meaning, decisions, designs and collective action.



1:59:40

12 October 2019, Vienna

Eliud Kipchoge became the first person to complete the marathon distance in under two hours.

No Human Is Limited

Kipchoge covered 42.195 kilometres in 1:59:40.2. It was an extraordinary human performance conducted under specially optimized conditions, rather than an official competitive marathon record.

But Kipchoge did not cross the barrier alone.



An entire knowledge system ran with him

The INEOS 1:59 Challenge combined:

01
Human physiology

02
Weather intelligence

03
Course selection

04
Precision pacing

05
Aerodynamic formations

01
Advanced footwear

02
Nutrition planning

03
Technology

04
Team coordination

05
41 pacemakers



Everything had to work together.

The weather was approximately 9°C, wind speeds were low, the course was protected from wind, an electric vehicle maintained the pace, and elite runners formed an aerodynamic structure around Kipchoge.

The achievement did not result from motivation replacing science. It resulted from science being organized around a clearly defined human objective.

Science made it possible. Narrative made it travel.

The science

A complex performance problem was decomposed, modelled and optimized.

The narrative

The complexity was translated into five memorable words:

> No Human Is Limited

The science produced the performance. The narrative produced its social meaning.
Millions of people did not need to understand every calculation behind the performance. They understood what the achievement represented.

INEOS did not communicate the science by presenting a list of variables. It created a story through which the public could encounter the science.

This is the bridge to climate science.

Climate science has its models. Where is its 1:59?

We have:

- Earth-system models
- Satellites and weather stations
- Downscaled projections
- Early-warning systems
- Climate data platforms
- Artificial intelligence
- Research networks
- Trained climate scientists
- Policy frameworks
- Growing institutional capacity

Yet climate knowledge still struggles to travel into:

- Everyday decisions
- Product development
- Industrial strategy
- Community imagination
- Investment choices
- Institutional action

We know more about the climate. But are we becoming proportionately better at acting on what we know?

We built data value chains. We neglected meaning value chains.

The climate-data value chain


Observation


Data


Model


Forecast

The climate-meaning value chain


Forecast


Translation


Meaning


Trust


Decision


Action


Learning

Most of our investment is concentrated before the forecast. Many of our failures occur after it.

Thesis:

A technically accurate forecast is not yet a successful climate service.
The knowledge journey is incomplete until somebody understands its relevance, has the authority and resources to act, and can return the resulting experience to the knowledge system.

We can downscale climate models.
Can we downscale climate meaning?



Climate scientists communicate through:

- Probability
- Anomalies
- Return periods
- Confidence intervals
- Emissions pathways
- Temperature thresholds

But users make decisions through:

- Cost
- Safety
- Comfort
- Livelihoods
- Identity
- Trust
- Memory
- Aspirations
- Perceptions of fairness

A warning can reach a phone without reaching a person's understanding.

The last kilometre of climate science is not data transmission.

It is meaning.

Better dissemination is useful, but dissemination assumes that knowledge only needs to be distributed. **Knowledge brokerage asks what the information must become before a specific user can act on it**.

One climate signal must become many decision languages

Farmer
Planting and harvesting decision

Doctor
Heat and disease protocol

Engineer
Design threshold

Insurer
Risk-pricing variable

District official
Budget and response trigger

Energy planner
Demand and reliability scenario

Investor
Exposure and opportunity assessment

Fashion designer
Material and garment specification

Climate translation is complete when a climate variable becomes a usable decision variable.

Climate science does not become useful by using simpler words alone. It becomes useful when it is translated into the language, constraints and decisions of another field.

Climate change is redesigning the world's wardrobe

Climate change affects:

- Thermal comfort
- Sweat and moisture management
- Workplace safety
- School uniforms
- Protective clothing
- Sports performance
- Textile production
- Material selection
- Fashion seasons
- Circular design

The design question is no longer only:

What must clothing become in a hotter, wetter and more humid world?

This is an example of climate science moving beyond its conventional domains.

Temperature, humidity, airflow and heat-stress data are not only meteorological variables. They can become inputs into textile science, apparel design, occupational health and manufacturing.



When a climate signal becomes yarn, mesh and airflow

In 2025, Nike introduced Aero-FIT cooling apparel for a "hotter, wetter world."

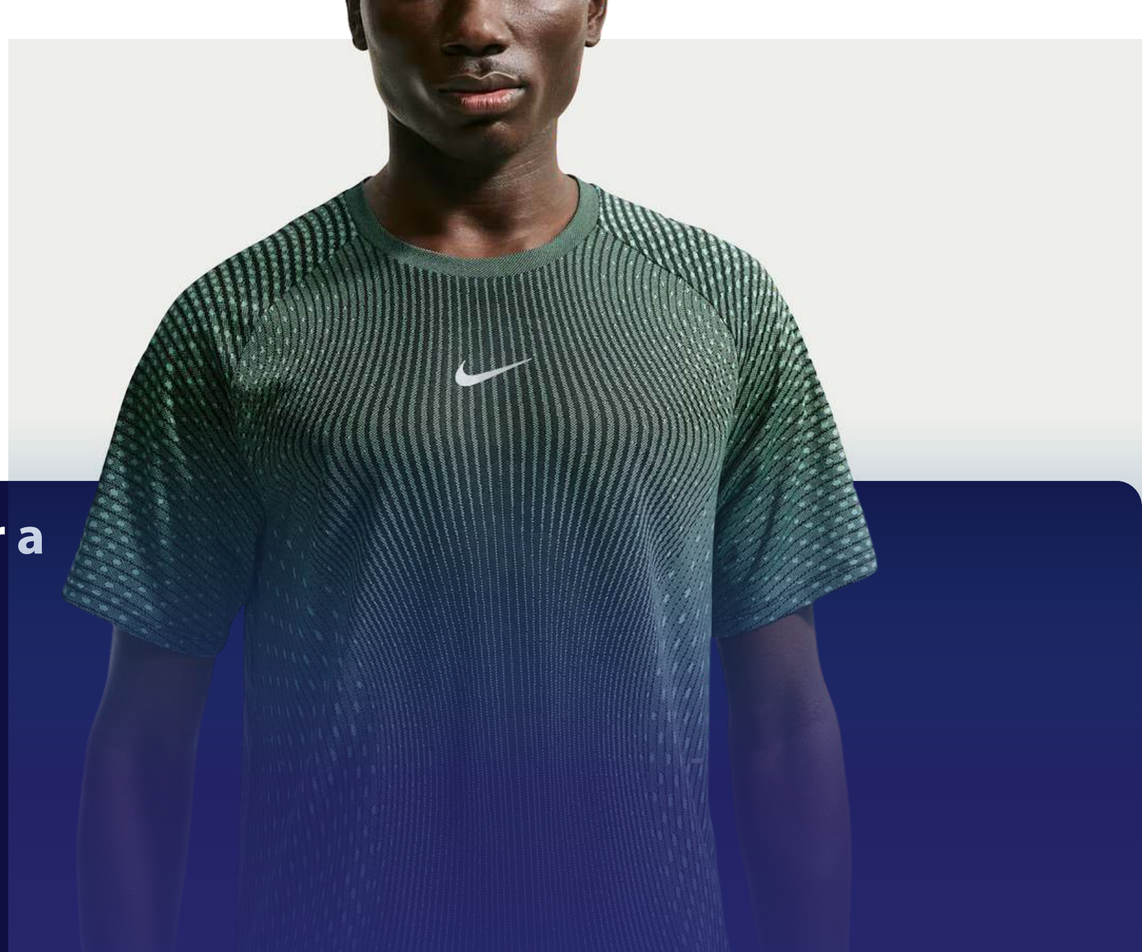
Its development combined:

- Heat mapping
- Motion data
- Athlete physiology
- Biomechanics
- Computational design
- Advanced materials
- Athlete testing
- Circular manufacturing

The result:

- More than twice the airflow of previous Nike athletic apparel
- Heat-specific ventilation zones
- Elite apparel manufactured from textile waste

The temperature projection did not remain a report. It became a product specification.



Nike is not being presented as the answer to climate change. The example demonstrates what happens when environmental data enter another discipline's design process. The relevant question for Rwanda is: **how many locally relevant products and services remain undiscovered because climate knowledge has not reached designers, entrepreneurs and manufacturers?**

The cost of poor communication is invisible innovation

When climate knowledge remains inside climate institutions, we lose possible innovations in:

- Heat-adaptive school uniforms
- Climate-responsive buildings
- Cooling technologies
- Worker-protection equipment
- Climate-sensitive credit
- Agricultural insurance
- Temperature-resilient medicines
- Adaptive tourism
- Climate-informed mental healthcare
- Resilient transport
- Sports science
- Energy services

Communication failure does not only produce ignorance. It conceals markets, products and solutions.

This reframes climate communication as an economic and innovation issue.

Storytelling is not the opposite of scientific rigour



Poor storytelling can:

- Distort evidence
- Hide uncertainty
- Manipulate emotion
- Oversimplify causation

Disciplined storytelling can:

- Preserve scientific uncertainty
- Establish relevance
- Connect fragmented evidence
- Expose trade-offs
- Carry knowledge across disciplines
- Include lived experience
- Invite participation
- Create feedback for research

The objective is to change the form of the knowledge without corrupting its meaning.
Storytelling must not be used to make weak science persuasive.
It should help strong science travel without abandoning its uncertainty, limitations or complexity.
Narrative is therefore not an alternative to scientific evidence. It is one of the systems through which evidence becomes socially intelligible.

The climate scientist must become more than a messenger

Dissemination asks:
How do we distribute this information?

Communication asks:
How do we explain this information?

Knowledge brokerage asks:
What must this knowledge become before a particular entity can use it?

The climate scientist as knowledge broker asks:

- Who can act on this finding?
- What decision do they control?
- In what language is that decision made?
- What prevents action?
- Which story currently shapes the decision?
- What should return to the research process?

The scientist does not stand at the end of the knowledge chain. The scientist participates in a learning relationship.

No climate knowledge should remain stranded

A climate model that cannot travel beyond the institution that produced it is a form of stranded knowledge. Rwanda needs a federated network connecting all stakeholders.

Federated principle:

Institutions retain responsibility for their data and expertise while collaborating through shared problems, standards and learning mechanisms. One national capacity to learn, not one institution that owns everything.

Rwanda can build a climate meaning value chain

Proposed national architecture

1	**Federated Climate Intelligence Grid** Connect climate, health, energy, agriculture, water, infrastructure and district intelligence.
2	**Climate Translation Laboratory** Convert climate findings into sector-specific design briefs, products and services.
3	**National Climate Narrative Observatory** Study how communities interpret climate risks, policies and transition choices.
4	**District Story and Science Laboratories** Bring scientists, communities and decision-makers together around lived climate problems.
5	**Youth Climate Knowledge-Broker Corps** Train young scientists, designers, communicators and entrepreneurs to move knowledge across institutional and disciplinary boundaries.
6	**Climate Innovation Challenges** Invite unconventional sectors to build with climate intelligence, including fashion, finance, architecture, tourism, sport, health and creative industries.

These should not become six disconnected projects. Together, they constitute a national infrastructure for moving climate knowledge from observation to social and economic value.

The future must not arrive untranslated

By 2050, Rwanda and Africa will be:

- Hotter
- More urban
- More digital
- Younger
- More electrified
- More dependent on intelligent systems

What narratives will survive?

The future must not arrive untranslated

The question is not only whether climate science can predict this future.
The question is whether every institution, enterprise and community can understand what that future requires of them.
The next breakthrough in climate science may not be a better model of the atmosphere. It may be a better model of how knowledge moves.

> Climate science must do more than tell Rwanda what future is coming. It must help Rwanda translate, negotiate and design what comes next.



- Eliud Kipchoge crossed the finish line in Vienna, but an entire system of knowledge crossed with him.
- Physiology became training. Weather became timing. Aerodynamics became formation. Materials science became footwear. Data became pacing. And all of it became a story that the world could carry: No Human Is Limited.
- **Climate science now faces its own barrier.**
- We have the observations. We have the models. We are building the institutions, data systems and scientific competencies.
- But our knowledge too often stops before it becomes meaning, design, enterprise, trust and action.
- **Rwanda can help cross that barrier.**
- It can demonstrate that the next frontier of climate science is not only the ability to see the future more clearly. It is the ability to move that knowledge through society without losing its integrity.
- **The future must not arrive imported. It must not arrive unexplained. And it must not arrive untranslated.**
- Climate science must help Rwanda understand, negotiate and design what comes next.



Thank You!

www.aimsric.org

info@aimsric.org

2nd RWANDA CLIMATE SCIENCE SYMPOSIUM 2026

Where Rwanda's climate research meets policy

Accelerating Climate Innovation and Scientific Collaboration for Sustainable Development

Connecting climate science, technology, policy, finance and communities

Presenter:

Dr. Louis Sibomana

National Council for Science and Technology

Climate Challenge and Opportunity

*Climate change is a **technological, health, food-security, infrastructure, and socio-economic-equity challenge**, not only an environmental challenge*

Climate Risks

Floods, landslides, drought, biodiversity/ecosystem stress

Impact on:

- Food insecurity/agriculture
- Water stress
- Infrastructure
- Health
- Biodiversity/Ecosystem loss
- Communities
- Disrupt service and slow economic transformation

Knowledge Gap

Research does not always translate:

- usable technology
- policy
- investment
- scalable practice

Opportunity

Science, technology and knowledge development:

- Smart agriculture
- Renewable/clean energy
- Digital climate services
- Green technologies
- Scientific partnerships
- Resilience/green jobs/enterprises
- Better public services

Climate Challenge and Opportunity

Why Climate Innovation Matters !!!

- Floods, landslides, lightning, rainstorms resulted in high loss and damage
- Temperature can expert an I crease up to 2°C by 2030 from 1.4°C in 1970
- Rwanda's NDC 3.0 committees 38% of reduction of greenhouse gas emissions by 2035

Disaster type	Deaths	Injured	Houses Damaged	Damages in crops Ha.	Lost Cattle	Other Livestock
Floods	307	101	5,081	11,269.6	967	3,286
Hailstorm	0	2	1,994	6,258.1	10	8
Landslides	425	187	5,970	2,059.8	166	329
Lightning	538	1,338	138	25	666	141
Rainstorms	315	612	40,871	17,285.4	384	4,664
Windstorm	10	128	8069	1107	11	86
Total	**1,595**	**2,368**	**62,123**	**38,002**	**2,204**	**8,514**

Ten Years (2014-2023) of damages related to climate change

Source: Rwanda's First Biennial Transparency Report, Dec, 2024, REMA

https://www.climatechange.gov.rw/rw/default-title/data

Climate Innovation- Scientific Collaboration

What is Climate Innovation?

Technology
Renewables, storage, resilient infrastructure

Digital
AI, Earth observation, climate data, early warning

Social & institutional
Finance, governance, community models

Nature-based
Restoration, agroforestry, watershed solutions

Why scientific collaboration?

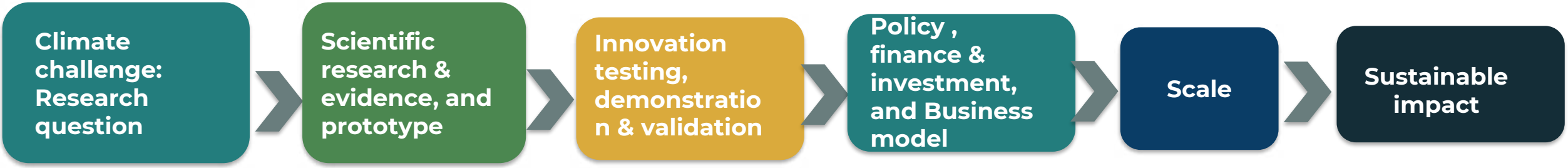
Disciplinary aspects
Climate science,
Engineering,
Agriculture,
Technology (AI),
Economics,
Health,
Social sciences

Actors
Universities,
Government,
Private sector,
Communities,
Investors,
Development partners

Co-designed research, Context-fit solutions, Testing and validation, Better policy uptake, Scaling & impact

Climate Science to Action: Closing the Gap

Question: *How can we translate climate science from knowledge into innovative solutions that are affordable, scalable and capable of improving people's lives?*



Quadruple Helix Model of Innovation: Academia/Industry (Business)/Government/Civil society

Climate Innovation is effective when science, policy , finance, industry and users are connected

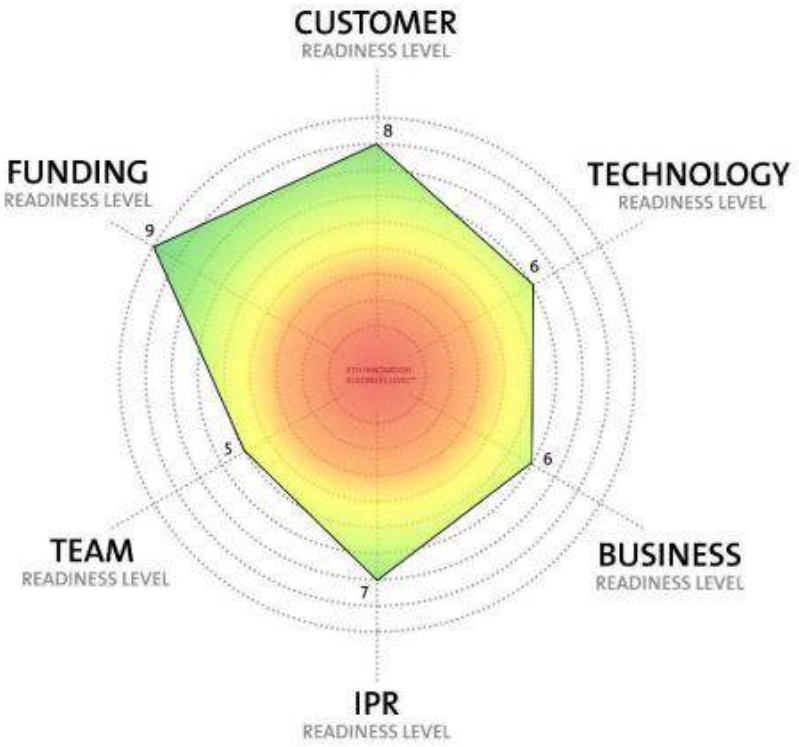
From climate knowledge to action, innovation and resilience: ***generate knowledge, solutions , decision and measurable development impact***

Climate Science to Action: Closing the Gap

Research to Innovation: TRL model/ Scale up process

TRL 1–2	TRL 3–4	TRL 5–6	TRL 7–8	TRL 9
Basic research	Proof of concept	Prototype & pilot	Demonstration & readiness	Deployment & adoption

- Engage end-users early
- Assess innovation and/or technology readiness levels towards markets and impact
- Include IP, policy, cost-effectiveness and scale-up pathways
- Measure outcomes
- The “valley of death” often occurs between promising research and scale up and deployment
- Support is needed for prototyping, demonstration, technology transfer, regulation, procurement and investment.



Source: KTH Innovation Readiness Model , Technology R Level (TRL) https://kthinnovationreadinesslevel.com/

Climate Science to Action: Closing the Gap

*Shifting from **research for users** to "**research with users**"*



From Silos to Collaborative model:

Researcher + policy maker + industry + community + investor → **co-designed solution**

Climate Development Direction: Rwanda

- Vision 2050 and NST2: focus on climate-resilient and low-carbon economy.
- Green Growth and Climate Resilience Strategy (GGCRS): integrates resilience and low-carbon development across sectors
- Nationally Determined Contributions (NDCs): translate climate ambition into mitigation and adaptation priorities
- **Enabling dimensions**:
  i. Institutions and governance
  ii. Policy, strategy and regulatory frameworks
  iii. Climate finance and investment
  iv. Digital transformation, STI and R&D

Climate resilience

Low-Carbon development

Green growth

Innovation

Climate Development Direction: Rwanda

1) Policy Environment: Examples of Policy/Strategy frameworks

National Environment and Climate Change Policy

Provides strategic direction, responses and adaptation to the issues and critical challenges in climate changes

Rwanda Climate Action Plan

Serves as a blueprint for Nationally Determined Contribution (NDC) and for advancing targeted and measurable climate action for climate change adaptation and mitigation

Green Growth and Climate Resilience Strategy

Defines a development pathway for Rwanda towards for climate resilient and harnesses green economic innovation

STI Policy

Attain and sustain an innovation-driven society through efficient and effective application of knowledge and technology

National AI Policy

Leverage the power of AI for sustainable and inclusive growth

Climate Development Direction: Rwanda

2) Establishment of Public/Private/ HLIs institutions

National and International renown universities:

AIMS African Institute for Mathematical Sciences RESEARCH & INNOVATION

Carnegie Mellon University Africa

ALU

African Leadership University

University of Rwanda

University of Global Health Equity

CoEB

RICA Rwanda Institute For Conservation Agriculture

RP Rwanda Polytechnic

University

Other Private HLIs

Public Institutions: policy makers, implementers, regulators, funding

Republic of Rwanda Ministry of Environment

Rwanda Meteorology Agency

Rwanda Green Fund — Financing Green Growth

REMA

RFA Rwanda Forestry Authority — Nurturing Rwanda's Green Heritage

NLA National Land Authority

RSA Rwanda Space Agency

RWB Rwanda Water Resources Board

ncst National Council for Science and Technology

All these Institutions support and offer climate related programs:

- **Human capital development: skills, knowledge and talent pool**
- **Innovation hubs and research performing activities**
- **Conductive environment: policy and funding instrument**

Climate Development Direction: Rwanda

2) Establishment of Public/Private/ HLIs institutions

Rwanda's Climate Science and Innovation Ecosystem

Government & policy

Strategy · regulation · implementation

MoE, REMA, Meteo Rwanda, etc.

Universities & research

Evidence · talent · discovery

UR, RP, AIMS, CMU-Africa, Private HLIs, CoES (e.g. Biodiversity)

Data institutions

Climate · weather · water · environment

REMA, Meteo Rwanda, RSA, RBC, RAB, NGO, Academia

Private sector

Technology · markets · entrepreneurship

Finance & partners

Grants · investment · technology transfer

Communities

Local knowledge · adoption · impact

Climate Development Direction: Rwanda

3) Financing Climate Innovation and R&D

Initiatives for climate research & innovation funding

- Green Fund (FONERWA)
- National Research and Innovation Fund (NIRF/NCST)
- Development partners: GIZ, LuxDev, FCDO, etc.
- Other climate awarding competitions programs such as HingaPitch, Youth, etc.

Purpose:

- Catalyzing **adequate finance** for appropriate investment that ensures that Rwanda's development pathway is climate resilient, low carbon and nature positive
- Reducing emissions by 38% by 2030, with financing plan estimated to 6.5 Billion USD

All these initiatives provided a foundation for accessing funds to support the country's development objectives to address climate changes and impacts

Climate Development Direction: Rwanda

3) Financing Climate Innovation and R&D

National Climate and Nature Finance Strategy (CNFS) of Rwanda (2024-2030)



Source: *https://www.environment.gov.rw/policies*

Climate Development Direction: Rwanda

3) Financing Climate Innovation and R&D

Green Fund (FONERWA)



Source: *Rwanda Green Fund Ten Years of Green Impact (2023-2023) Report, July 2024, Rwanda Green Fund*
https://greenfund.rw/impact-at-glance

Climate Development Direction: Rwanda

Rwanda's Environment Priorities



Wetlands



Climate



Air



Biodiversity



Water



Forests



Land

Source: https://www.rema.gov.rw/home

Climate Development Direction: Rwanda

Priority Areas for Climate Innovation in Rwanda

Climate-smart agriculture

Precision agriculture · resilient crops · smart irrigation

Water & disaster resilience

Flood forecasting · sensors · catchment restoration

Clean energy & mobility

Solar · storage · clean cooking · e-mobility

Nature-based solutions

Wetlands · forests · agroforestry · biodiversity

Climate-resilient cities

Drainage · green infrastructure · buildings · circularity

Climate & health

Early warning · surveillance · climate-health analytics

Climate Development Direction: Rwanda

High-Potential Scientific Collaboration for Climate Innovation in Rwanda

Climate-smart agriculture

AI + Earth observation + irrigation
+ farmer knowledge

Water & disaster resilience

Hydrological models + IoT
+ early warning

Clean technology

Solar + storage + e-mobility + efficiency

Biodiversity & ecosystems

Remote sensing + restoration
+ community conservation

Green cities

Climate modelling + planning
+ green infrastructure

Circular economy

Waste data + recycling + biogas
sustainable production

Climate Development Direction: Rwanda

Emerging Technologies as Enablers for Climate Innovation and Scientific Collaboration

AI & analytics
Prediction, modelling, decision support

Earth observation
Land, forests, agriculture and disaster monitoring

IoT & sensors
Flood, water, agriculture and environmental monitoring

Drones
Precision agriculture, mapping and rapid assessment

Digital twins
Urban and infrastructure climate-risk modelling

Advanced technologies
Clean materials, biotechnology and circular solutions

Data, AI and Emerging Technologies

DATA
Earth observation
Climate datasets
Open research
Interoperability

AI & ANALYTICS
Forecasting
Risk mapping
Agricultural advisory
Early warning

ENABLERS
Computing
Skills
Responsible AI
Data governance

Climate Development Direction: Rwanda

How to Measure Success? (Inputs vs Outputs)

Science
Datasets + research publications + researchers trained

Innovation
Prototypes+ validated technologies+ start-ups + IP

Policy
Evidence-informed plans + decisions + investments

Finance
Climate finance mobilized + private capital leveraged

Impact
Resilience + emissions + livelihoods + green jobs

Global Innovation index 2025, Rwanda

Year	GII Position	Innovation Inputs	Innovation Outputs
2020	91st	79th	112nd
2021	102nd	91st	108th
2022	105th	91st	123rd
2023	103rd	85th	113rd
2024	104th	81st	116th
2025	104th	86th	116th

Rwanda produces less innovation outputs relative to its level of innovation investments

Source: https://www.wipo.int/gii-ranking/en/rwanda

Climate Development Direction: Rwanda

Measure Success: Beyond publication



From Climate Science to Climate Solutions

DATA → DECISIONS

RESEARCH → INNOVATION

PILOTS → SCALE

Evidence → Innovation → Investment → Adoption → Scale → Resilience

Rwanda's climate resilience will depend on how effectively we connect science, innovation, finance, policy and communities

Key Points for Accelerating Climate Innovation and Scientific Collaboration

Building Climate Innovation & Knowledge Ecosystem

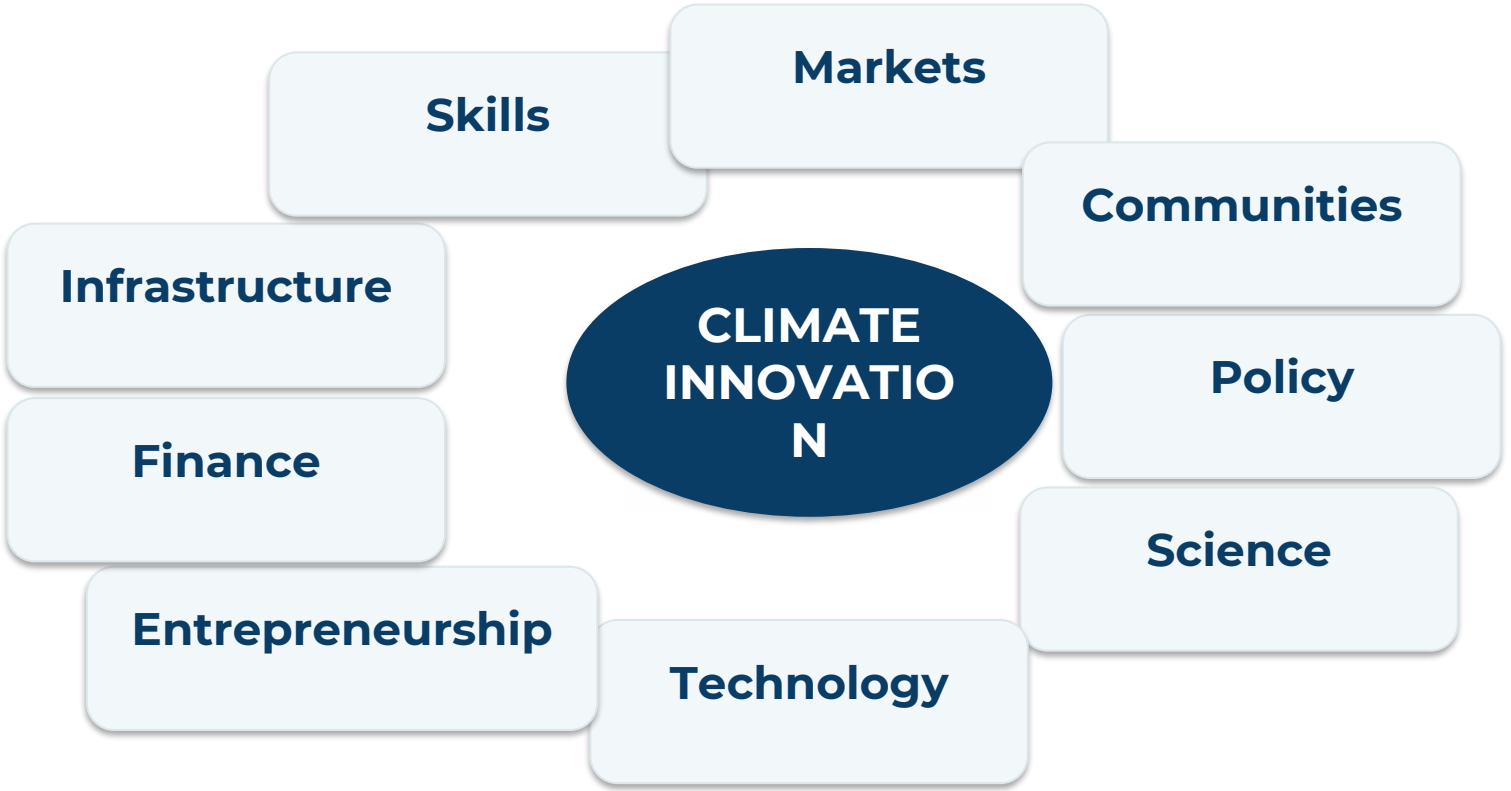
Climate data: Weather · water · land · satellite · biodiversity

Research & innovation outputs: Publications · datasets · prototypes · IP

Digital knowledge platforms: Repositories · open data · dashboards

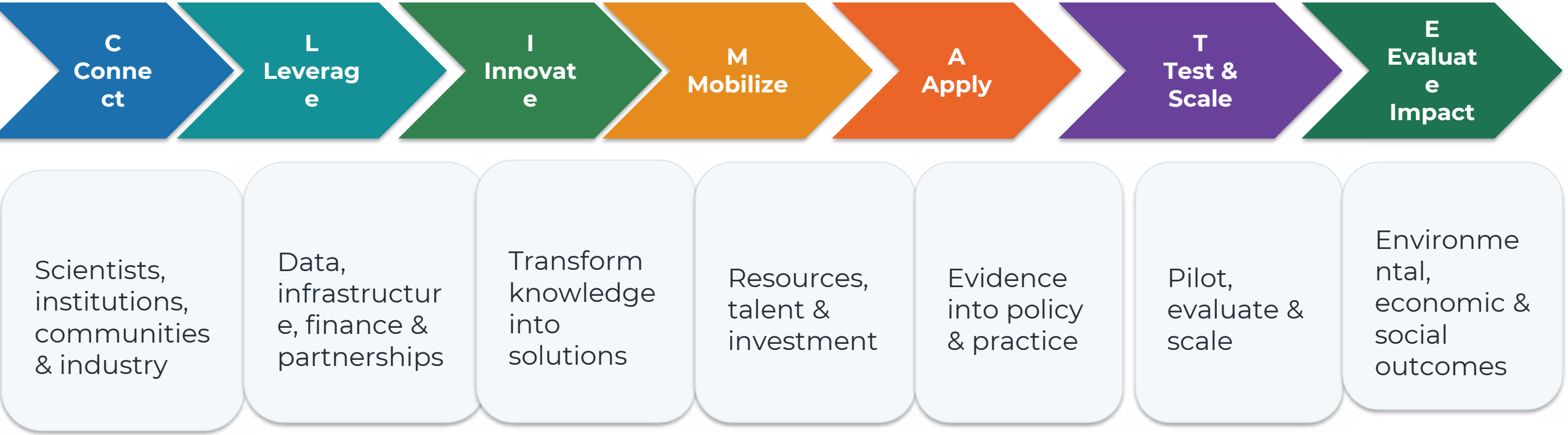
Policy intelligence: Evidence briefs · scenarios · decision tools

Users : Policymakers · researchers · businesses · communities



Key Points for Accelerating Climate Innovation and Scientific Collaboration

Building Climate Collaboration Framework (C-L-I-M-A-T-E approach)



Source: *Adapted from the IPCC AR6 WGIII Chapter 16; UNFCCC Technology Mechanism work on National Systems of Innovation and RD&D; mission-driven/transdisciplinary climate research literature (not established by IPCC(Intergovernmental Panel on Climate Change) or UNFCC framework) .*

Key Points for Accelerating Climate Innovation and Scientific Collaboration

Actions for Every Actor

1. Build a national climate research network
2. Align research priorities with national climate needs
3. Fund interdisciplinary climate innovation programs
4. Strengthen interoperable climate data infrastructure
5. Expand finance across the innovation pipeline
6. Establish more living laboratories and field testbeds
7. Strengthen university–industry technology transfer
8. Develop climate science and innovation talent
9. Expand African and international scientific partnerships
10. Institutionalize evidence-to-policy mechanisms

INVEST
Climate science & infrastructure

COLLABORATE
National & global partnerships

INNOVATE
Solutions from knowledge

SCALE
From pilots to adoption

MEASURE
Environmental & social impact

From knowledge → innovation → implementation → sustainable development impact

Key Points for Accelerating Climate Innovation and Scientific Collaboration

Actions for Every Actor: From Knowledge to Impact

- Science generates knowledge: Researchers: generate actionable evidence
- Universities build talent and innovation capacity
- Private sector turns knowledge into products and services
- Investors & partners: finance the pathway from prototype to scale (enabling scale up process)
- Collaboration connects knowledge
- Innovation transforms knowledge into solutions
- Policy creates an enabling environment: Policymakers: create demand for science
- Communities create lasting impact: Communities: co-create, validate and adopt solutions

Moving from collaboration as an event to collaboration as a system: **More Collaboration. More Innovation. Greater Impact**

Thank you!

2nd RWANDA CLIMATE SCIENCE SYMPOSIUM 2026
Where Rwanda's climate research meets policy

Rwanda's Future Population Exposure to Record Breaking Climate Extremes

Dr. IYAKAREMYE Vedaste, PhD Meteorology
Division Manager of Data Observations, Quality Control and Processing/ Meteo Rwanda

STUDY DOMAIN, DATA & METHOD

- Study domain & Period : Rwanda 1994-2014 for historical and 2031-2050 for future
- Climate data: ISIMIP3b (Ensemble of 6 models considered, 1km resolution under SSP126, SSP370 & SSP585)
- Population data: NASA (Global 1-km Downscaled Population, under SSP1, SSP3 & SSP5)
- Methods: Compute precipitation extremes:

RX1D = The highest amount of rainfall recorded on any single day in the year

PRCPTOT = Total rainfall received on wet days during a year

R50 = Number of days in a year when rainfall is at least 50 mm

Population Exposure Calculation

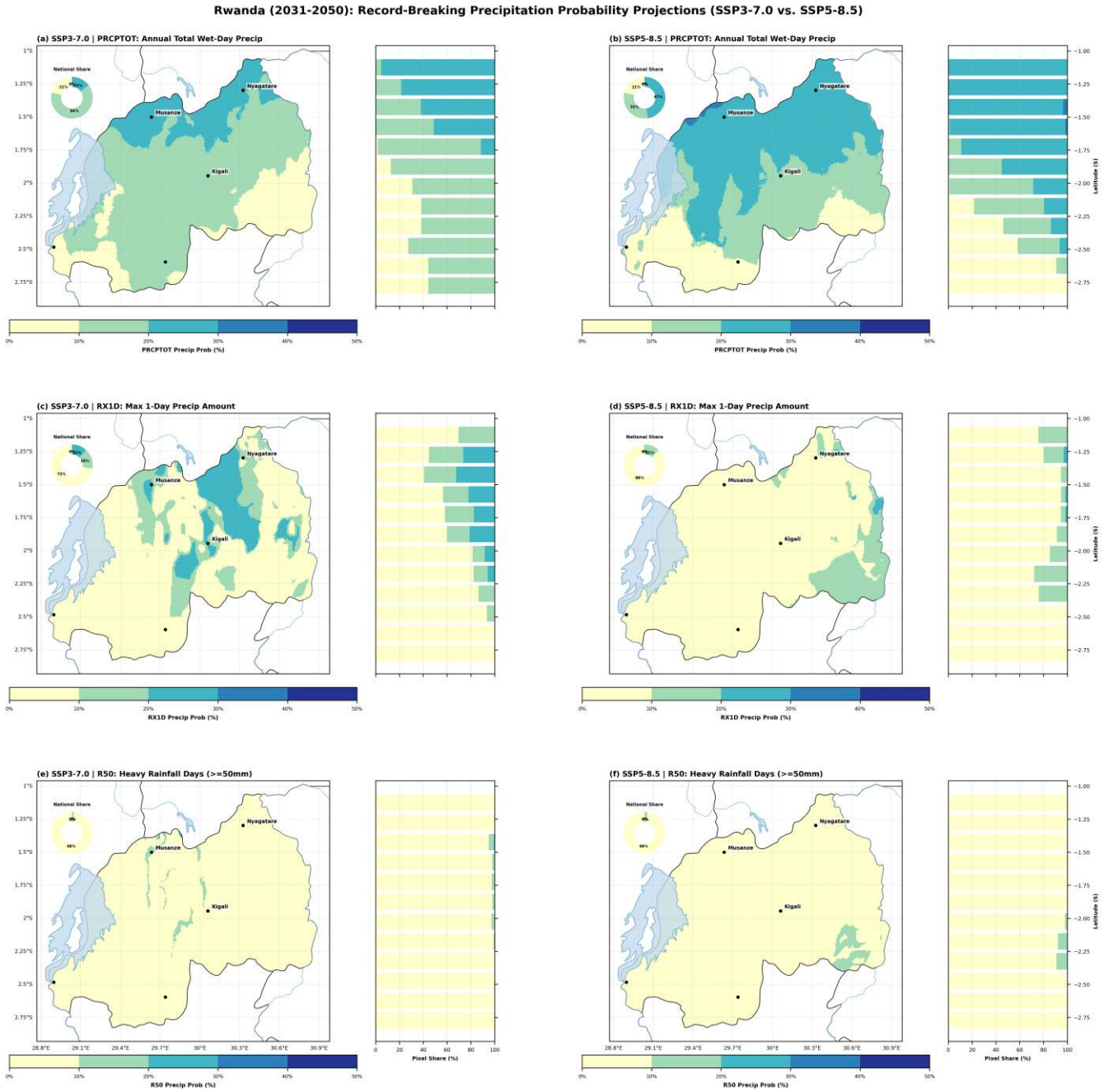
$$E_i = P_i \times C_i$$

- Relative Decomposition Framework

To isolate the driving factors behind changes in exposure between a baseline period and a future period, the absolute change in exposure is decomposed into three distinct components:

$$\Delta E = \underbrace{C_b \cdot \Delta P}_{\text{Population Effect}} + \underbrace{P_b \cdot \Delta C}_{\text{Climate Effect}} + \underbrace{\Delta P \cdot \Delta C}_{\text{Interaction Effect}}$$

Record Breaking precipitation probability projections

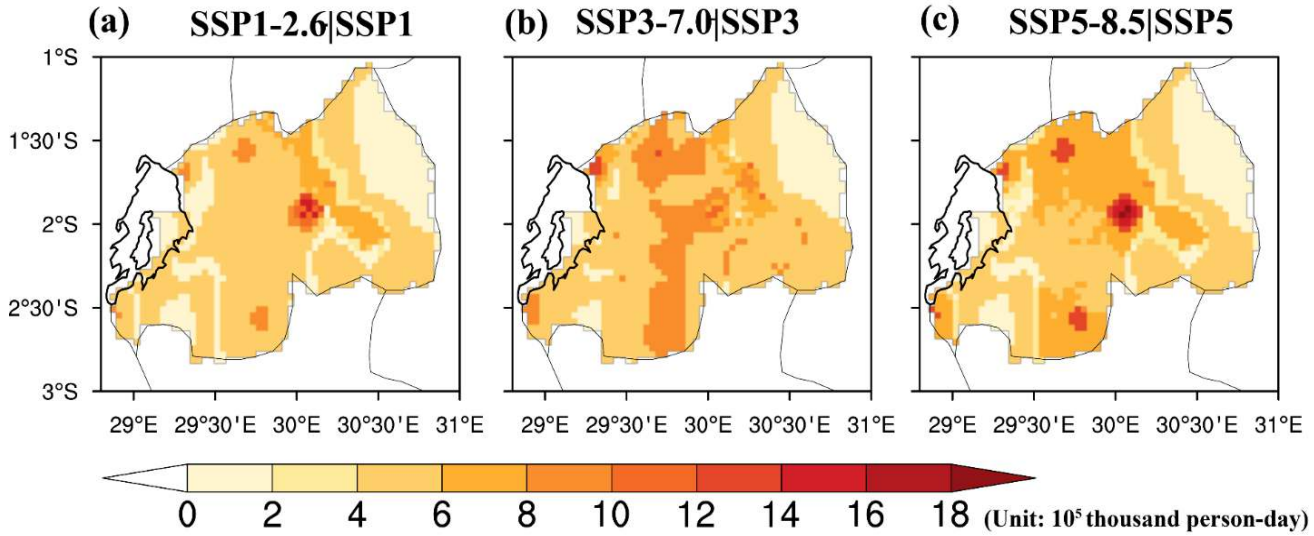


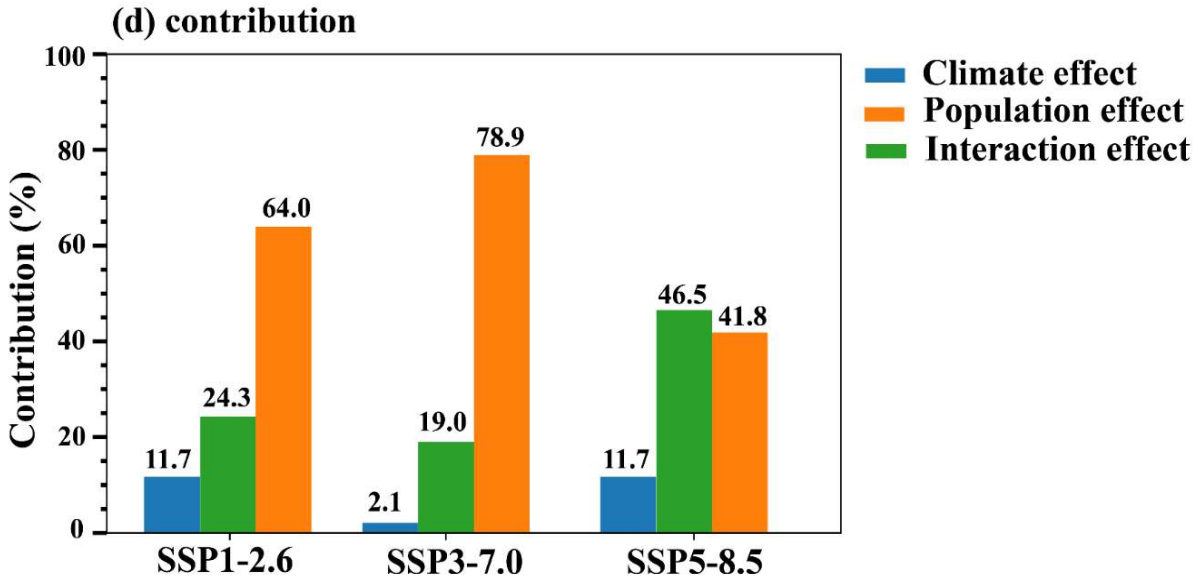
- During 2031–2050, Rwanda may exhibit a substantially stronger and more spatially coherent probability of record-breaking annual wet-day precipitation (PRCPTOT) than of record-breaking maximum 1-day precipitation (RX1D) or the number of heavy-rainfall days ≥50 mm (R50).
- The PRCPTOT signal intensifies and expands spatially under SSP5-8.5, particularly across northern, western and central Rwanda, indicating an increased likelihood of years exceeding the historical maximum in cumulative wet-day precipitation.
- In contrast, RX1D and R50 exhibit predominantly low and spatially heterogeneous probabilities, with localized hotspots rather than a nationwide signal.
- The localized nature of RX1D and R50 extremes also emphasizes the importance of spatially targeted flood-risk management and high-resolution early warning systems.

Key implication for Rwanda

- From a climate-risk perspective, the results suggests that Rwanda's precipitation risk in 2031–2050 may increasingly involve changes in the overall seasonal/annual rainfall regime, while localized intense rainfall remains a more spatially variable hazard.
- **Agriculture**: changes in cumulative wet-day precipitation may affect planting calendars, soil moisture, crop diseases and flood/waterlogging risk.
- **Flood management**: localized RX1D hotspots remain important even where national-average signals are weak.
- **Infrastructure**: drainage and flood-control systems should consider localized extreme rainfall rather than relying only on national precipitation averages.
- **Early warning**: monitoring should distinguish between cumulative rainfall anomalies and short-duration extreme rainfall, because they represent different hazards.
- **Spatial planning**: northern, western/central and eastern areas should not necessarily be treated as having the same precipitation-risk profile.

Projected change in population exposure to heavy precipitation under (a) SSP1-2.6|SSP1, (b) SSP3-7.0|SSP3, and (a) SSP5-8.5|SSP5 over Rwanda by 2050





- Urban Concentration Hotspot: Across all three Shared Socioeconomic Pathways (SSP1-2.6, SSP3-7.0, and SSP5-8.5), the highest population exposure to heavy precipitation is consistently concentrated around the Kigali metropolitan region (exceeding 18×10^5 thousand person-days
- Northwestern & Western Expansion: Secondary exposure hotspots emerge in the high-elevation, densely populated districts of the Northwest (Musanze region) and West (along Lake Kivu) under SSP3-7.0 and SSP5-8.5.
- Pathway Severity: Spatial exposure expands significantly from SSP1-2.6 to SSP3-7.0/SSP5-8.5, driven by both rapid urbanization and intensified regional extreme precipitation.

Call for Action

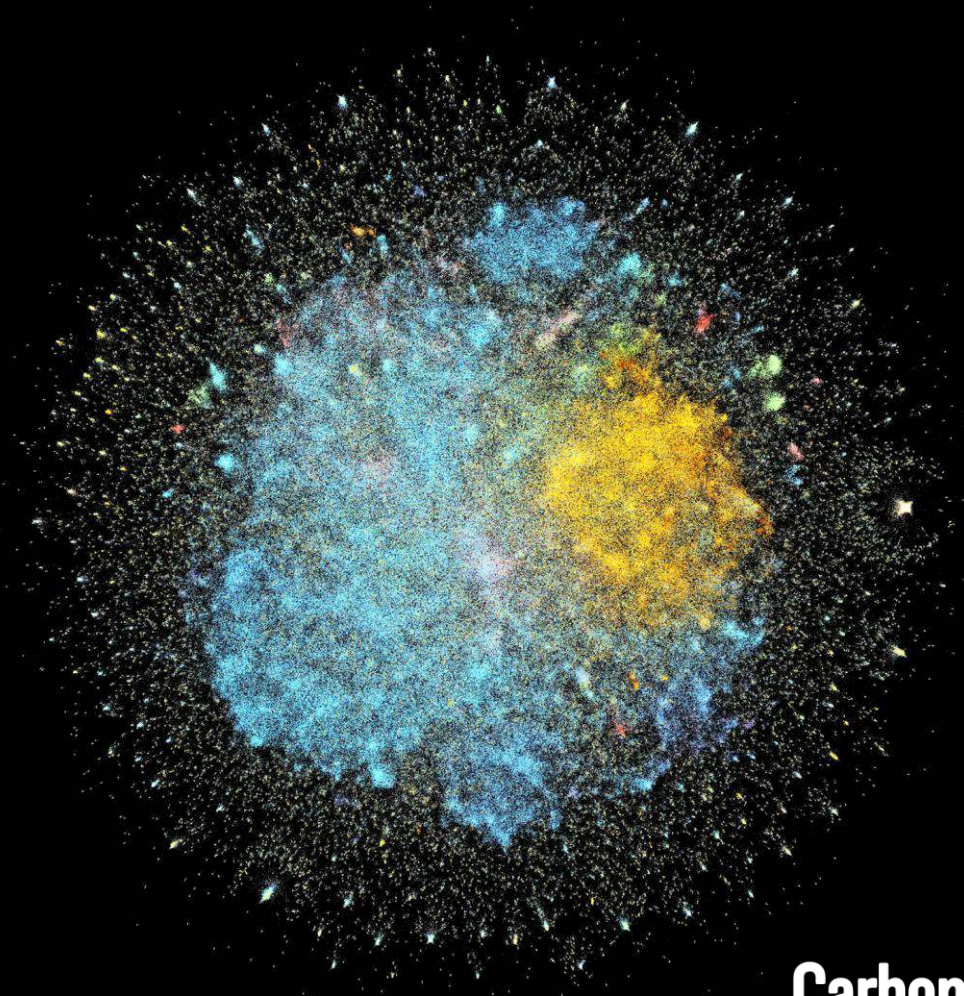
- Because the largest exposure hotspot centers on Kigali, climate-proofing urban drainage systems, slope stabilization, and informal settlement upgrading should be prioritized.
- Since demographic growth drives the vast majority of exposure changes (up to 78.9%), smart urban zoning that prevents residential expansion into floodplains and steep slopes will yield the highest risk-reduction return on investment.
- Climate adaptation policies must account for non-linear interaction effects; treating demographic trends and climate hazards in isolation will severely underestimate future exposure under high-emissions futures.

MURAKOZE

Dr. IYAKAREMYE Vedaste, PhD Meteorology
Division Manager of Data Observations, Quality Control and Processing/ Meteo Rwanda

Introducing Project Cosmos:

Carbon Brief's 'universe' of climate science



Ayesha Tandon | *Science correspondent*
Tom Pearson | *Interactive developer*

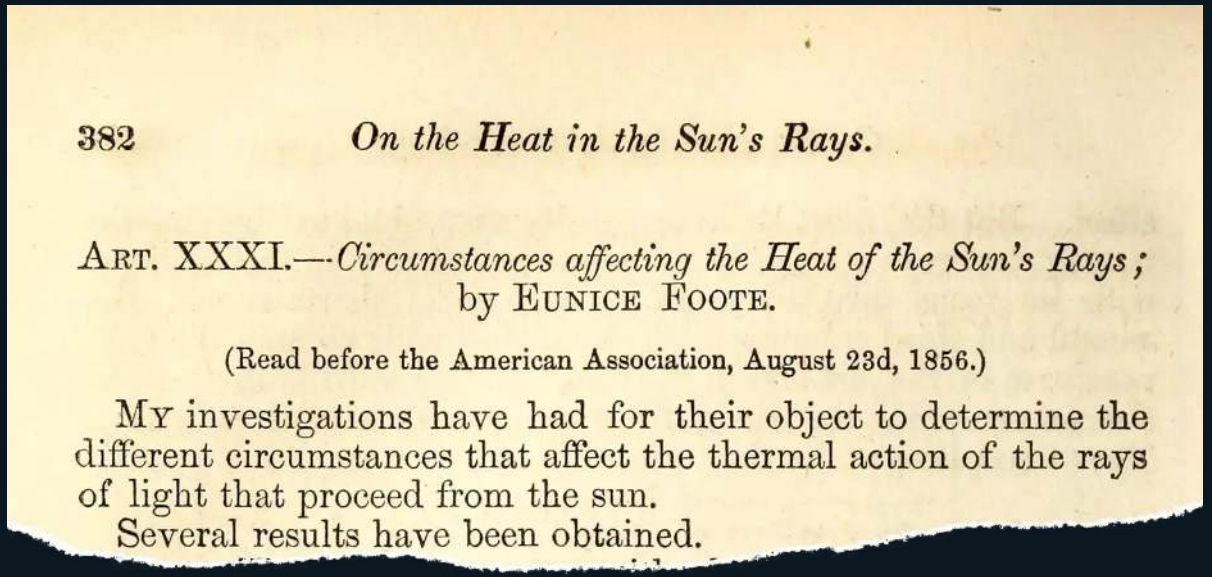
PROJECT COSMOS

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What is ‘climate change research’?

One of the first scientific studies to connect atmospheric CO2 to a rise in global temperatures was published in 1856 by Eunice Newton Foote.



382 *On the Heat in the Sun's Rays.*

ART. XXXI.—*Circumstances affecting the Heat of the Sun's Rays;* by EUNICE FOOTE.

(Read before the American Association, August 23d, 1856.)

MY investigations have had for their object to determine the different circumstances that affect the thermal action of the rays of light that proceed from the sun.

Several results have been obtained.

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The Intergovernmental Panel on Climate Change



FAR (1990)



SAR (1995)



TAR (2001)



AR4 (2007)



AR5 (2013-14)


AR6 (2021-23)

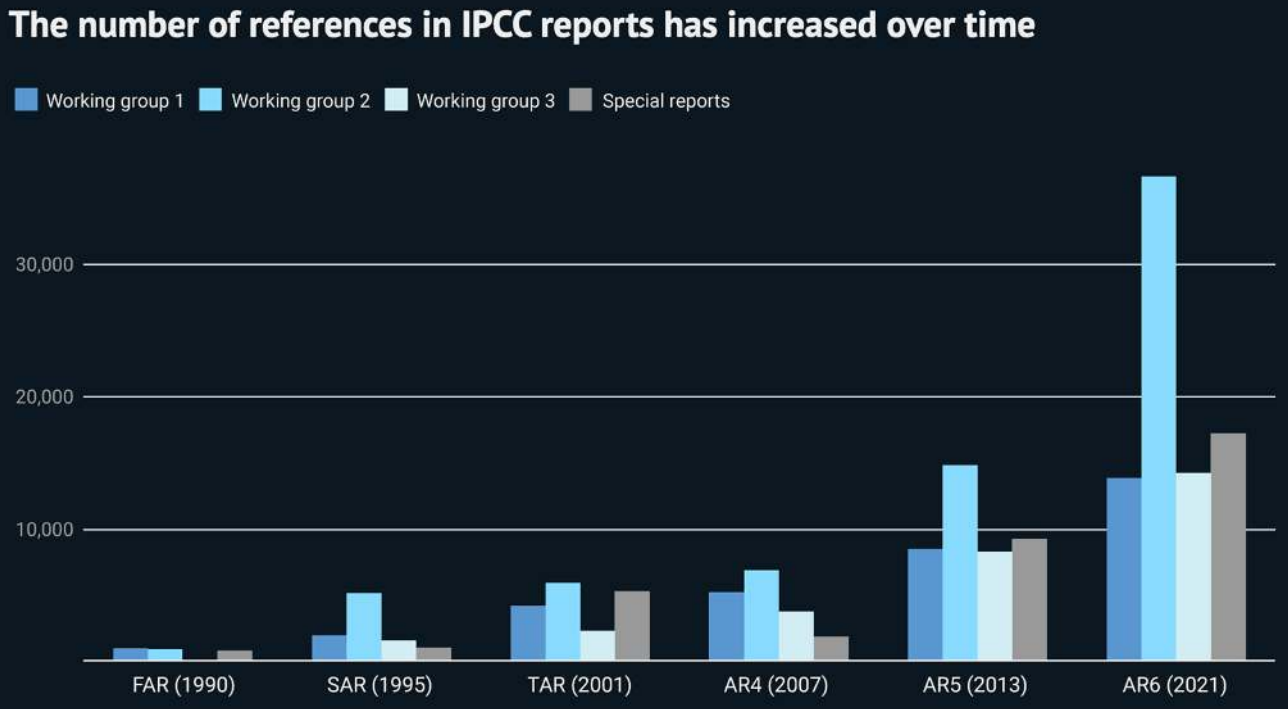
The IPCC publishes the world's most authoritative summaries of the latest climate science.

The organisation has published six "assessment cycles" so far.

These reports are the "core" of the Cosmos database.

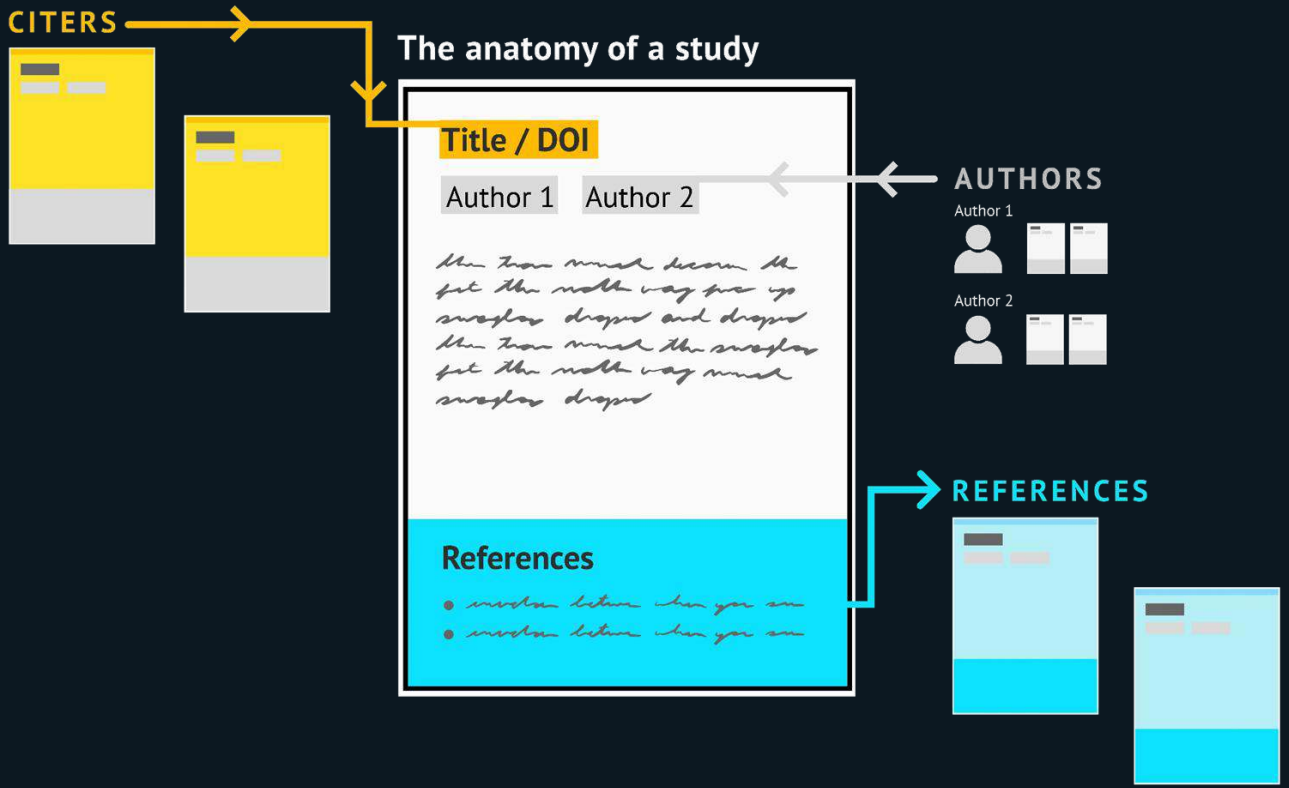
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The Intergovernmental Panel on Climate Change



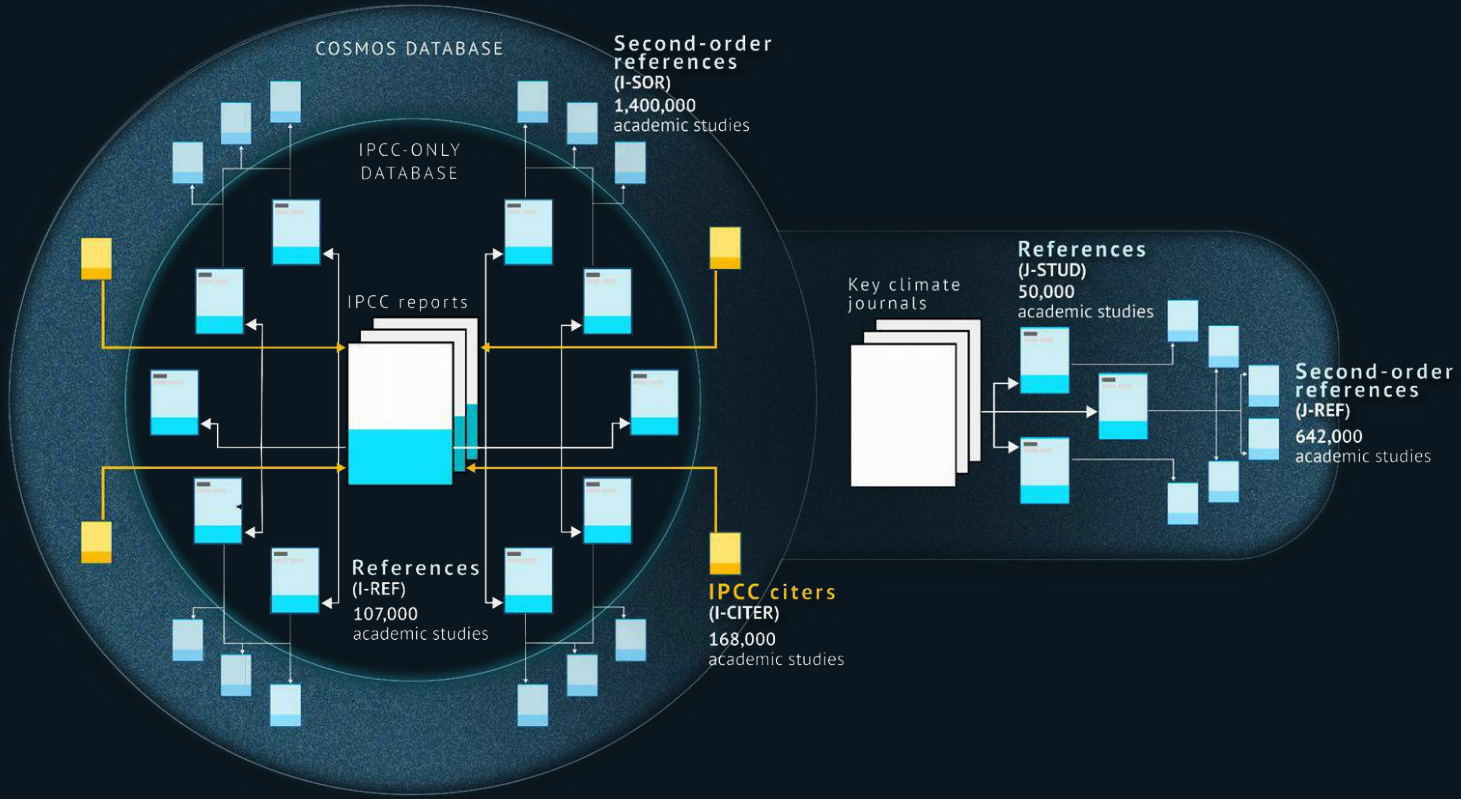
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What is a reference?



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How did Carbon Brief create the database?



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The Cosmos 500

The Cosmos 500: authors

Citation count: How many times each expert's publications are referenced by others within the Cosmos database.

Almost half of the authors in the Cosmos 500 are from institutions in the US

Experts from global south countries account for only 4% of authors

Only 10% of the authors in the Cosmos 500 are women.

The first 35 entries of the Cosmos 500 ranking are men.

You can also view results for the "IPCC-only" database.

Rank	Name	Citation count	h index	Country	Institution
1	Philippe Ciais	69,655	223	France	Université Paris-Saclay
2	P. D. Jones	66,375	155	UK	University of East Anglia
3	F. Stuart Chapin	57,432	168	US	University of Alaska Fairbanks
4	Gerald A. Meehl	55,138	117	US	University Corporation for Atmospheric Research
5	Carl Folke	52,438	144	Sweden	Stockholm University
6	Detlef P. van Vuuren	49,721	148	Netherlands	Netherlands Environmental Assessment Agency
7	Kevin E. Trenberth	45,751	122	US	University Corporation for Atmospheric Research
8	I. Colin Prentice	44,836	115	UK	Imperial College London
9	Pierre Friedlingstein	44,673	139	UK	University of Exeter
10	David Tilman	43,411	180	US	University of Minnesota
11	Jean-François Lamarque	43,253	128	US	University Corporation for Atmospheric Research
12	Ronald J. Stouffer	42,740	85	US	National Oceanic and Atmospheric Administration
13	Keywan Riahi	41,414	112	Austria	International Institute for Applied Systems Analysis
14	Stephen R. Carpenter	39,567	145	US	University of Wisconsin System
15	William D. Collins	38,041	69	US	United States Department of Energy
16	Dennis P. Lettenmaier	37,296	145	US	University of California, Los Angeles
17	Scott C. Doney	36,332	129	US	University of Virginia
18	John H. Seinfeld	35,807	185	US	California Institute of Technology
19	Karl E. Taylor	35,539	69	US	Lawrence Livermore National Laboratory
20	Christopher B. Field	35,422	143	US	Carnegie Institution for Science

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The Cosmos 500: authors



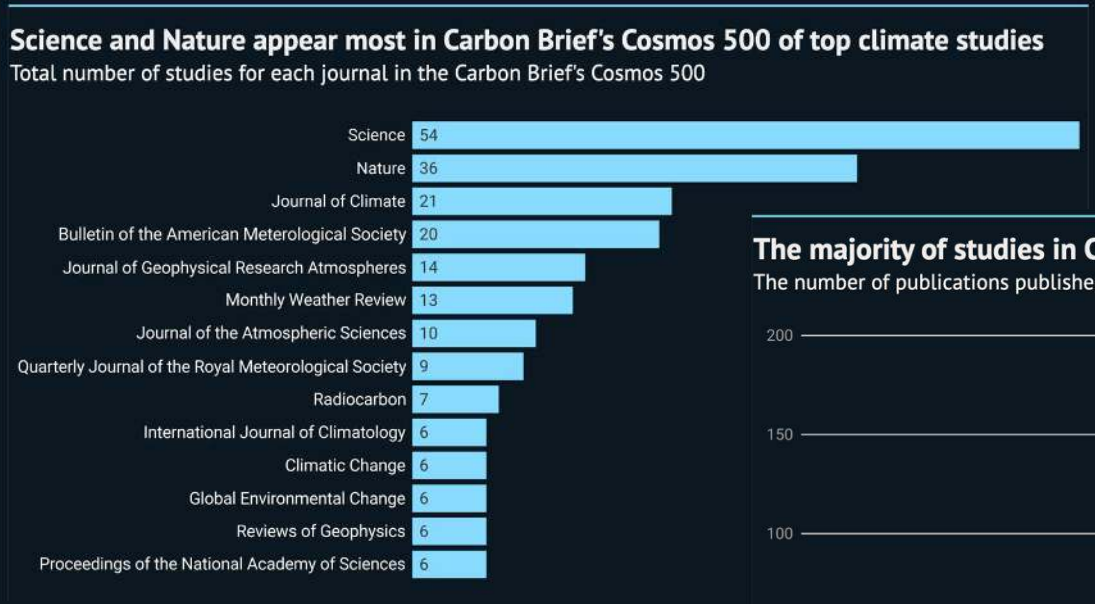
Prof Philippe Ciais

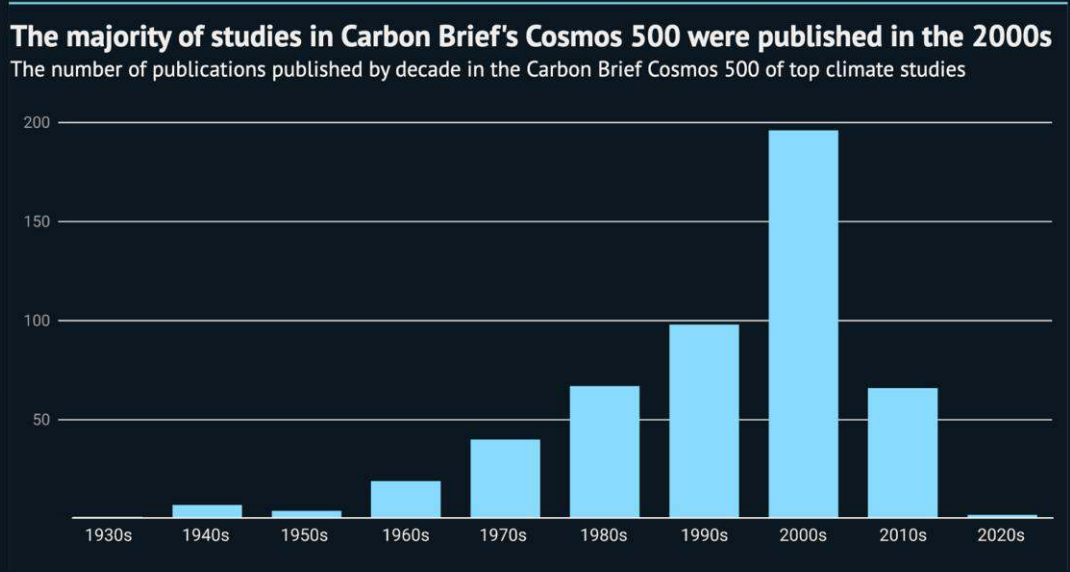


Prof Detlef van Vuuren

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The Cosmos 500: publications

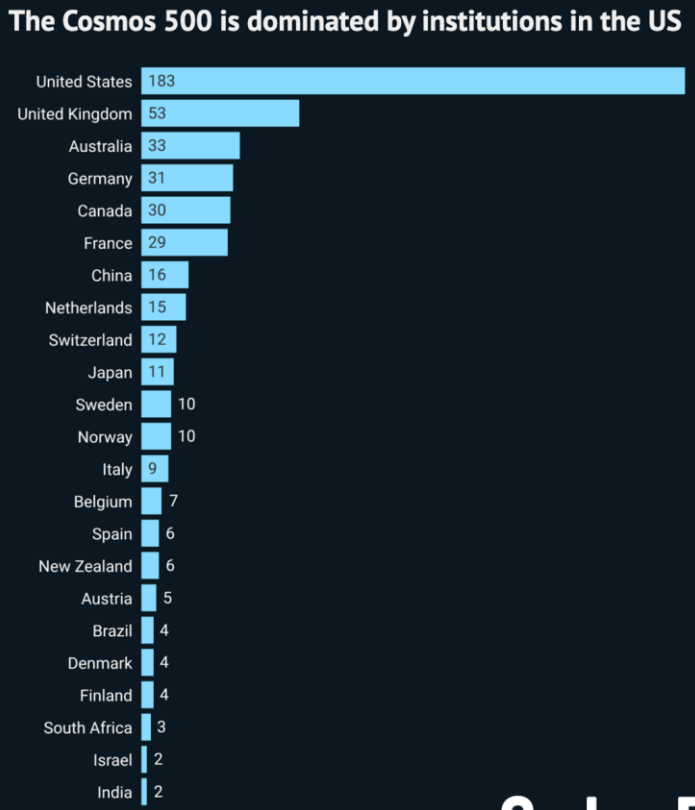




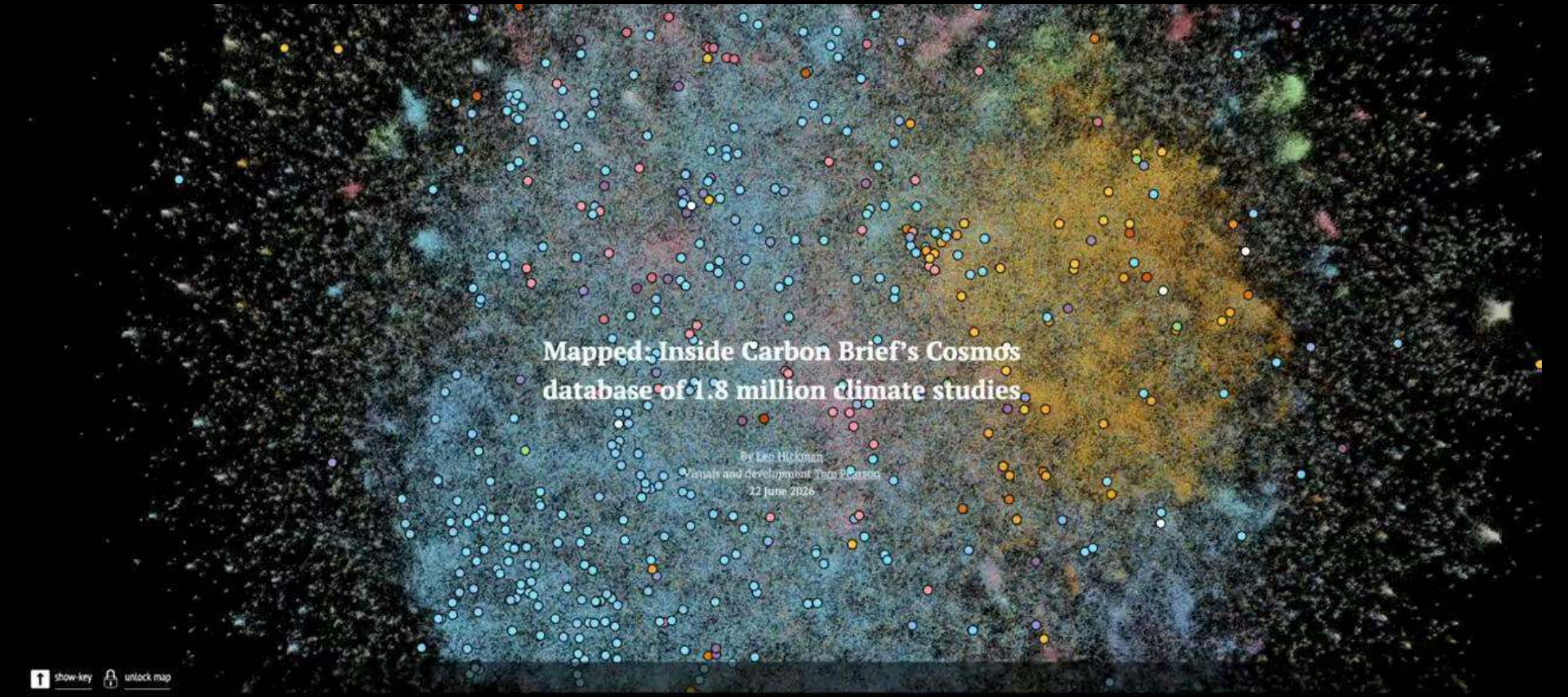
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The Cosmos 500: institutions

Rank	Name	Citations	Country
1	Centre National de la Recherche Scientifique	864,154	France
2	NSF National Center for Atmospheric Research	721,372	US
3	University of Washington	662,032	US
4	Chinese Academy of Sciences	530,244	China
5	Columbia University	505,465	US
6	Goddard Space Flight Center	471,663	US
7	University of California, Berkeley	452,748	US
8	University of Colorado Boulder	442,368	US
9	United States Geological Survey	431,595	US
10	Stanford University	408,605	US
11	National Oceanic and Atmospheric Administration	402,451	US
12	University of Oxford	400,870	UK
13	Harvard University	399,821	US
14	Princeton University	389,300	US
15	Met Office	387,194	UK
16	University of Wisconsin–Madison	356,339	US
17	University of Maryland, College Park	353,587	US
18	ETH Zurich	349,973	Switzerland
19	University of East Anglia	348,177	UK
20	Wageningen University & Research	346,851	Netherlands



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Next steps

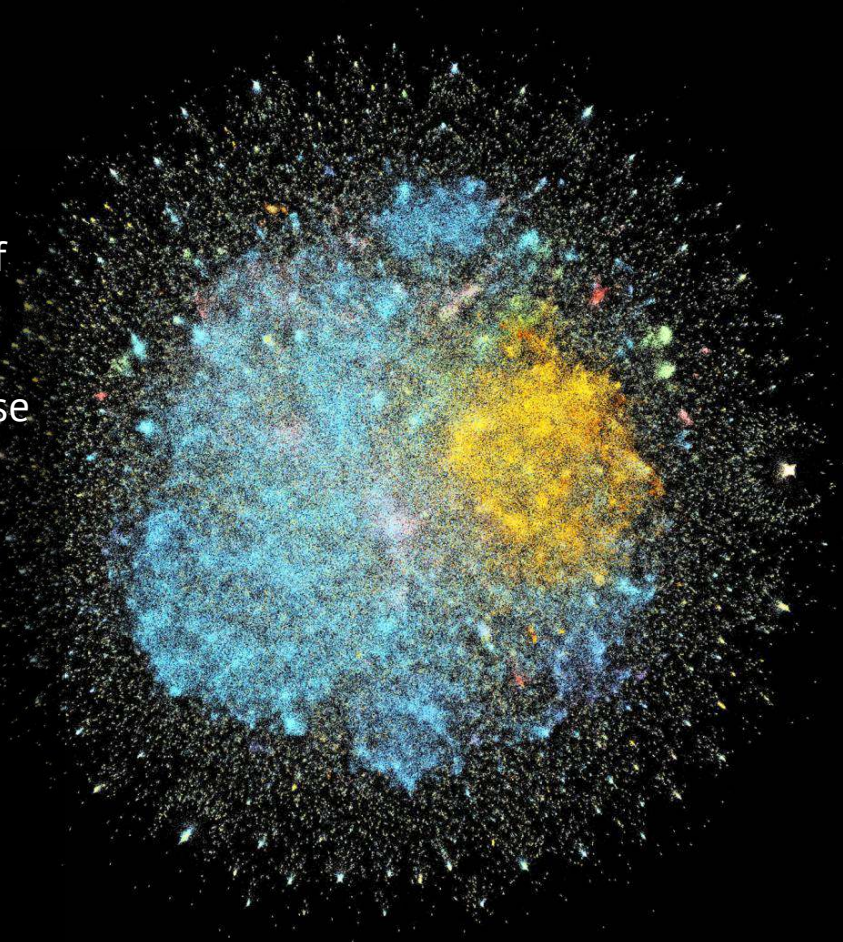
Carbon Brief has published an initial wave of preliminary analysis to demonstrate the scope of the Cosmos database.

Carbon Brief will update and expand the database annually, as well as undertaking new analysis

Carbon Brief now invites researchers to submit their own proposals for co-authored studies and projects.

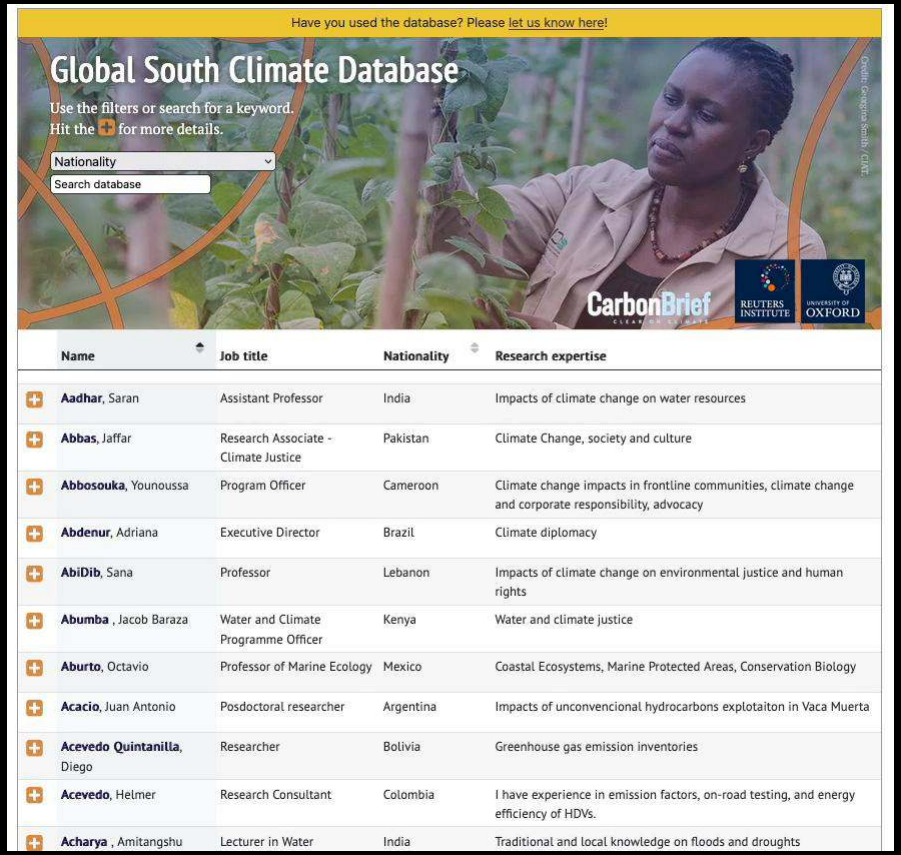
Proposals should be sent to: cosmos@carbonbrief.org

Access the database here: https://interactive.carbonbrief.org/cosmos/



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The Global South Climate Database



Name	Job title	Nationality	Research expertise
Aadhar, Saran	Assistant Professor	India	Impacts of climate change on water resources
Abbas, Jaffar	Research Associate - Climate Justice	Pakistan	Climate Change, society and culture
Abbosouka, Younoussa	Program Officer	Cameroon	Climate change impacts in frontline communities, climate change and corporate responsibility, advocacy
Abdenur, Adriana	Executive Director	Brazil	Climate diplomacy
AbiDib, Sana	Professor	Lebanon	Impacts of climate change on environmental justice and human rights
Abumba , Jacob Baraza	Water and Climate Programme Officer	Kenya	Water and climate justice
Aburto, Octavio	Professor of Marine Ecology	Mexico	Coastal Ecosystems, Marine Protected Areas, Conservation Biology
Acacio, Juan Antonio	Posdoctoral researcher	Argentina	Impacts of unconvencional hydrocarbons explotaiton in Vaca Muerta
Acevedo Quintanilla, Diego	Researcher	Bolivia	Greenhouse gas emission inventories
Acevedo, Helmer	Research Consultant	Colombia	I have experience in emission factors, on-road testing, and energy efficiency of HDVs.
Acharya , Amitangshu	Lecturer in Water	India	Traditional and local knowledge on floods and droughts

A publicly available, searchable database of scientists and experts in climate science, policy and energy from Asia, Africa, Latin America and the Caribbean, and the Pacific.

The database lists each person's area of expertise, institutional affiliation, contact details and other relevant information. The experts cover many different languages from around the world, but all speak English too.

You can filter by research expertise, nationality, institution, pronouns etc.

CarbonBrief

23 September 2025

Designing Global Carbon Markets under Article 6 of the UNFCCC: A climate-smart carbon trading mechanism for African states?

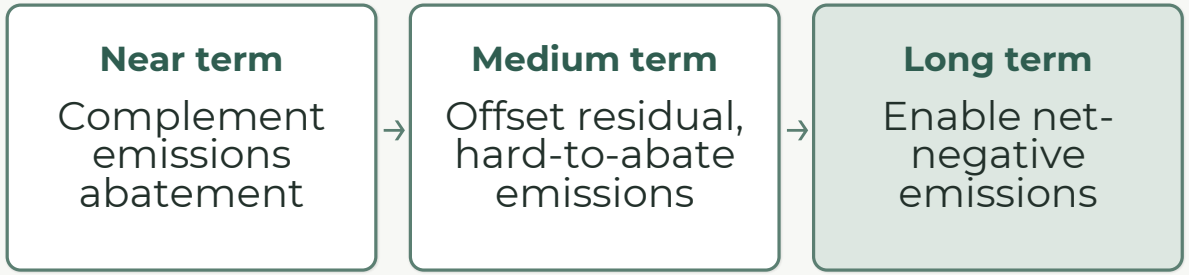
Prof. Dr. Christian Henning
Chief Scientist, Akademiya2063
chenning@akademiya2063.org

WHY CARBON DIOXIDE REMOVAL MATTERS

CDR is becoming a core element of Paris-aligned climate strategies

Scientific consensus

Meeting the Paris temperature goals is likely to require substantial carbon dioxide removal (CDR) in addition to deep emissions reductions.



- Scale: Paris-consistent CDR could mobilize financial flows equivalent to several percent of global GDP.
- Research gap: technology has received most attention; governance and market integration remain comparatively underexplored.
- **Policy implication: CDR should be treated not only as a technology issue, but also as a market-design and governance challenge.**

Selected references from source text: IPCC (2018); Warszawski et al. (2021); Ker et al. (2024).

WHY AGRICULTURE AND LAND USE MATTER

Article 6 creates new opportunities for land-based mitigation — with important co-benefits

UP TO

37%

of cost-effective CO_2 mitigation needed by 2030 for a pathway with a chance of staying below 2°C could come from natural climate solutions.

Forests • wetlands • agricultural landscapes

Growing relevance under the Paris Agreement

- Agriculture and land use were historically underrepresented in international carbon markets, including the CDM.
- Land-based CDR can combine mitigation with food-security, biodiversity and rural-livelihood objectives.
- Potential co-benefits include rural income diversification, improved soil and water management, job creation and knowledge transfer.

Persistent barriers

- Limited recognition of carbon-farming practices and a narrow set of eligible methodologies.
- Sequestration has often been excluded from compliance markets; project costs remain high relative to carbon revenues.

Selected references from source text: Griscom et al. (2017); Seddon et al. (2020, 2021); Lee et al. (2016).

TWO IMPLEMENTATION CHALLENGES — AND THE PROPOSED CONTRIBUTION

Effective agricultural carbon markets require credible MRV and robust market governance

1 Measurement, Reporting & Verification (MRV)

- Avoid double counting; demonstrate additionality; establish credible baselines.
- Reduce the technical and cost burden of quantification, especially for smallholders.
- Ensure consistency with national inventories and NDC accounting.

2 Governance of carbon markets

- Define participation rules and property rights over emission units.
- Create credible demand and price-stability mechanisms.
- Build institutional and technical capacity to meet Article 6 requirements.

PROPOSED CONTRIBUTION

An integrated method combining remote sensing, machine learning and blockchain to support high-quality Article 6.2 / 6.4 carbon-credit offers.

Proof of concept & market analysis

- Tree-based carbon farming in Senegalese Sahel rangelands
- Bilateral climate-club simulations with the EU, US and China
- Distributional effects of alternative emission-right allocation principles

Source: Henning, C., R. Ly, J.P. Faye and J. Ziesmer 2026

ECONOMIC VALUE OF TEMPORARY CARBON STORAGE

Non-permanent CDR requires pricing rules that reflect storage duration and future release risk

Temporary storage discount

$$\lambda = r / (r + \delta)$$

$$\delta = \ln(2) / T$$

r = discount rate · δ = carbon release rate
T = storage half-life

Implication

A tonne stored temporarily is worth less than a permanently avoided tonne of CO_2.

Three pricing approaches

1. **Downstream pricing** — Removal is paid at the full carbon price today; later release is fully priced.
2. **Upstream pricing** — Removal is paid at λ × carbon price; later stock release is not separately priced.
3. **Storage subsidy** — Stored carbon receives a recurring reward linked to expected marginal climate damages.

All three systems depend on continuous, credible MRV.

Source: Henning, C., R. Ly, J.P. Faye and J. Ziesmer 2026 drawing on Kalkuhl et al. (2022).

BILATERAL CLIMATE CLUBS PROVIDE THE MARKET ARCHITECTURE

The model links one major emitter with Sub-Saharan Africa through a common permit market

Core member

EU • USA • China

→

COMMON PERMIT MARKET

Equilibrium permit price Pc

determines abatement and CDR demand

→

Associated member

Sub-Saharan Africa

Four constitutional rules in the model

1 Common emissions-reduction target

implemented through a shared permit market

2 Core member sets the permit price

to maximize modeled club welfare

3 Polluter-pays financing

each member pays for emission rights used domestically

4 Allocation rule distributes emission rights

grandfathering or per-capita universalism

Source: Henning, C., R. Ly, J.P. Faye and J. Ziesmer 2026

A DIGITAL MRV CHAIN CAN MAKE SCATTERED TREES VISIBLE TO CARBON MARKETS

The proposed system links satellite monitoring, AI-based biomass estimation and transparent credit tracking

1 Satellite remote sensing

Sentinel-2 red and near-infrared bands; NDVI identifies woody vegetation during suitable seasonal windows.

→

2 AI tree detection

Detect individual crowns, estimate crown area and monitor vegetation change across heterogeneous landscapes.

→

3 Biomass & carbon

Allometric equations estimate wood, foliage and roots; dry mass is converted to carbon stock.

→

4 Credit tracking

Digital registries / blockchain can support traceability, transparency and lower transaction costs.

Why it matters for Article 6

Continuous, lower-cost monitoring supports credible baselines, reduces double counting risk, and can make non-forest tree carbon eligible for transparent carbon-credit accounting.

Source: Henning, C., R. Ly, J.P. Faye and J. Ziesmer 2026

PROOF OF CONCEPT: SCATTERED TREES IN SENEGAL'S SAHEL

The Senegalese Basin illustrates how non-forest trees can be quantified and valued as a carbon asset

2.5 mio ha	656,176	848,983 t	≈0.3 t/ha
Study area	**Trees detected**	**CO_2 stored**	**CO_2 density**
Senegalese Basin	crown area > 3 m²	estimated stock	reported average

Biomass calculation

$$Mw = 3.9448\ A^{1.1068}$$
$$Mf = 0.2693\ A^{0.9441}$$
$$Mr = 0.8339\ A^{1.1730}$$

Total dry mass = wood + foliage + roots
Carbon = 0.47 × total dry mass

Interpretation

- Trees outside forests can represent a measurable carbon stock that conventional forest-focused inventories may miss.
- Rangelands may offer sequestration opportunities with comparatively low land-use opportunity costs.

Source: Henning, C., R. Ly, J.P. Faye and J. Ziesmer 2026; allometric equations from Hiernaux et al. (2023).

SCENARIO ANALYSIS COMBINES ABATEMENT COSTS, CDR LIMITS AND TEMPORARY-STORAGE PRICING

The simulations compare EU–SSA, USA–SSA and China–SSA bilateral clubs under common modeling assumptions

Abatement costs

Estimated for EU, USA, China and SSA using metamodeling of the DART model.

Land-based CDR cap

Maximum removal is constrained to 5% of total emissions reductions in each club.

Temporary-storage factor

Discount rates 1–7% and half-lives 10–100 years imply $\lambda = 0.22–0.91$; the analysis uses $\lambda = 0.67$.

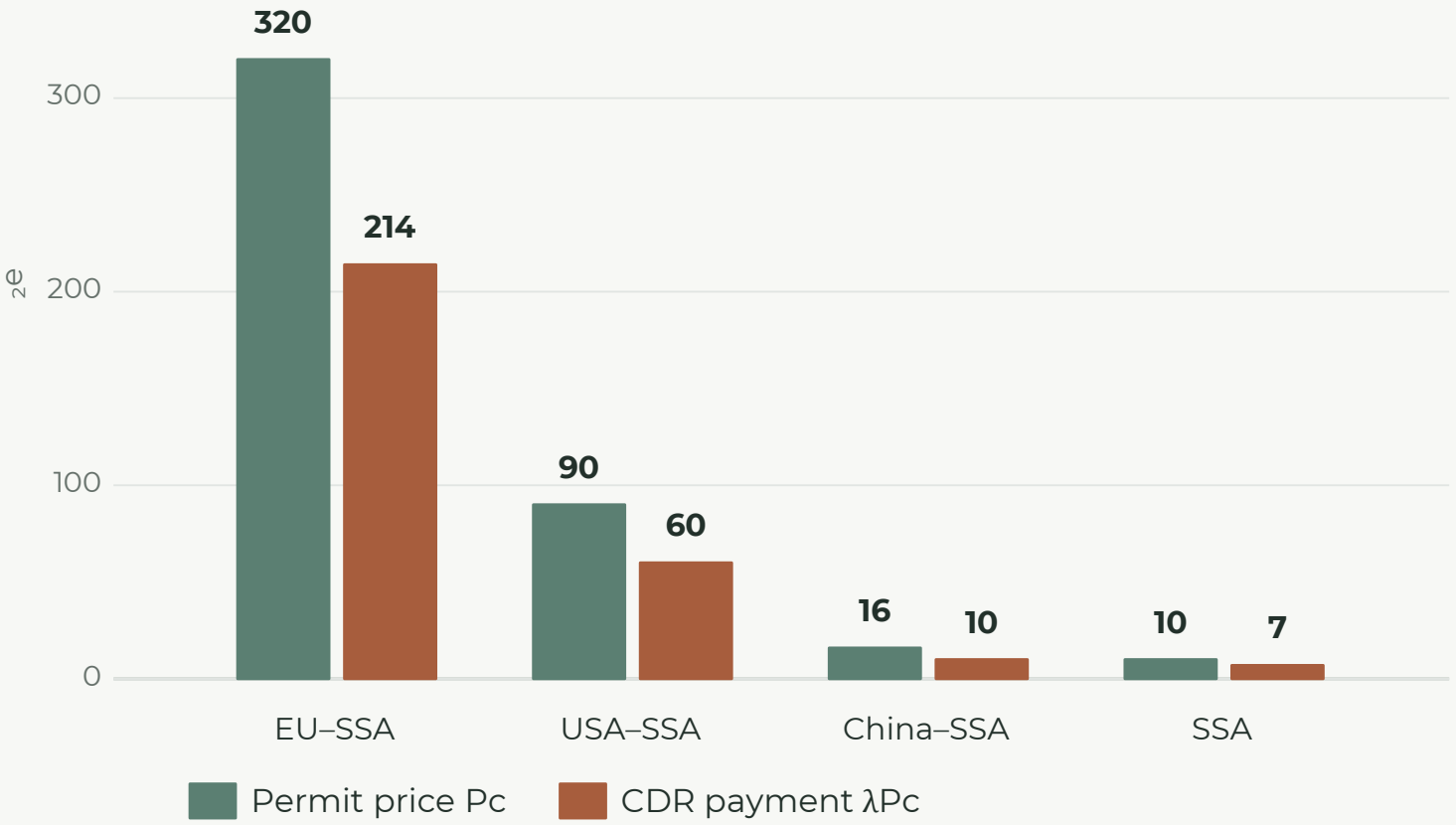
Outcome calculation

Permit price Pc → effective CDR payment λPc → removal demand (≤5%) → CDR revenues → net transfers under alternative permit-allocation rules

Source: Henning, C., R. Ly, J.P. Faye and J. Ziesmer 2026

CARBON PRICES DIFFER SHARPLY ACROSS BILATERAL CLIMATE CLUBS

The modeled EU–SSA club produces the highest permit price and therefore the highest payment for temporary CDR



What drives the differences?

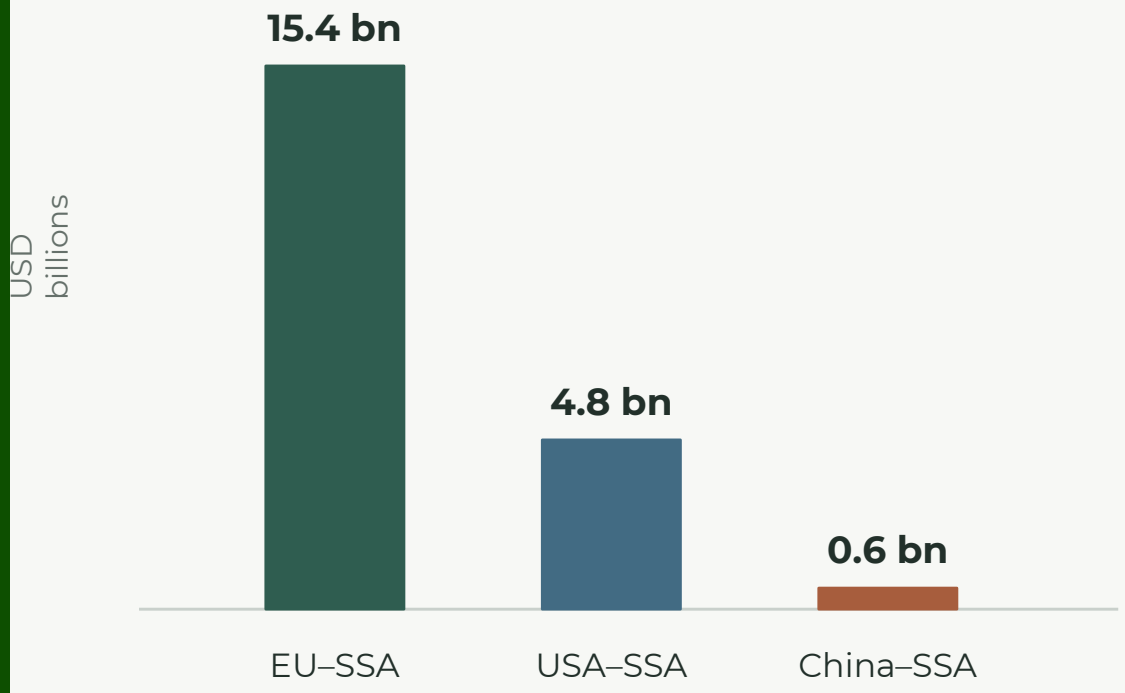
- Climate ambition / NDC stringency of the core club member.
- Marginal abatement costs: lower costs imply lower equilibrium permit prices.
- **Temporary storage receives only λ = 0.67 of the permit price in the baseline.**

Source: Henning, C., R. Ly, J.P. Faye and J. Ziesmer 2026.

LAND-BASED CDR CREATES REVENUE — BUT REMAINS MACROECONOMICALLY MODEST

For SSA, the modeled value depends on both carbon price and the volume of removal demand

Total CDR revenue



Economic scale

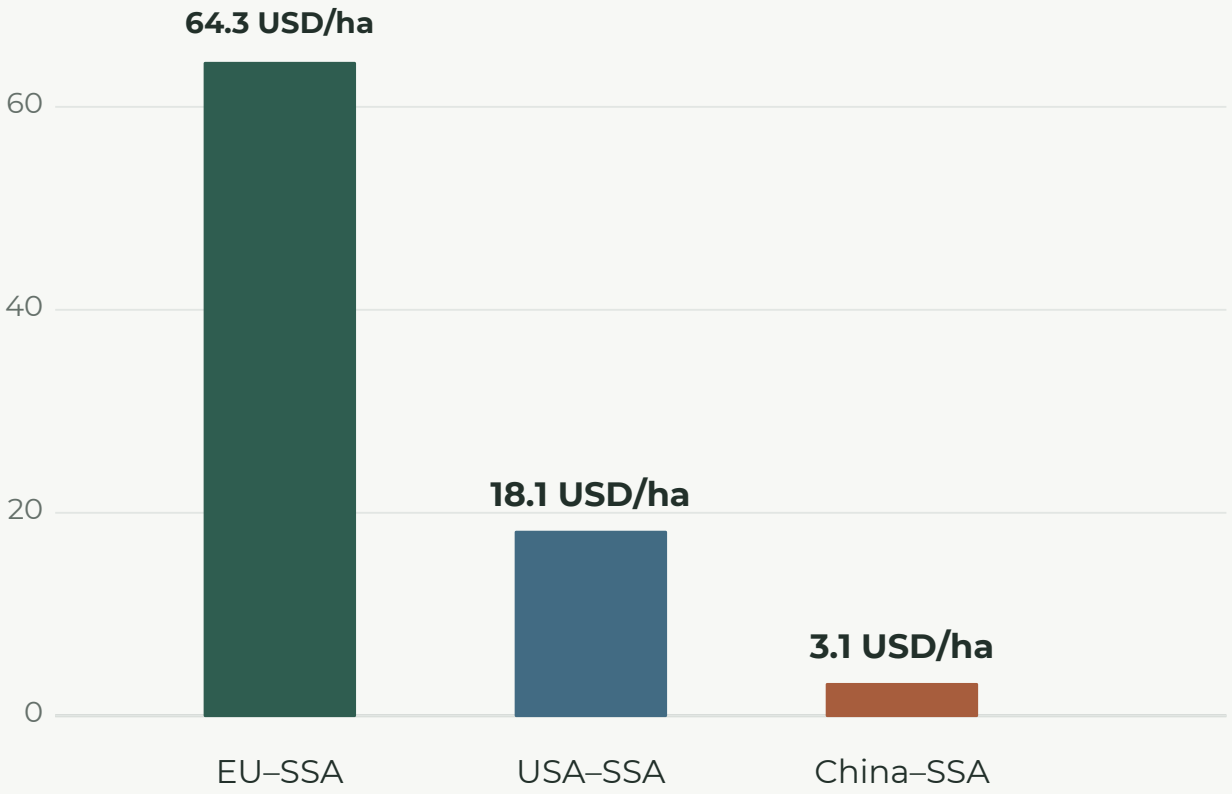
Club	USD/ha	% SSA GDP
EU–SSA	10.1	0.75%
USA–SSA	3.2	0.24%
China–SSA	0.4	0.03%

Finding: even in the EU–SSA scenario, modeled land-based CDR revenue is below 1% of SSA GDP.

Source: Henning, C., R. Ly, J.P. Faye and J. Ziesmer 2026 .

SENEGAL: RETURNS FROM TREE-BASED CDR ARE HIGHLY SENSITIVE TO THE PARTNER MARKET

The working paper's figure implies an order-of-magnitude spread across bilateral clubs



Reported macro effect

≈0.50%

of Senegal GDP in the EU–SSA scenario (0.14% USA–SSA; 0.02% China–SSA)

CHECK BEFORE PUBLICATION

Figure 6 reports 64.3 USD/ha for Senegal–EU, while the text on p. 10 states "664 USD/ha". The deck uses the figure value and flags the discrepancy.

Source: Henning, C., R. Ly, J.P. Faye and J. Ziesmer 2026

PERMIT ALLOCATION IS THE CENTRAL DISTRIBUTIONAL CHOICE

Grandfathering and universalism assign the same market instrument very different ownership rights

Grandfathering

Historical emissions

Countries receive emission rights in proportion to past emissions.

With polluter-pays financing, cross-country transfers are close to zero in the model.

Universalism

Per-capita allocation

Emission rights are distributed according to population shares.

Low historical emissions and large population shares generate positive transfers to SSA in the model.

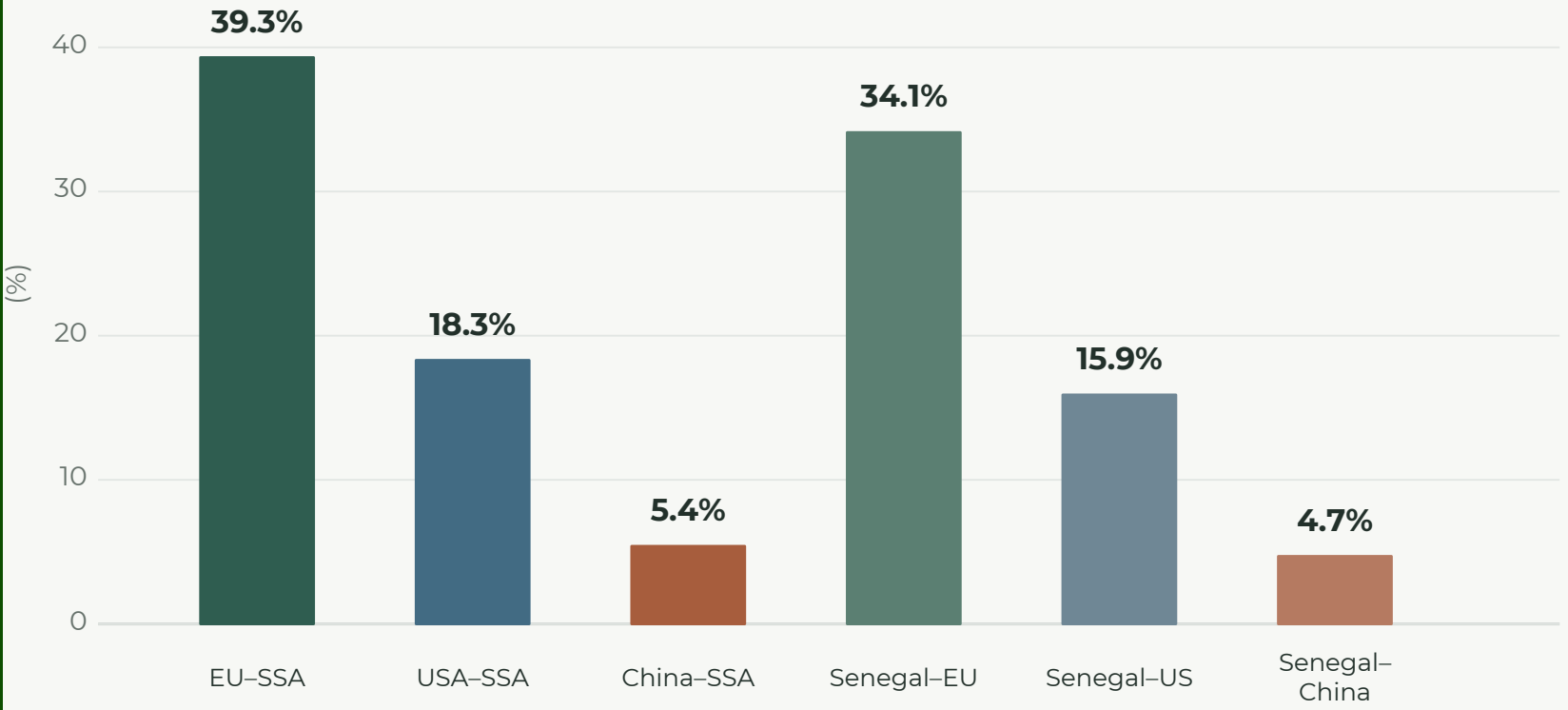
Same climate target + same permit market

Different initial property-right allocation → different distribution of financial gains

Working paper, Section 5.2.

UNDER PER-CAPITA ALLOCATION, MODELED TRANSFERS ARE MUCH LARGER THAN CDR REVENUES

Universalism shifts initial emission-right ownership toward countries with low historical emissions and large populations



Core finding

Allocation rules dominate the modeled distributional outcome.

The difference is substantially larger than the direct revenue from land-based CDR.

Terminology check

Figure 8 labels the outcome as change in per-capita income, while the surrounding text also describes GDP shares. Harmonize the metric before publication.

Values reproduced from Figure 8; metric wording follows the figure and is flagged for harmonization.

WHAT DETERMINES AFRICA'S GAINS FROM ARTICLE 6 CARBON MARKETS?

The working paper identifies two distinct channels: access to CDR revenues and distribution of emission-right ownership

CHANNEL 1

Land-based CDR revenues

- Require credible, low-cost MRV and eligible Article 6 methodologies.
- Depend strongly on the partner market's permit price and removal demand.
- **Remain below 1% of SSA GDP in all modeled scenarios.**

CHANNEL 2

Allocation of emission rights

- Determines who initially owns scarce emission permits within the club.
- Grandfathering favors historical emitters; per-capita allocation shifts rights toward populous low-emitting regions.
- **In the paper's model, this channel generates much larger transfers than CDR sales.**

MRV determines whether carbon assets can enter the market; governance determines how much of the market value accrues to each member.

Source: Henning, C., R. Ly, J.P. Faye and J. Ziesmer 2026

POLICY-FACING CONCLUSIONS

Article 6 opportunities for Africa depend on both technical readiness and the negotiated rules of market governance

1

Technical readiness

- MRV must make dispersed land-based carbon measurable, additional and traceable.
- National inventories and NDC accounting need to remain consistent with project-level credits.

2

Market economics

- Temporary CDR should be valued in a way that reflects storage duration and release risk.
- Direct land-based CDR revenue is useful but modest at the macroeconomic scale in the modeled cases.

3

Governance choices

- Property-right allocation determines the distribution of permit-market gains.
- The model finds much larger transfers under per-capita allocation than under grandfathering; this is a negotiated distributional choice, not a technical inevitability.

For decision-makers, the paper therefore separates two questions: Can Africa generate high-integrity credits? And how are the gains from the wider permit market allocated?

Source: Henning, C., R. Ly, J.P. Faye and J. Ziesmer 2026

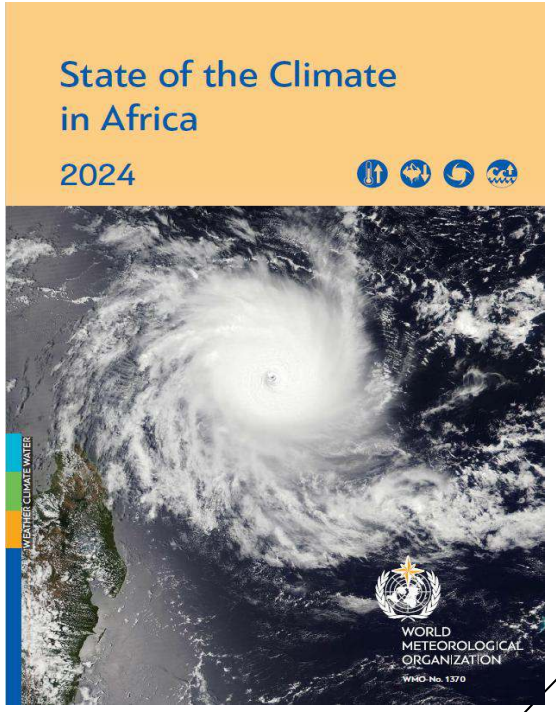
2nd Rwanda Climate Science Symposium: Where Rwanda's climate research meets policy
22-23 September 2026, Kigali, Rwanda

Changing climate hazards over Rwanda (1985-2024)

Dr. Mouhamadou Bamba SYLLA
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AIMS-Network Research Chair, African Institute for Mathematical Sciences (AIMS)
Research and Innovation Centre, Kigali, Rwanda
Lead and Contributing Author for the IPCC 6th and 7th Assessment Reports
Lead Author for the WMO State of Climate in Africa Annual Reports

I/ Regional



Heatwaves *Morocco, Algeria*
Heavy Rainfall *Morocco*

Flooding
Nigeria, Niger

Heatwaves
Across Sahel

Flooding
Cameroon, Chad & Central African Republic

Drought
South Africa, Zambia, Malawi and Zimbabwe
Tropical Cyclones
Mozambique & South Africa



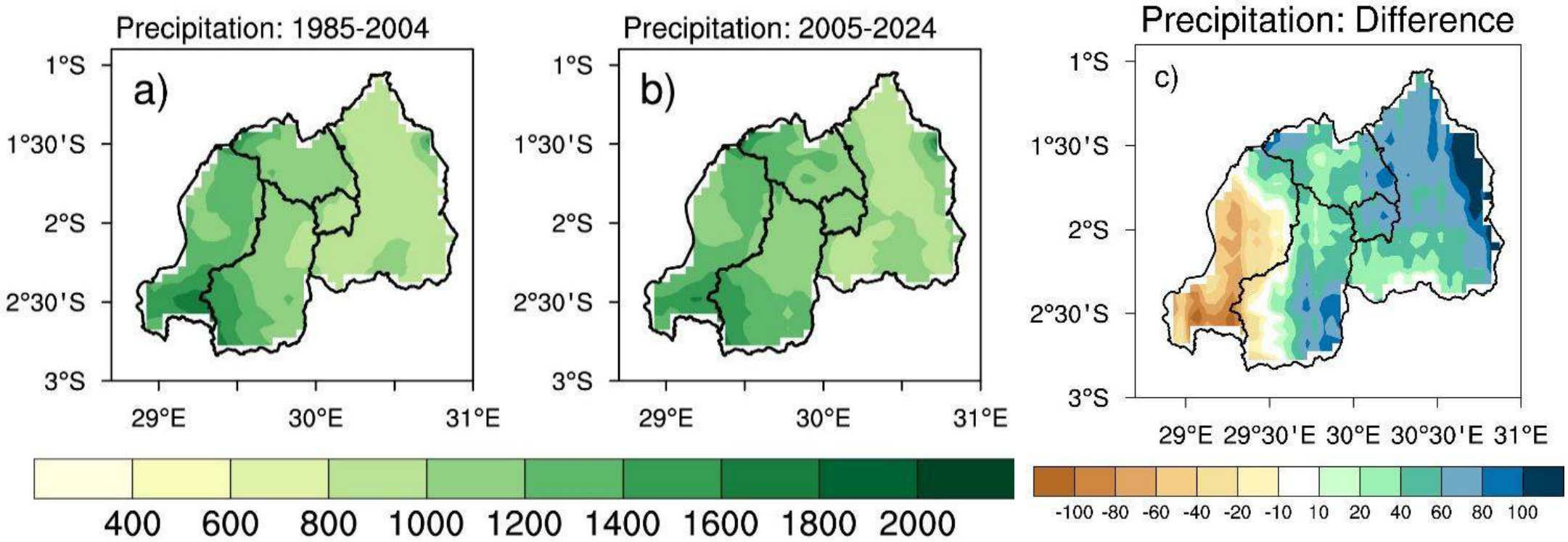
Flooding
Kenya, Tanzania, Burundi
Landslide
Ethiopia
Heatwaves
Somalia

Tropical Cyclones & Tropical Storms
Comoros, Mauritius, Madagascar

Extreme Events in 2024

II/ National

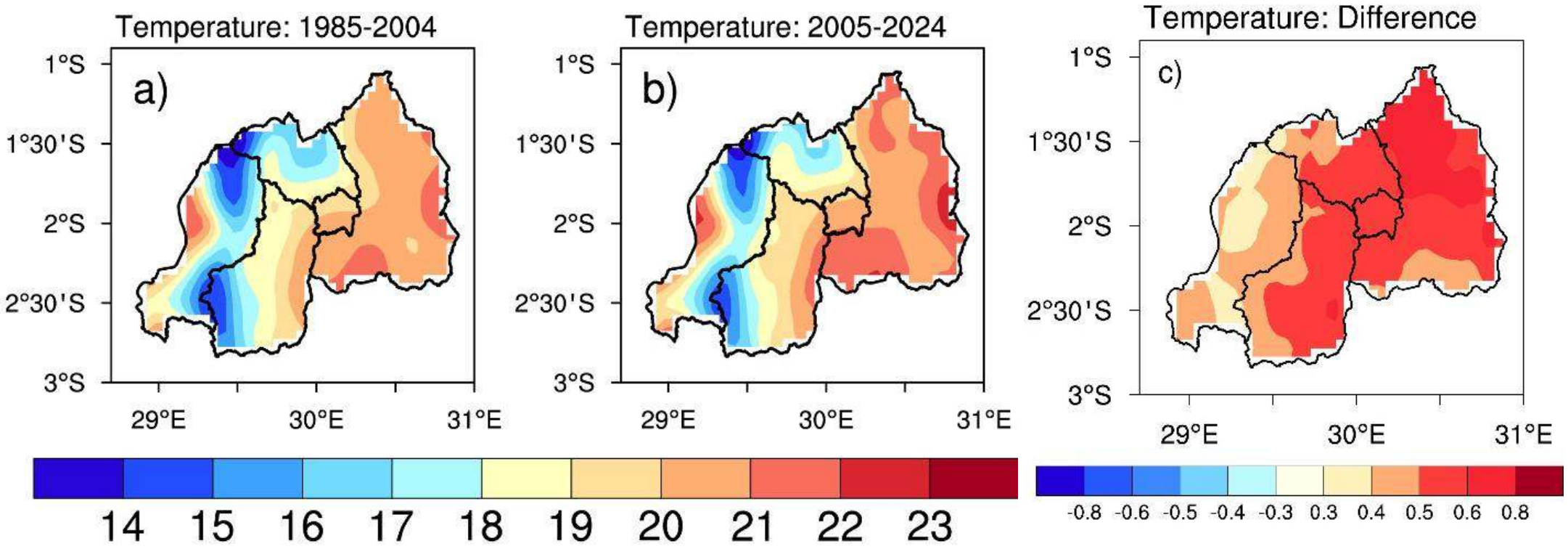
❑ Mean Precipitation



Rwanda has experienced increases in precipitation mainly over Northern Province, Southern Province and Eastern Province and decreases in Western Province during 2005-2024 compared to 1985-2004

II/ National

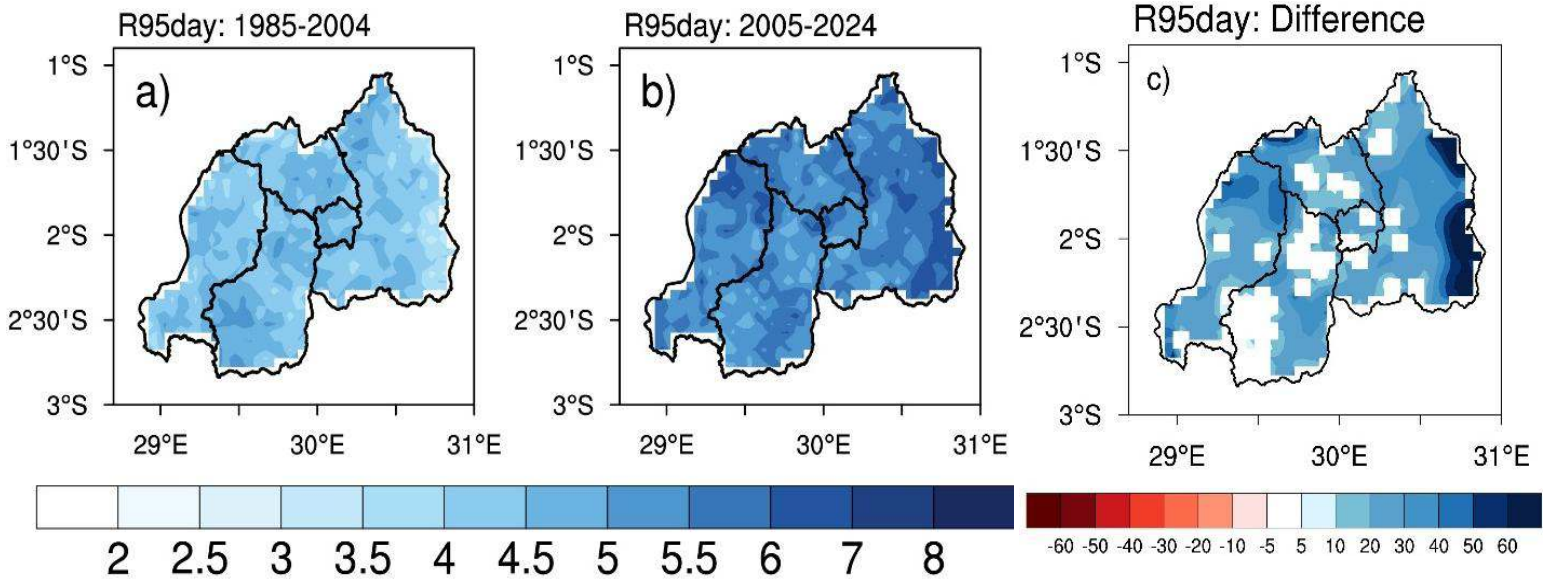
❑ Mean Temperature

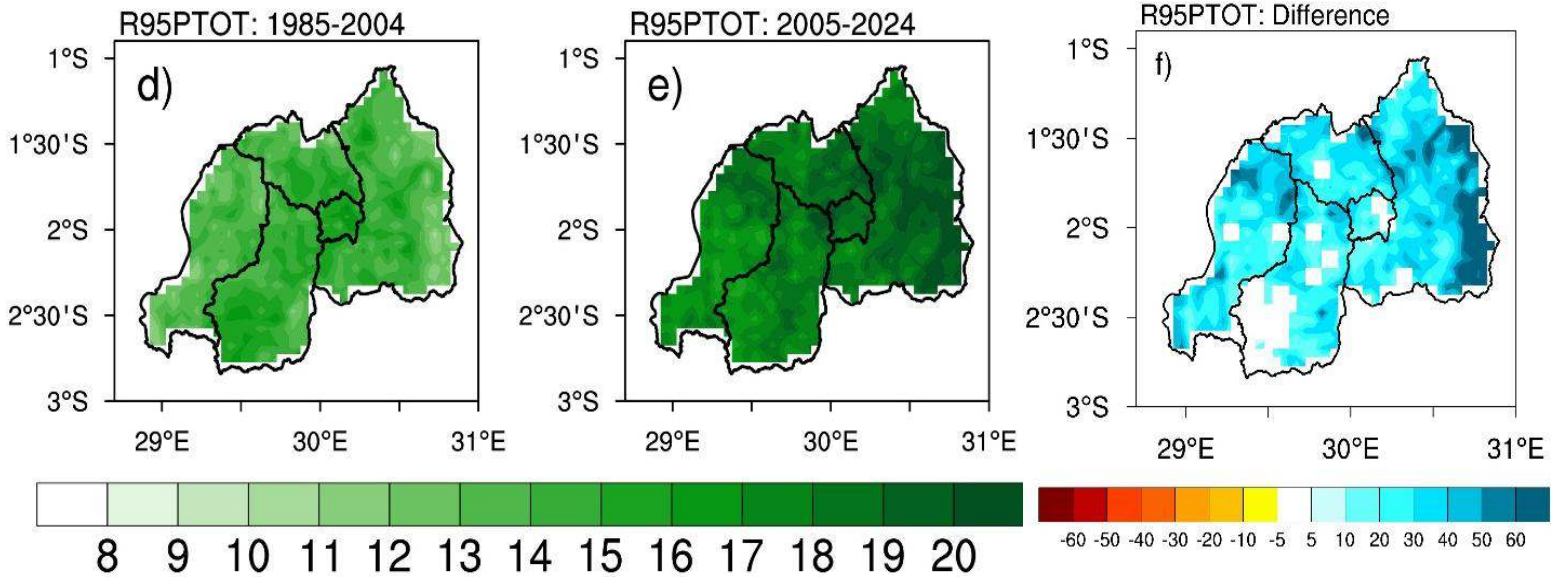


Rwanda has become hotter during 2005-2024 compared to 1985-2004. Northern Province, Southern Province and Eastern Province show the largest warming.

II/ National

❑ Extreme Precipitation





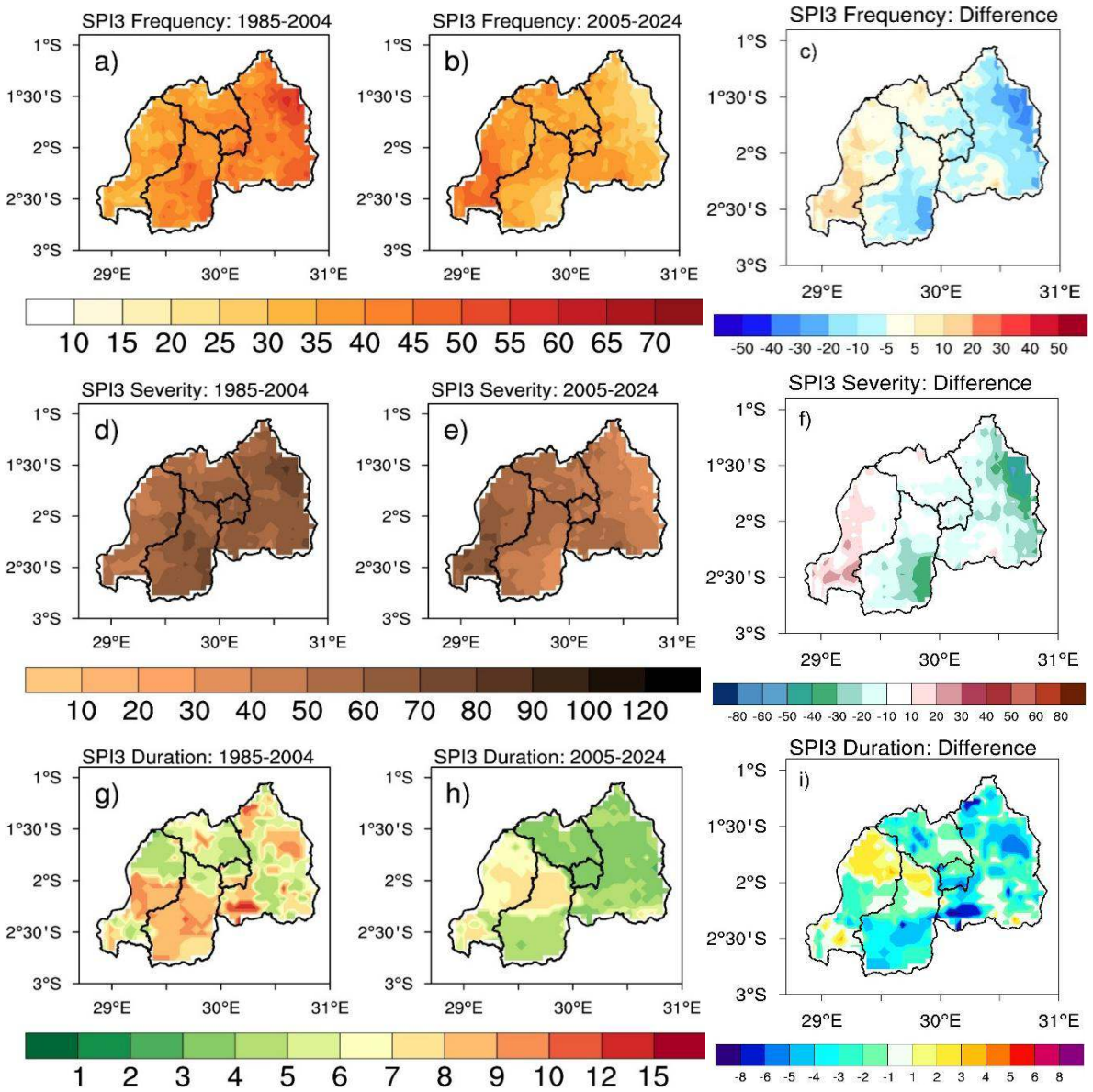
More intense and more frequent extreme precipitation events have hit Rwanda in 2005-2024 compared to 1985-2004.

The largest relative changes are recorded in Eastern Province.

However, Western, Northern and Southern Provinces, which were already receiving large amounts of precipitation, face the highest absolute extremes.

II/ National

❑ Droughts

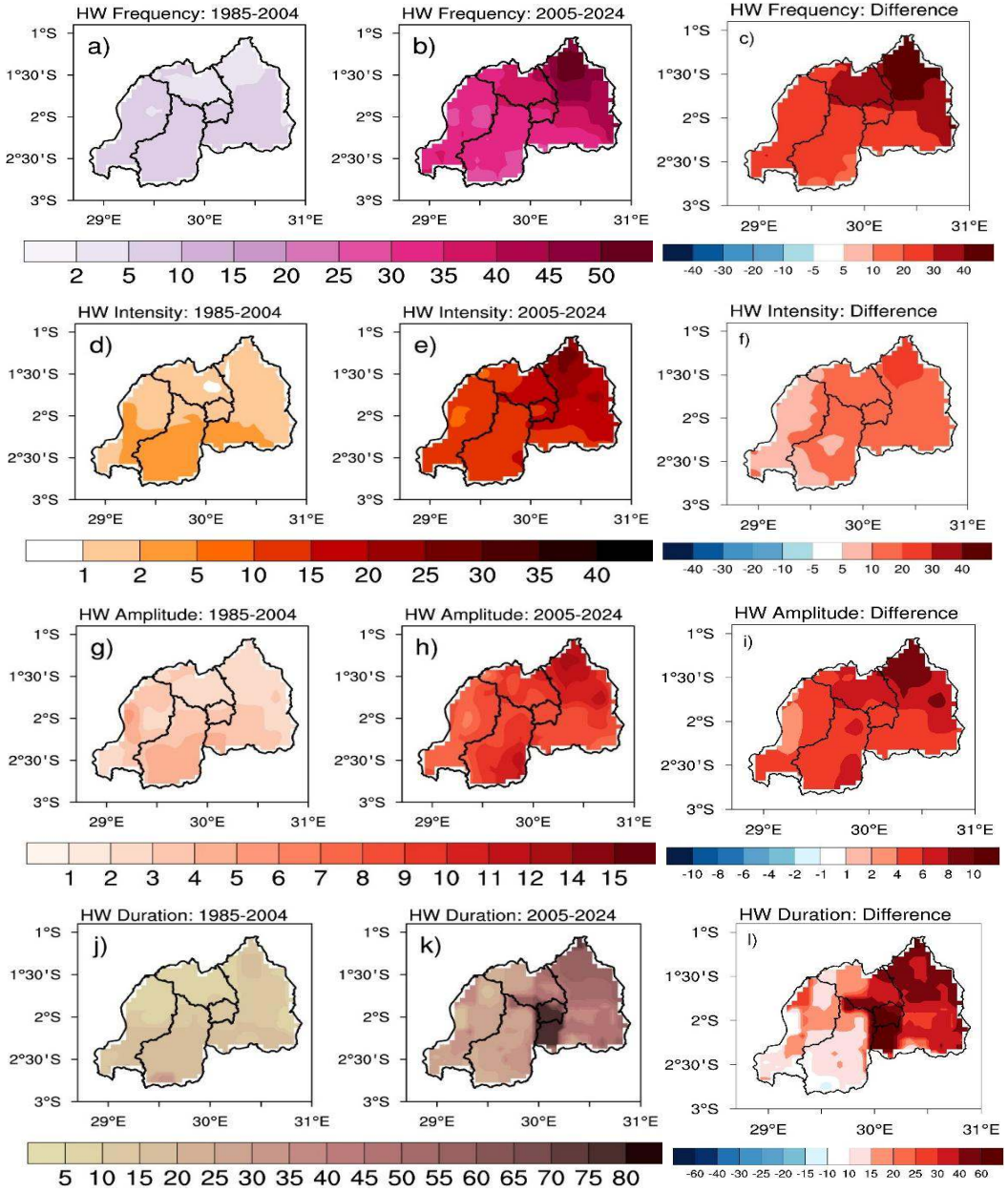


Severe droughts have occurred in Rwanda during both periods. Eastern Province was most impacted in 1985-2004 and Western Province in 2005-2024.

In the recent period, droughts have become more frequent, more severe and longer in a few regions of Western Province and less frequent, less severe and shorter in a few regions of Eastern and Southern Provinces.

II/ National

❑ Heatwaves



Rwanda is now feeling the heat.

Heatwaves had very low frequency, very low intensity, very small amplitudes and very short durations in 1985-2004.

However, they have increased to become considerably more frequent and more intense, with higher amplitudes and longer durations in 2005-2024.

Although the whole country faces these increases, Northern and Eastern Provinces, as well as Kigali City, face the most extreme heat.

Population density and urbanization might have further increased the impacts.

III/ Conclusion and Outlook

- Most parts of Rwanda have experienced an increase in precipitation and a general warming in recent years.
- Extreme precipitation has affected the whole country, with the highest impacts expected in provinces that were already receiving large amounts of precipitation (Northern, Western and Southern).
- Droughts have occurred across the whole country during both periods. They have become more frequent, more severe and longer in parts of Western Rwanda, and slightly less so in Eastern Rwanda.
- Extreme heat is becoming common with more frequent occurrences of intense heatwaves of larger amplitudes and longer duration hitting the country.

III/ Conclusion and Outlook …

- Attribution studies of major flood, drought and heatwave events are needed
- Assessment of projected changes using a large Multimodel Ensemble (MME) for different levels of global warming is critical for the country
- Robust climate information is needed for input into the development of Rwanda's Nationally Determined Contribution (NDC) and Long-Term Low Emission Development Strategy (LT-LEDS)

https://aimsric.org/publications

GIZ Rwanda, AIMS RIC (2025). *Historical changes in climate hazards over Rwanda (1985–2024). GIZ Rwanda, Kigali*

Thank you for your attention

german cooperation
DEUTSCHE ZUSAMMENARBEIT

Implemented by
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

AIMS | African Institute for Mathematical Sciences
RESEARCH & INNOVATION

2ND RWANDA CLIMATE SCIENCE SYMPOSIUM 2026
Where Rwanda's climate research meets policy

Future Suitability of Arabica coffee in Rwanda

Evidence from coffee suitability modelling using downscaled climate data

Delice IZERE
AIMS RIC, Rwanda

Why Arabica Coffee Matters in Rwanda

- Coffee is an important source of livelihoods and agricultural export earnings in Rwanda

>400,000
Smallholder farmers
Depend on coffee as a main source of income

$60-70m
Annual coffee revenue
Typical annual range reported by NAEB,varies with Global market conditions

Sources:NAEB(2025),FAO(2026)

Arabica Coffee Requirements and Climate Change Impacts



source:NAEB(International coffee day)

What Does Arabica Coffee Need?

- Suitable temperature and rainfall
- Appropriate altitude and soil conditions

- A favorable environment for healthy growth and productivity

How Can Climate Change Affect Coffee?

- Rising temperatures and changing rainfall may affect coffee-growing conditions.
- Areas suitable for Arabica coffee may shift across Rwanda.
- Understanding these changes is important for future agricultural planning.

Study Rationales and Objectives

Why downscaled climate data matters

~50 km — **~1 km**

Global climate models

Downscaled climate data

The finer resolution is better suited to Rwanda's steep, varied terrain and local microclimates.

Research Objectives

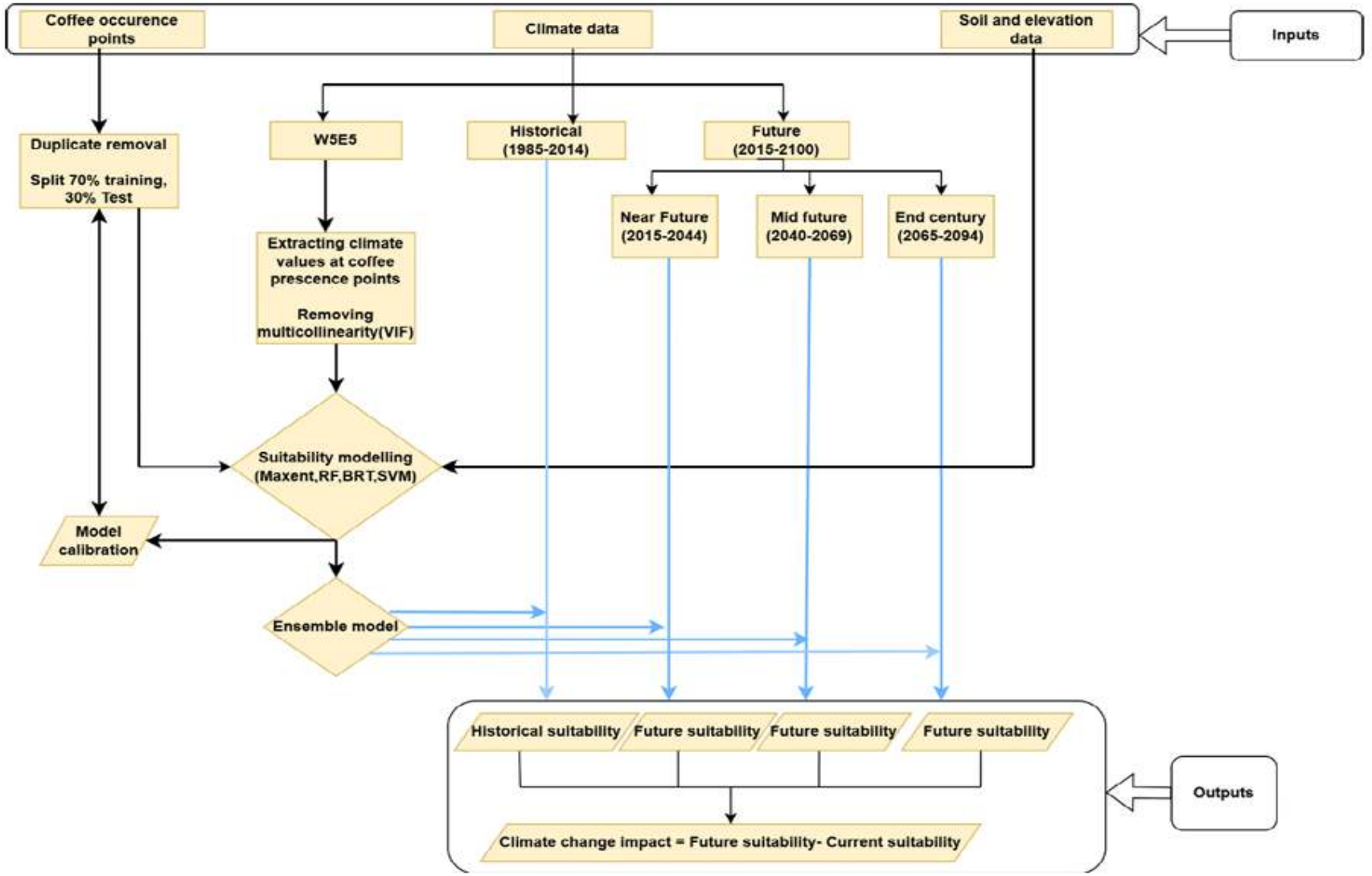
Main objective

- Assess how climate change may influence Arabica coffee suitability in Rwanda using downscaled climate data.

Specific objectives

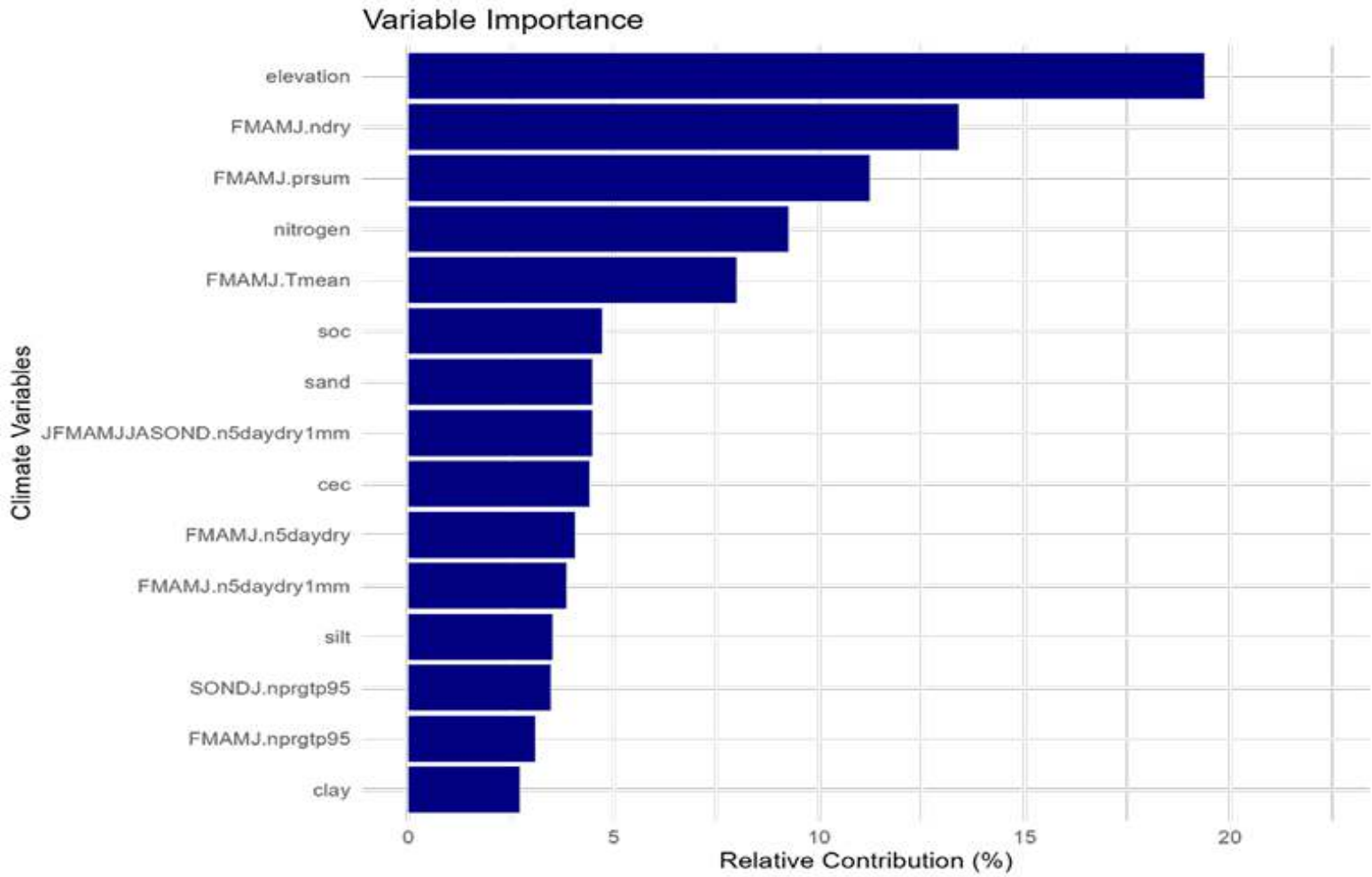
- Model coffee suitability under present and projected climate scenarios.
- Identify potential shifts in suitable growing areas to support climate-resilient agricultural planning

Methodological Framework



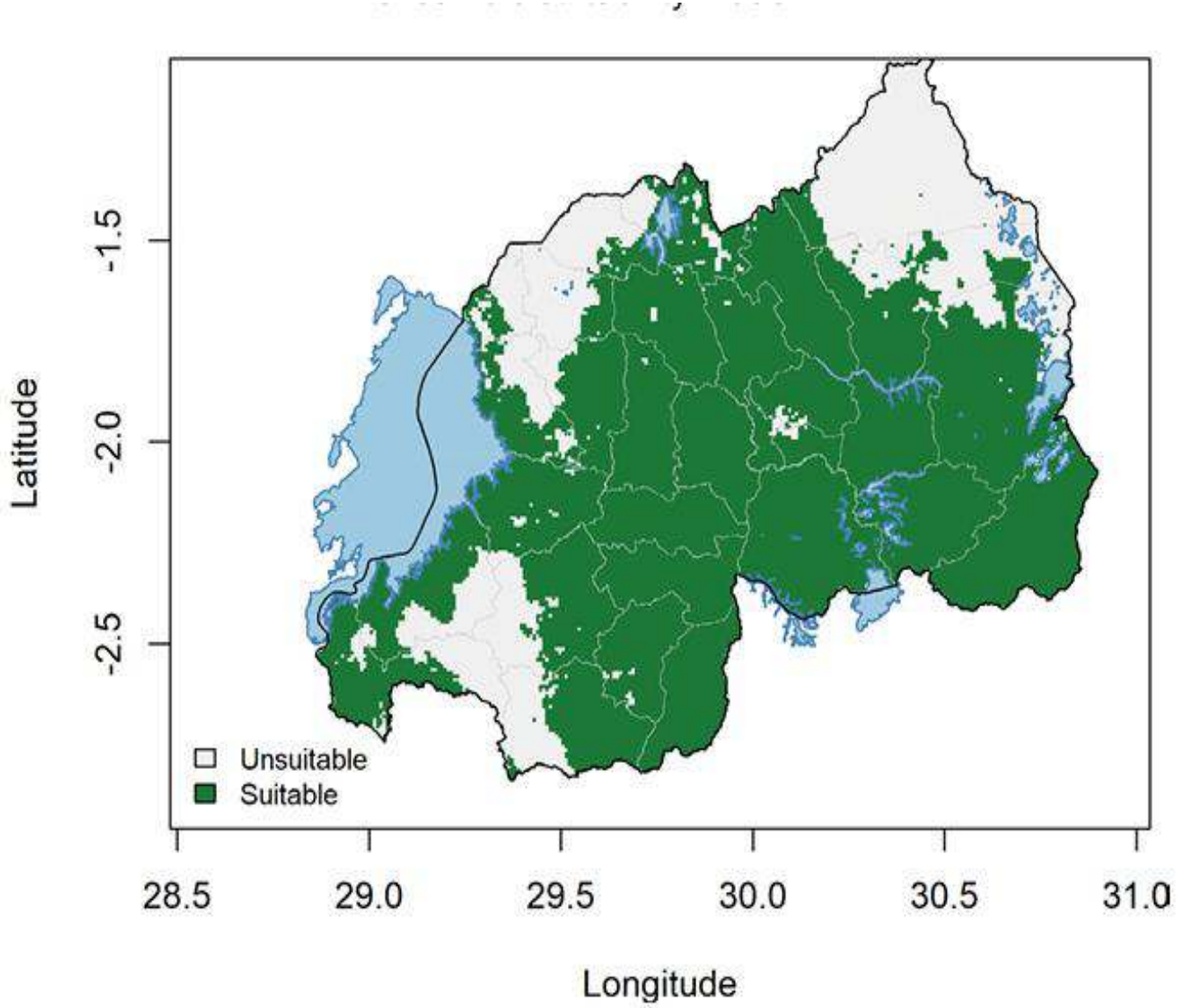
Methodological Framework for Coffee Suitability Modelling

Key Environmental Variables Influencing Coffee Suitability



Relative Importance of Environmental variables

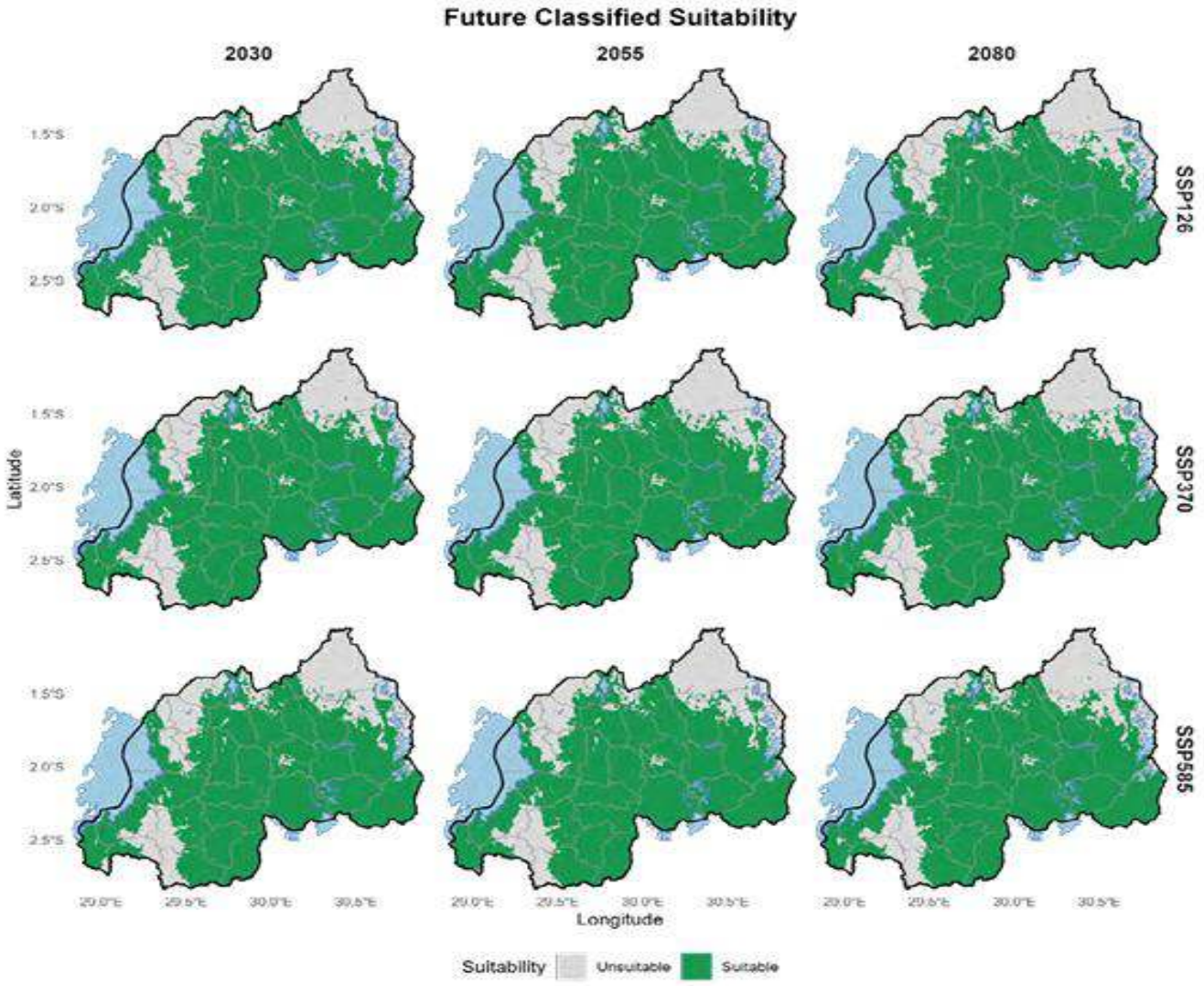
Current classified Arabica Coffee Suitability in Rwanda



Current Arabica coffee suitability classification

- About 71% of Rwanda is classified as suitable
- Suitable areas are mainly concentrated in the highlands
- Lower suitability is mainly found in the eastern and southern lowlands.

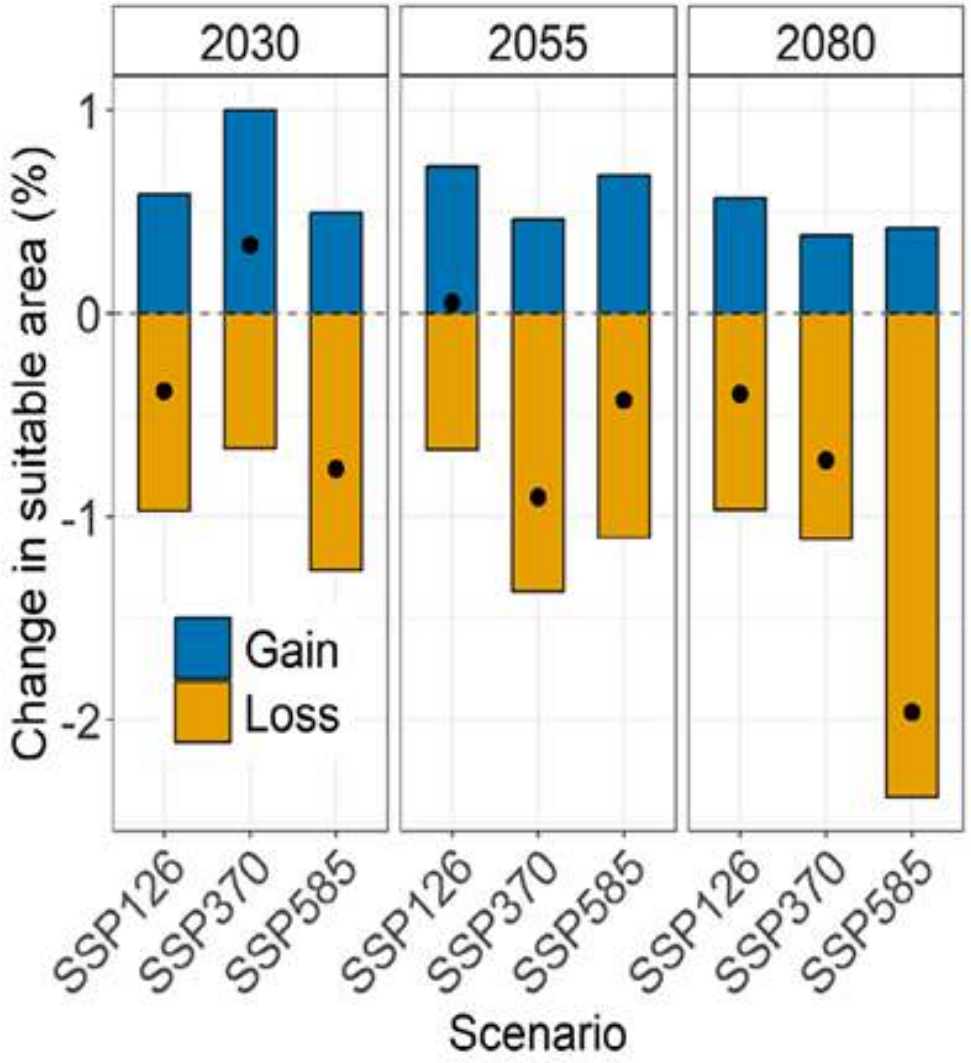
Future Classified Suitability of Arabica coffee



- Suitability remains relatively suitable under SSP126
- Suitability varies across SSP126,SSP370 and SSP585
- Some eastern and southern areas shows small changes in suitability over time

Future Classified Suitability under Different Climate Scenarios

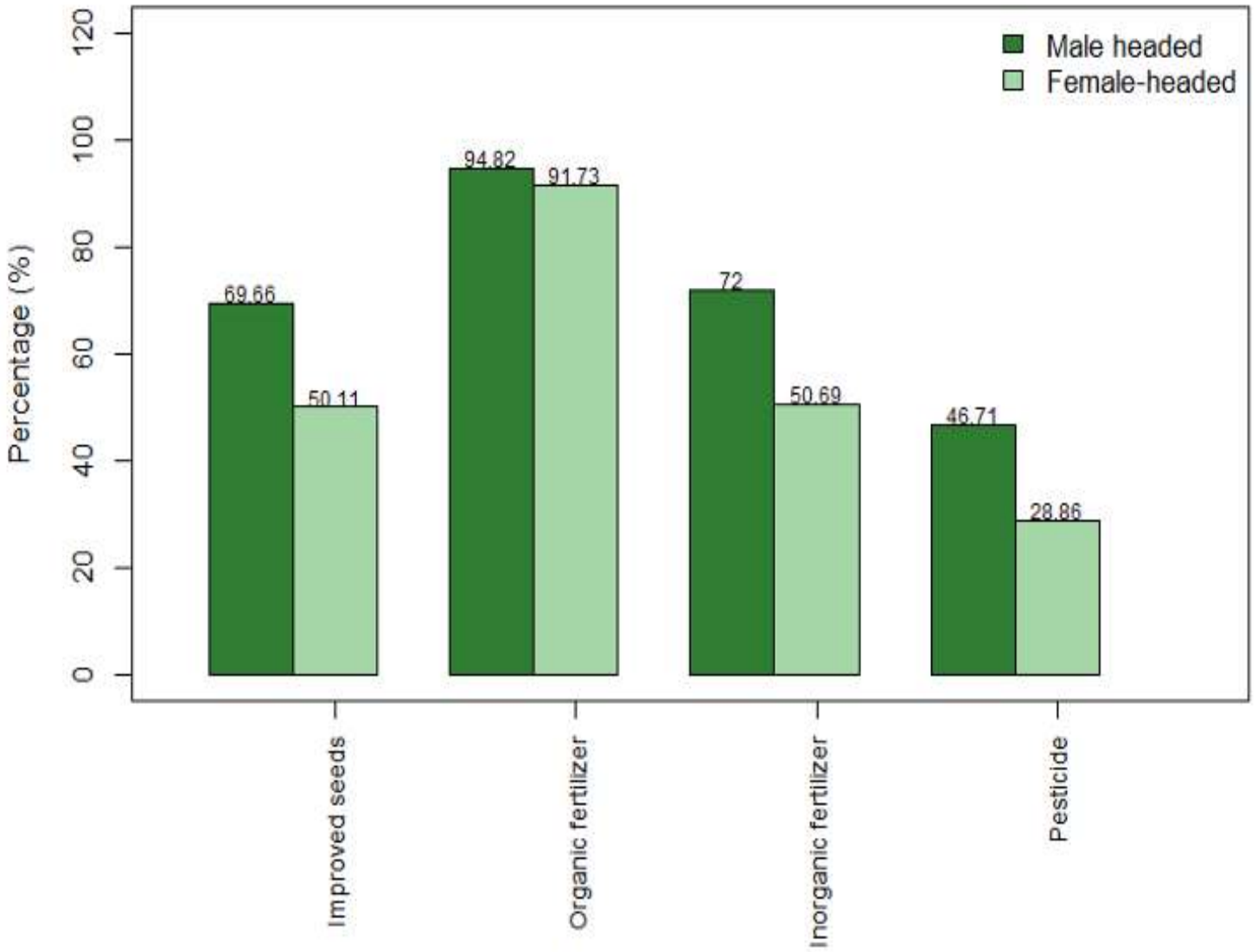
Projected Gains and Losses in Coffee Suitability



Projected Changes in Arabica Coffee Suitability.

- Small gains are seen in 2030 under SSP370.
- Losses are generally higher than gains across the scenarios.
- The Losses increase over time especially under SSP585

Gender Differences in Agricultural Input use



Source: Agricultural Household Survey 2024, National Institute of Statistics of Rwanda

- Female-headed households report lower use of key agricultural inputs.
- Differences are observed in improved seeds, fertilizers, and pesticides.
- These differences highlight inequalities in access to agricultural resources.

Study Implications and Key Considerations

- Coffee suitability is projected to change over time, with greater losses in lower-elevation areas.
- Suitable areas are not automatically available for coffee production, as land-use plans and conservation priorities must also be considered.
- The findings show general climate-related trends and should be used to inform, rather than determine, future planning

Conclusion and way forward

- Arabica coffee is expected to remain suitable in Rwanda, but climate change may gradually change where it can be grown.
- This study provides a starting point for understanding these changes and supporting future planning.
- Future decisions should consider climate suitability alongside land-use plans, environmental protection and farmers' needs.
- The approach can also be applied to other crops to better understand climate risks in Rwanda's agricultural sector

Thank You!



The IPCC
A scientific and Governmental Body

Christiane Textor
German IPCC Coordination Office | DLR Project Management Agency
www.de-ipcc.de

The Intergovernmental Panel on Climate Change



- Established 1988 by UNEP and WMO
- Regular, objective and comprehensive assessment of the state of knowledge on climate change
- Uses existing knowledge – does not conduct own research does not have models
- 195 member governments formally endorse reports => political recognition of statements
- **scientific and intergovernmental body**

Who is the IPCC?



Photo by IISD/ENB | Anastasia Rodopoulou

Governments

- Determine procedures
- Elect the Bureau (just happened)
- Approve themes and outlines
- Nominate authors
- Review reports
- Approve Summaries for Policymakers (SPM)



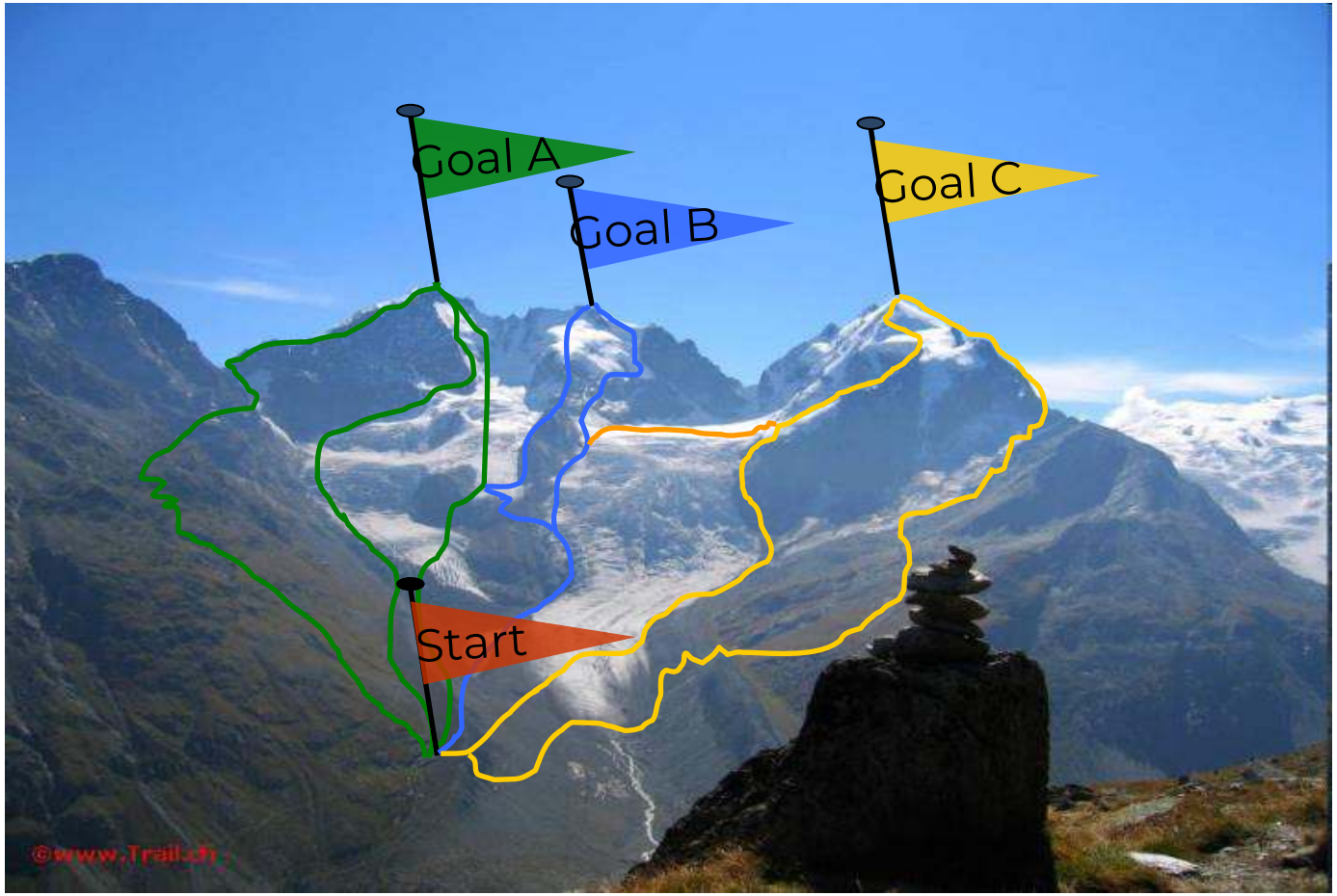
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Experts

- Independent & balanced teams
- Evaluates the state of research from a scientific perspective
- Prepares reports Without additional payment
- Actively involved in adoption
- Reviews reports

IPCC's guiding principle

- Policy-relevant and yet policy-neutral – never policy-prescriptive



From O. Edenhofer

Comprehensive!

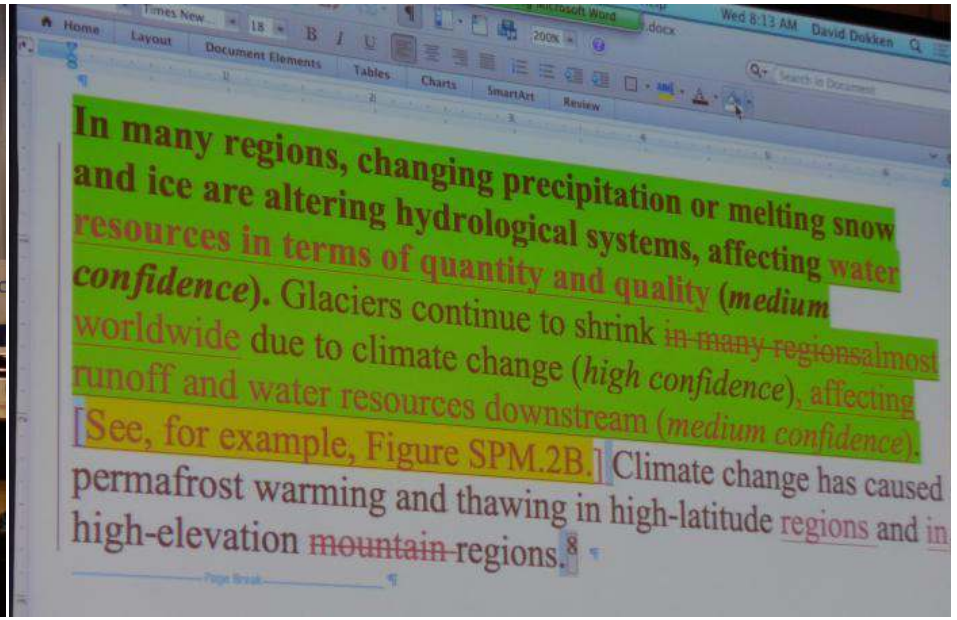
Sixth IPCC Assessment Report in numbers

- About 1000 authors from almost 100 countries
- About 66.000 publications assessed
- About 8000 pages
- About 2000 reviewers
- About 200.000 review comments
- About 2-3 years preparation time for 1 report



Approval of the Summary for Policy Makers





The Plenary approves the summary for policymakers' line by line and accepts the full report.

Science has the right of veto.

Governments thereby endorse the scientific findings of the IPCC reports.

HISTORY |EVOLUTION OF THE IPCC



[Overview of the IPCC Activities | PPT (slideshare.net)]

IPCC Scholarship programme

- Research on climate change
- PhD students and post-doctorals from developing countries
- Maximum 15,000 EUR per year for up to two years during the period
- Established 2007 with the funds from the 2007 Nobel Peace Prize, partnerships with Prince Albert II of Monaco Foundation, the Cuomo Foundation and others
- 18 scholarships awarded from 297 applications in the 8th round (2025-2027)
- *The IPCC is currently not accepting any applications for its scholarship programme.*

Useful Links (check also social media)

IPCC website

- Documentation of the Institution: https://www.ipcc.ch/documentation/
- IPCC Scholarship: https://www.ipcc.ch/about/scholarship/

Recent report

- IPCC AR6 Physical Science Basis: https://www.ipcc.ch/report/ar6/wg1/
- IPCC AR6 Impacts, Adaptation, Vulnerability: https://www.ipcc.ch/report/ar6/wg2/
- IPCC AR6 Mitigation of Climate Change: https://www.ipcc.ch/report/ar6/wg3/
- IPCC AR6 Synthesis Report: https://www.ipcc.ch/report/ar6/syr/

Upcoming reports

- IPCC Seventh Assessment Report (AR7): https://www.ipcc.ch/assessment-report/ar7
- Special Report on Climate Change and Cities: https://www.ipcc.ch/report/special-report-on-climate-change-and-cities/
- Two Methodology Reports for National Inventories https://www.ipcc.ch/working-group/tfi

Thank you very much!

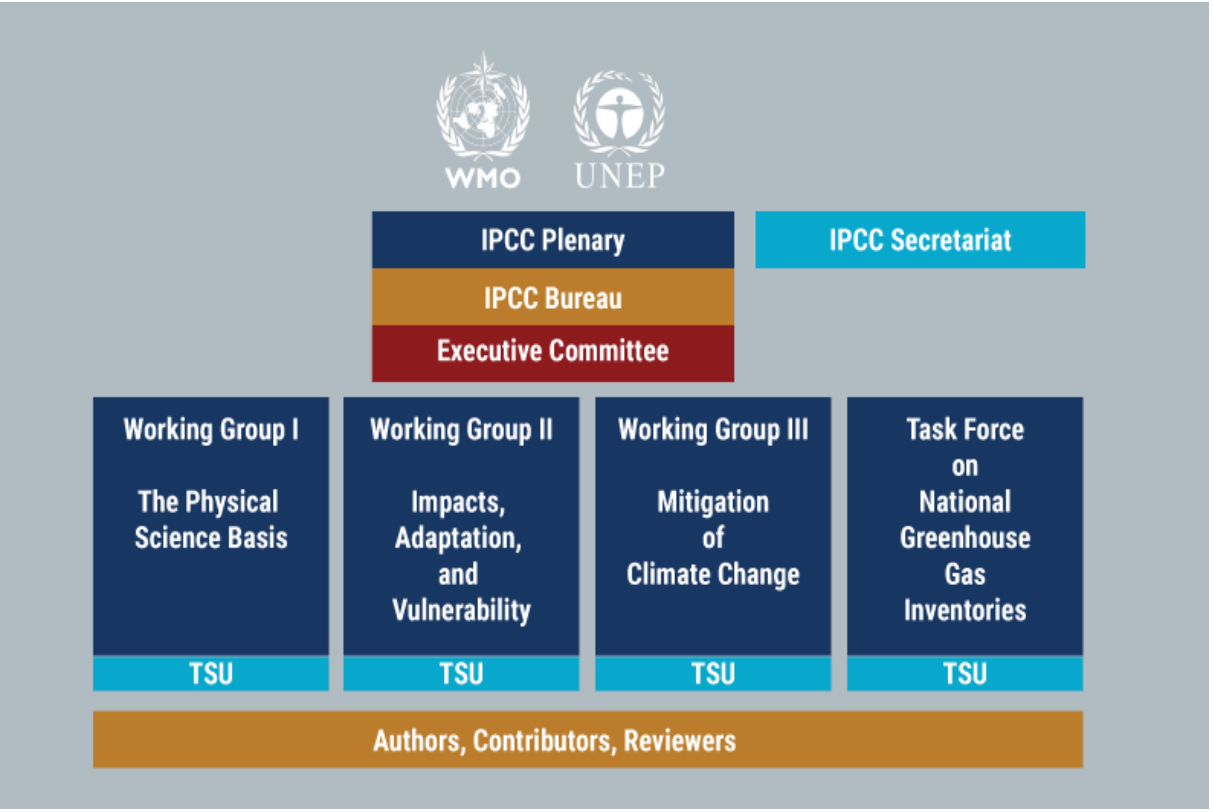
Christiane Textor
German IPCC Coordination Office | DLR Project Management Agency
www.de-ipcc.de

AIMS African Institute for Mathematical Sciences RESEARCH & INNOVATION

IPCC Process and Rwanda's Role: A Scientific Perspective

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IPCC AR6: Lead Author WGI Ch. 12; Contributing Author WGI Ch. 11, Atlas, WGII Ch. 9; SR1.5 Ch. 3
Lead Author, WMO State of the Climate in Africa Reports

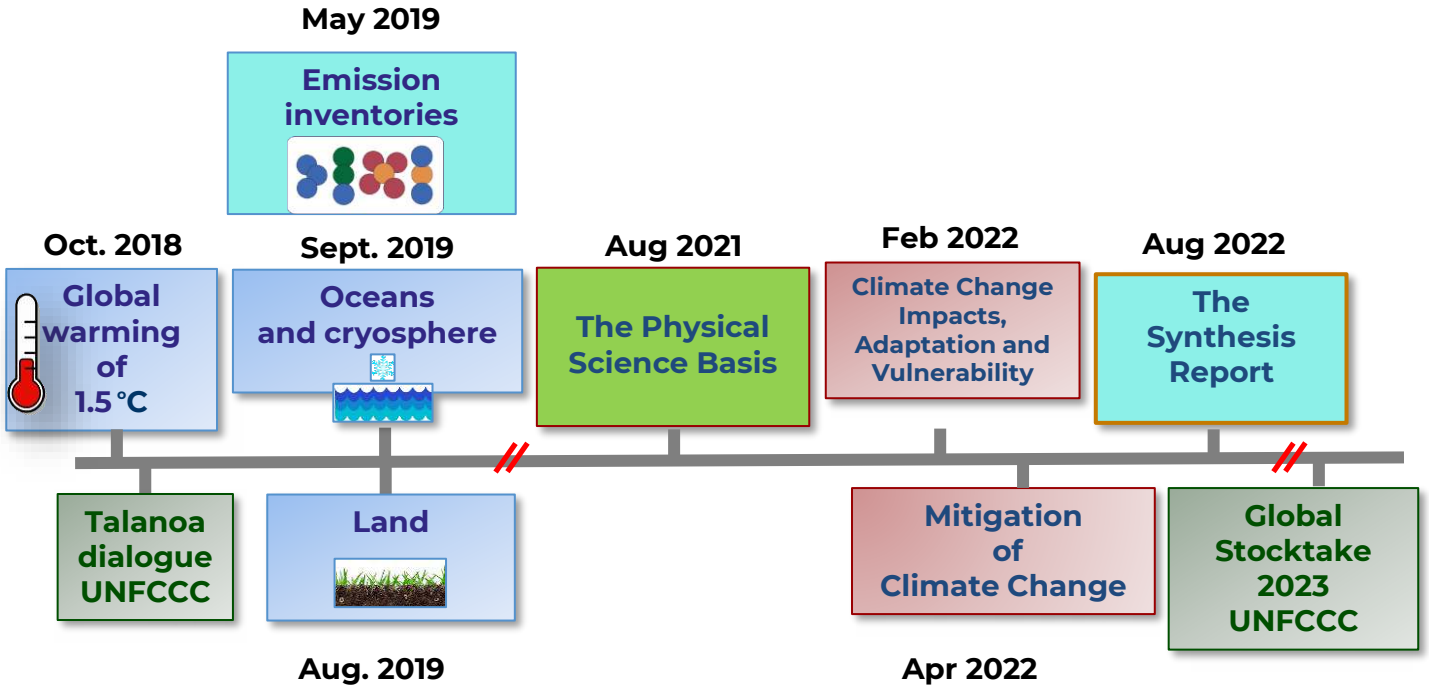
Structure



Who does what

- 195 member governments
- 3 Working Groups and 1 Task Force
- Authors assess, experts review
- Governments approve the SPM

Reports to deliver – under challenging circumstances



AR6 Cycle

How an IPCC report is written



AR6 WGI (2021)
234 authors, 66 countries, 14,000+ references, 78,007 review comments

AR6 WGII (2022)
270 authors, 67 countries, 34,000+ references, 62,418 review comments

Every review comment receives a written response from the authors.

❑ AR7: the new assessment cycle

- Outlines of the three Working Group reports approved in February 2025 (Hangzhou)
- 664 authors from 111 countries, selected from 3,771 nominations
- 51% from developing countries and 46% women (AR6: 44% and 33%)
- Special Report on Climate Change and Cities: approval in March 2027
- Working Group report timeline not yet agreed. Next Plenary: IPCC-65, Addis Ababa, October 2026
- Synthesis Report by late 2029

My role in AR7

- Lead Author, WGI Chapter 1: Framing, methods and knowledge sources
- Author, WGII Chapter 7: Africa

What authors do

- Assess published evidence, not new research
- Assign confidence and likelihood
- Respond to every review comment
- Work for free, as volunteers

SIXTH ASSESSMENT REPORT
Working Group I – The Physical Science Basis

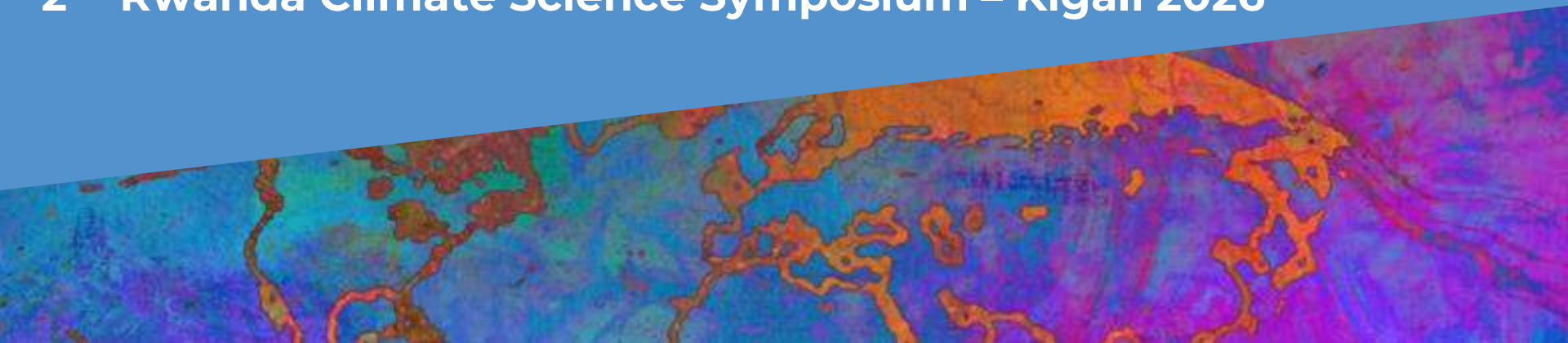
ipcc
INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP

Regional Climate Change Information - Africa

Dr. Mouhamadou Bamba Sylla (Rwanda/Senegal)
Lead Author, IPCC AR6 WG1, Chapter 12

2nd Rwanda Climate Science Symposium – Kigali 2026



Human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years

(a) Change in global surface temperature (decadal average) as reconstructed (1–2000) and **observed** (1850–2020)

(b) Change in global surface temperature (annual average) as **observed** and simulated using human & natural and only natural factors (both 1850–2020)

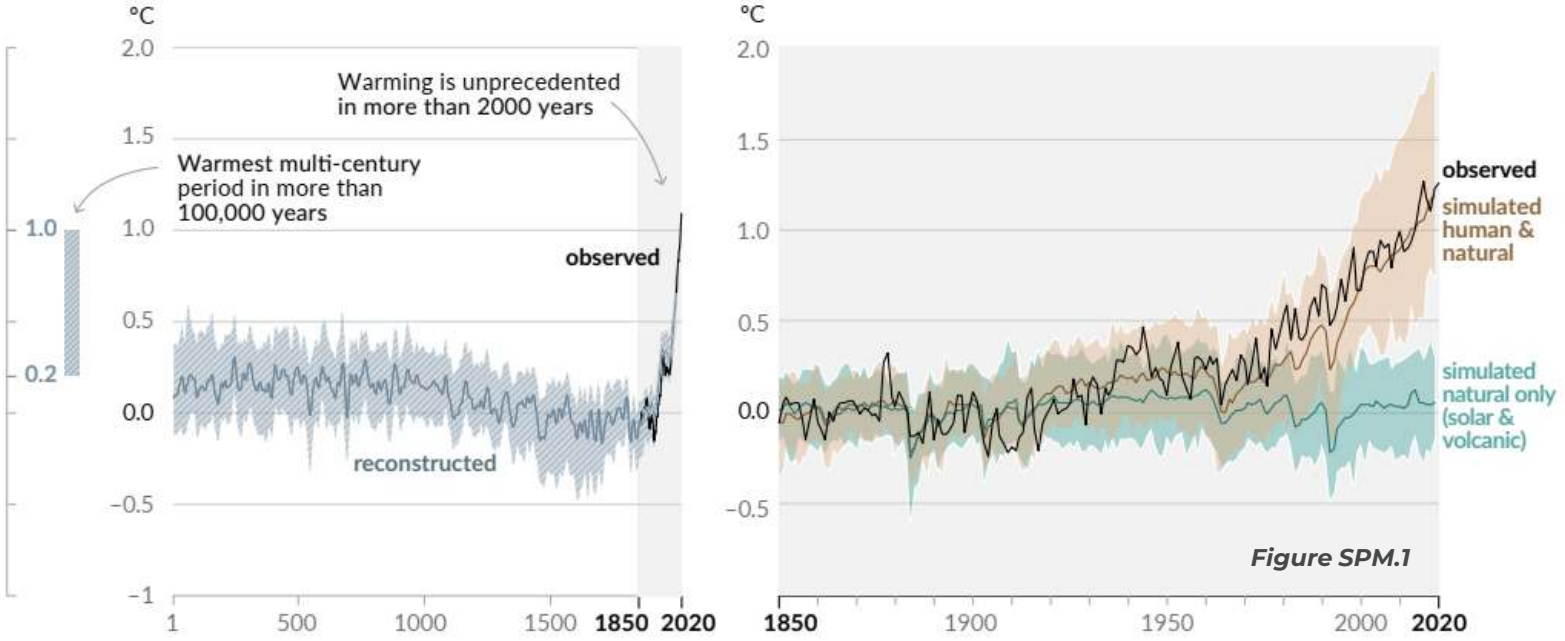
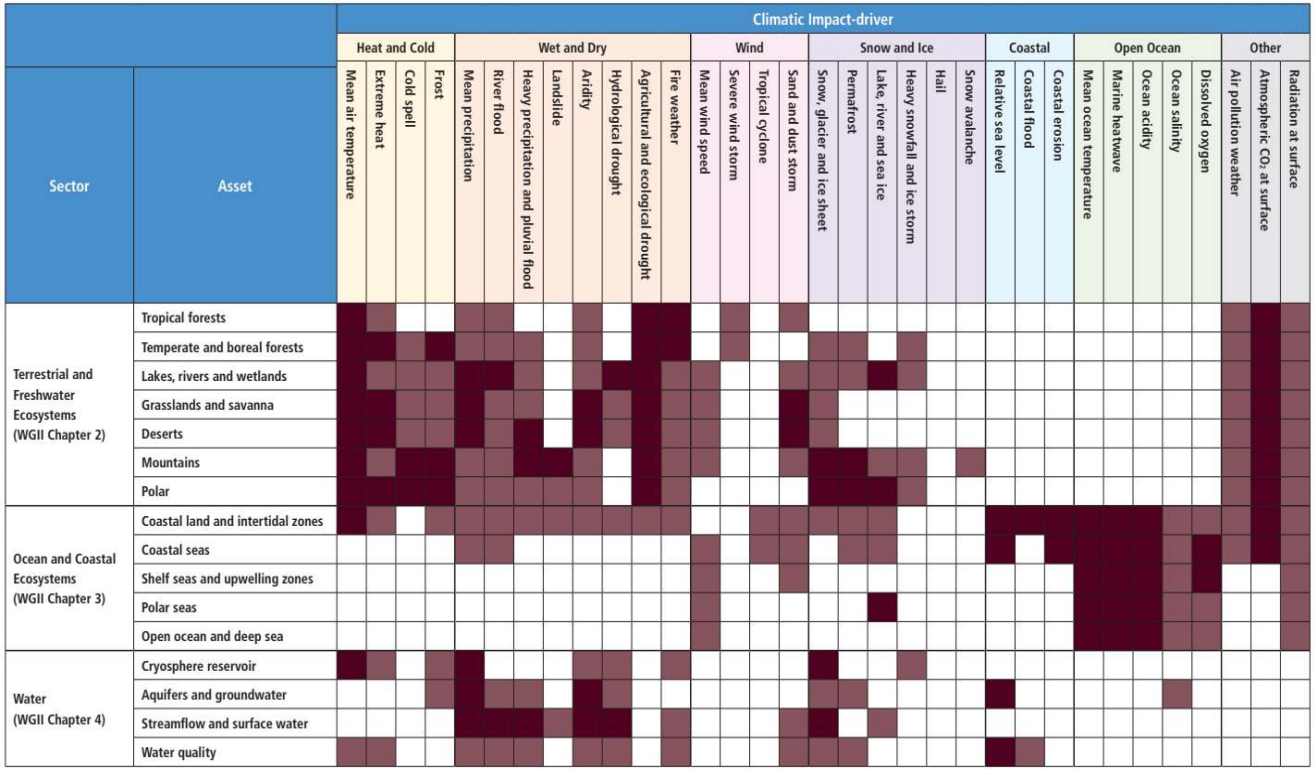


Figure SPM.1

➢ Climatic Impact-drivers (CID)

- CID is a climate condition that directly affects elements of society or ecosystems
- CIDs and their changes can lead to positive, negative or inconsequential outcomes (or a mixture)
- Each CID is relevant for one or many sectors/assets



IPCC WG1, 2021

❑ Changes in mid-century

- Most common changes: Heat, Coastal and Heavy Precipitation
- Southern Africa: Drought and Fire Weather are added
- Eastern Africa: Decreased Snow/Ice coverage emerges

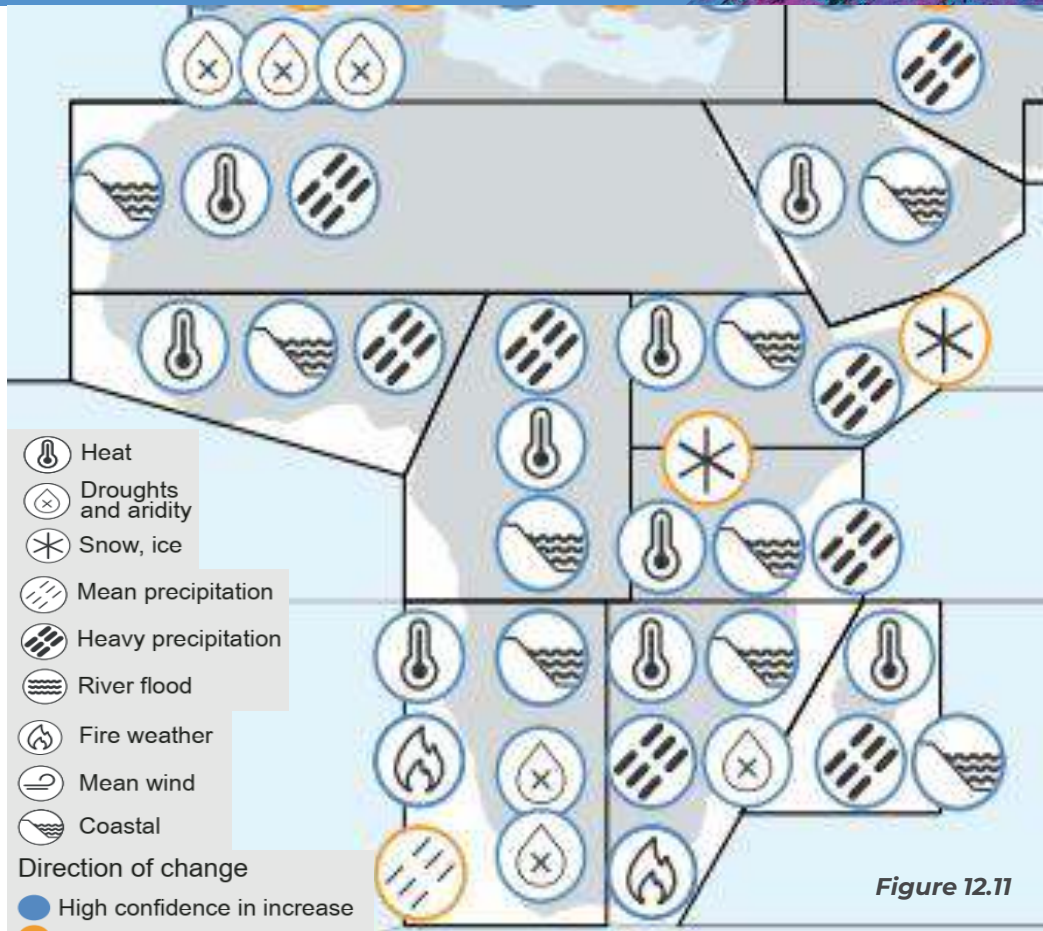
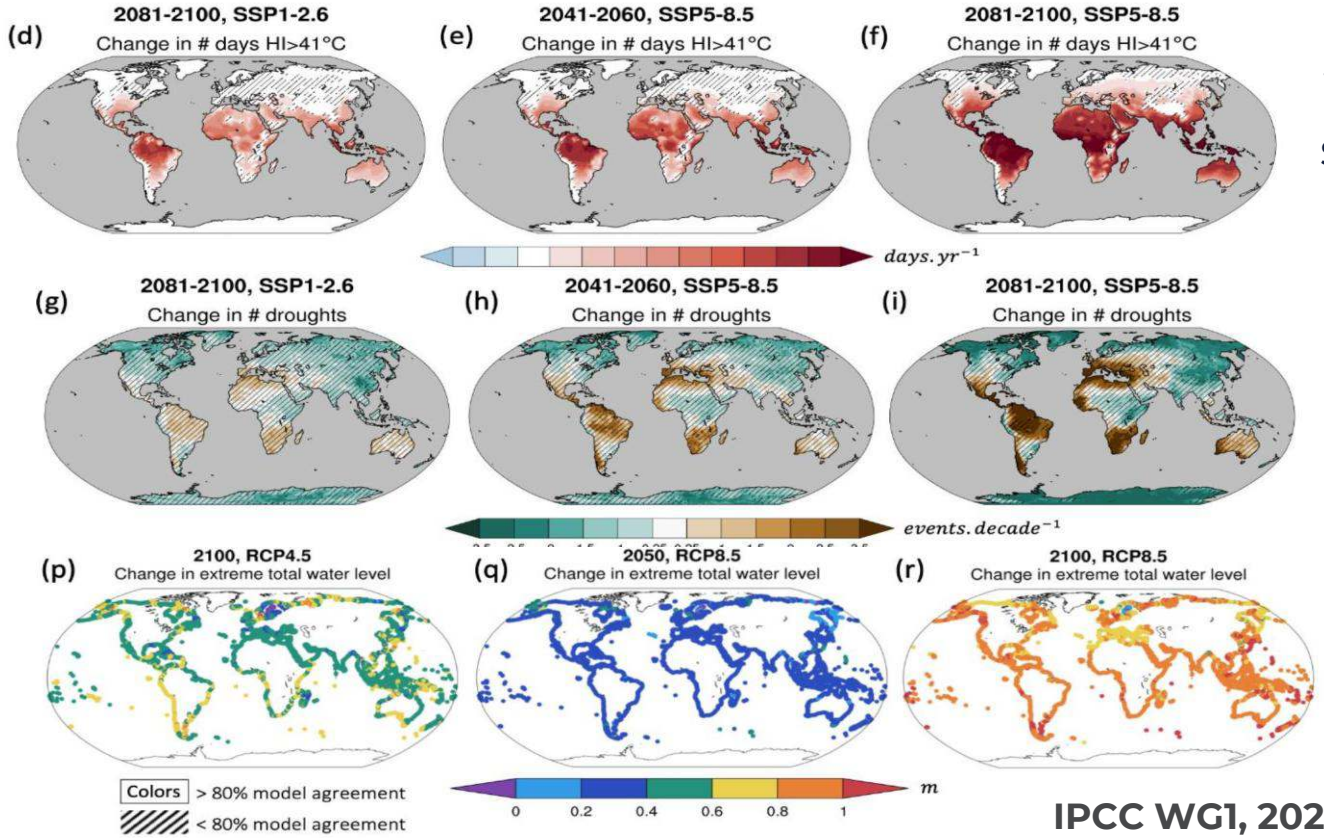


Figure 12.11

❑ Comparison with changes at the global level



East Africa: increases in extreme heat stronger

Southern Africa: increase in drought stronger

Both regions experience similar increases in ESLR

IPCC WG1, 2021

SIXTH ASSESSMENT REPORT

Working Group II – Impacts, Adaptation and Vulnerability

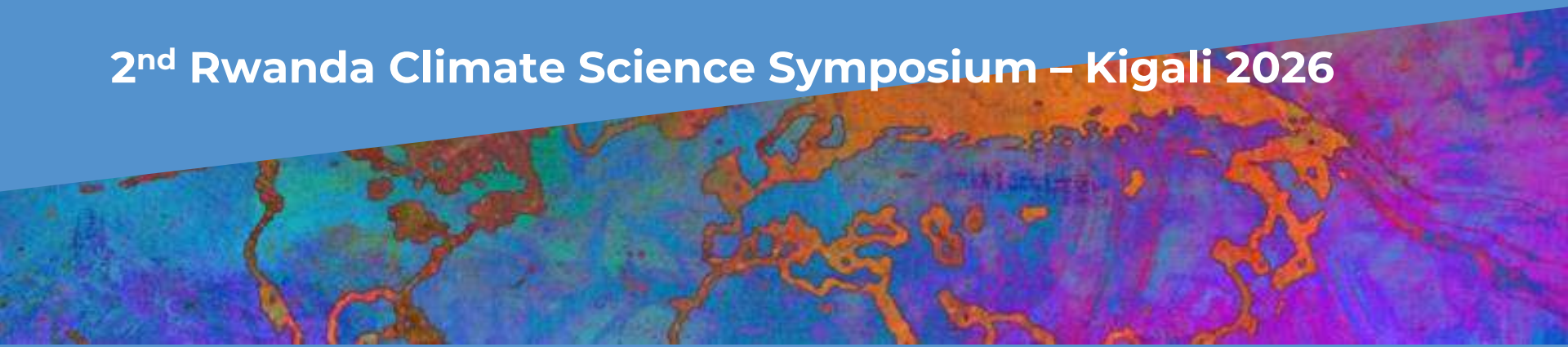
IPCC INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP

Impacts, Adaptation and Vulnerability - Africa

Dr. Mouhamadou Bamba Sylla (Rwanda/Senegal)
Contributing Author, IPCC AR6 WG2, Chapter 9

2nd Rwanda Climate Science Symposium – Kigali 2026



❑ Crop Yields

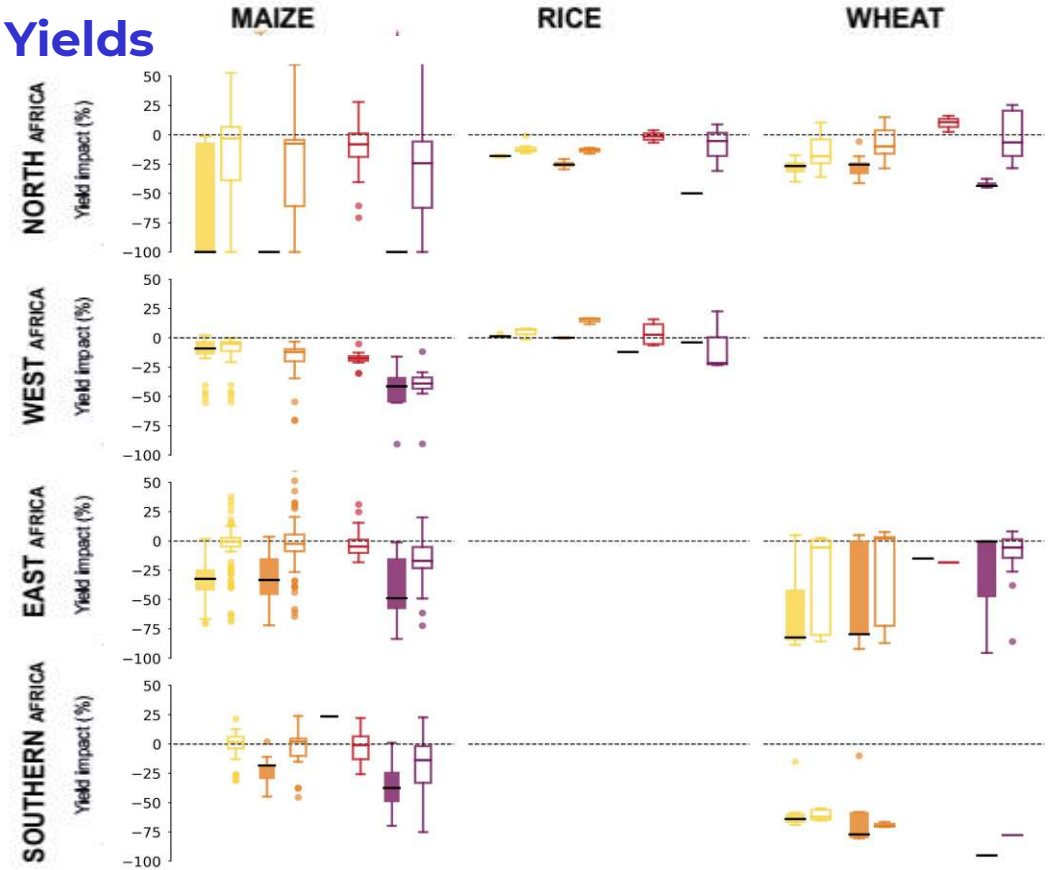


Figure 9.22

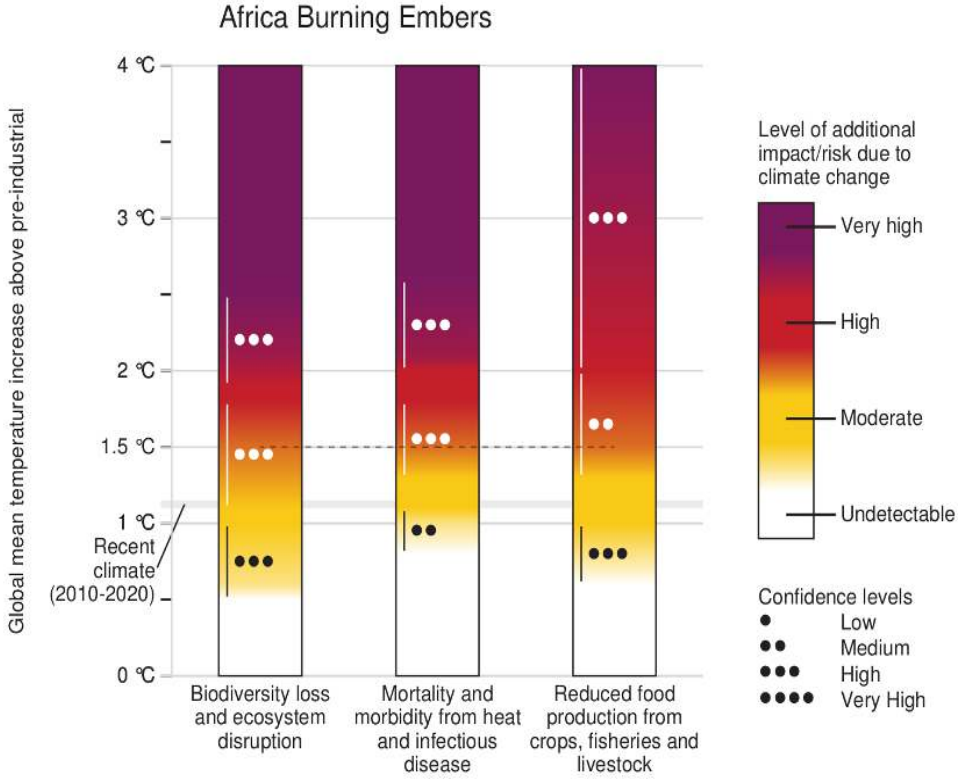
- Crop yields are projected to decrease with increasing global warming across staple crops in Africa

- The overall adaptation potential to offset yield losses across Africa for rice, maize and wheat reduces with increasing global warming

❑ Risk profile in Africa

Figure 9.6

- Risk profile with respect to global warming level
- Risk for biodiversity loss and ecosystem disruption increases faster
- At 4°C, all risks are equal and very high



❑ Rwanda in the IPCC: two roles

Government

- IPCC member country, like all UN and WMO members
- National Focal Point nominates experts and coordinates government review
- Delegates approve each SPM line by line in Plenary
- IPCC findings feed national plans: NDC 3.0 (2025) and LT-LEDS

Science

- Rwanda-based authors and reviewers in AR6 and AR7
- Evidence producers: Meteo Rwanda, University of Rwanda, REMA, AIMS RIC
- National climate studies, such as the three presented this morning
- Gap: few Rwanda-specific studies in the assessed literature

II/ Rwanda

❑ From Rwandan science to the IPCC, and back

Observations (Meteo Rwanda) → **National studies and models** → **Peer-reviewed publications** → **IPCC assessment (AR7)** → **National policy: NDC, LT-LEDS, early warning**

What Rwanda can do now

1. Publish national climate studies in peer-reviewed journals, within the AR7 literature cut-off dates

2. Register as expert reviewers for AR7 drafts. Review is open to qualified experts

3. Nominate Rwandan experts for future IPCC reports through the National Focal Point

4. Link science and government in one national IPCC team: Ministry of Environment, REMA, Meteo Rwanda, University of Rwanda, AIMS RIC, etc.

5. Train the next generation: IPCC Scholarship Programme (Dr. Christiane Textor)

Thank you for your attention