



SECOND EDITION

RWANDA CLIMATE SCIENCE SYMPOSIUM 2026

Where Rwanda's Climate Research Meets Policy

BOOK OF ABSTRACTS

Kigali, Rwanda
22–23 September 2026

Foreword

Under the theme “*Where Rwanda’s Climate Research Meets Policy*,” the Second Rwanda Climate Science Symposium brought together researchers, policymakers, practitioners and development partners to strengthen the connection between scientific evidence and climate action. Building on the foundation established by the first edition, RCSS 2026 placed particular emphasis on ensuring that research does not remain within academic circles, but is translated into knowledge that can inform policy, investment, planning and implementation.

The contributions presented in this Book of Abstracts span five thematic areas: Agriculture & Food Systems; Climate Data & Monitoring Systems; Urbanization, Infrastructure & Energy; Nature-Based Solutions & Ecosystems; and Health–Climate Nexus. Together, they reflect the diversity of climate-related research being undertaken in Rwanda and across the wider region, from high-resolution climate information and early-warning systems to resilient agriculture, infrastructure, ecosystems and climate-sensitive health risks. The range of approaches and perspectives also highlights the importance of interdisciplinary collaboration in addressing increasingly complex climate challenges.

Most abstracts presented in this volume are based on completed studies, while a smaller number reflect ongoing or planned research shared to stimulate scientific exchange, feedback and future collaboration. Accordingly, the contributions should be read as a record of the work presented at RCSS 2026 rather than as peer-reviewed publications. This Book of Abstracts provides a concise reference to the evidence, ideas and emerging research directions discussed at the symposium, while helping make locally relevant climate knowledge more visible and accessible to decision-makers, researchers and the wider scientific community.

The organizers sincerely thank all authors, scientific reviewers, session hosts and partner institutions whose time, expertise and commitment made this symposium and publication possible. Their collective contribution continues to strengthen Rwanda’s climate science community and the pathway from research to evidence, policy and action.

RCSS 2026 Organizing Team

Contents

Foreword.....	i
Future Suitability of Arabica Coffee in Rwanda: Evidence from Coffee Suitability Modelling Using Downscaled Climate Data	1
Trends and variability of rainfall and related extreme indices with implications for climate sensitive planning in Kirehe district of the eastern province of Rwanda.....	2
Projected change in precipitation and temperatures under a changing climate in Rwanda.....	3
Spatial variability of seasonal rainfall onset, cessation, length and rainy days in Rwanda.....	4
Rhizosphere Microbial Effect of Native Woody Species in Heavy Metal-Contaminated Soils: Pathways for Ecosystem Remediation.....	5
E-Motorbike Adoption in Kigali: Challenges, Opportunities, and Policy Pathways for Sustainable Urban Mobility	6
From Waste to Worth: NutriFarm's Circular Bioeconomy Model for Climate Mitigation, Green Jobs, and Nutrition Security in Rwanda.....	7
Community Participation as a Pathway to Climate-Resilient Housing Development in Rapidly Urbanizing Municipalities: Evidence from Bafoussam II, Cameroon	8
Beyond Restoration: An integrated indicator assessment of social-ecological resilience restored river Sironko wetland, Eastern Uganda	9
A Progressive Approach Towards Postharvest Loss Reduction	10
Effects of Irrigation and Crop Type on Soil Respiration (CO ₂ emissions) in Rwanda's Tropical Marshland Agroecosystems.....	11
Assessing the Impact of Circular Economy Practices on Construction and Demolition Waste Management in Kigali, Rwanda	12
Mapping the Drivers of Tomato Waste: Developing a Stakeholder-Informed Framework for Climate-Resilient Food Systems in Botswana	13
Climatic origin shapes photosynthetic and growth sensitivity to water limitation in Rwanda native tree species.....	14
Lepidoptera diversity within three remnant forests of Rwanda	15
Estimating the subnational burden of temperature-attributable under-five malaria cases in Rwanda using standards for official climate-health statistics.....	16
"The Floods are Moving with Us": Vulnerability Transferability and the Limits of Relocation-Based Adaptation in Urban Informal Settlements	17
Assessing the impact of community awareness and adoption of climate adaptation strategies among residents on flood risk reduction in Rusizi district in Western Rwanda.....	18
Greening Last-Mile Vaccine Delivery in Resource-Limited Settings: Acceptance of Drone-Based Vaccine Delivery and Associated Factors Among Healthcare Workers in Rwanda	19
Growth and Biomass Responses to Warming in Afrotropical Native Trees.....	20
Community Willingness to Participate in Innovative Ecosystem-Based Adaptation to Climate Change: Evidence from a Butterfly Farming Project in the Ibanda-Makera Forest, Eastern Rwanda	21

Landslide-induced Displacement and Relocation Strategies in Rutsiro District, Western Rwanda.....	22
Optimizing stem cutting propagation of <i>Myrianthus holstii</i> for climate-resilient agroforestry.....	23
Financing Africa's Net-Zero Transition: A Systematic Review and Integrated Framework of Climate Finance, Green Bonds, and Carbon Markets.....	24
Assessing the Role of Agroforestry in Landscape Restoration for Building.....	25
Planning Irrigation Electrification and its Impact on Electric System.....	26
Mid-Season Machine Learning Prediction of End-of-Season Water Requirement Satisfaction Index (WRSI) for Maize in Kirehe District, Rwanda (Season B, 2001–2023)	27
Can Africa's Bioeconomy Remain Sustainable Under Climate Change? Evidence from Emerging Bioeconomy Initiatives in East Africa.....	28
Microclimatic Drivers of Malaria Vector Distribution and Transmission in Ghana: Implications for Climate-Informed Disease Surveillance and Control	29
Impact of social economic factor to the adoption of liquefied petroleum gas among households in the city of kigali - kimironko and bumbogo sectors.....	30
Potato tuber moth (<i>Phthorimaea operculella</i> (<i>Lepidoptera: Gelechiidae</i>) farmers' perception and seasonal occurrence in Burera and Rutsiro districts of Rwanda	31
Fluorinated Greenhouse Gases and Climate Change: A Critical Review of Emissions, Impacts, and Regulatory Gaps.....	32
Risk Assessment and Seasonal Variation of Greenhouse Gases in Agricultural Farmland in Nigeria.....	33
A Predictive Climate Model for Africa Capable of Identifying Precise Extreme Event Periods, Recommending Adapted Crops and Generating Targeted Institutional Alerts.....	34
Integrated Radiative Index for the Sahel (IRIS): A Multivariate Satellite-Based Framework for Monitoring Hydroclimatic Variability.....	35
Nature-Based Flood Adaptation Measures in Mpazi Sub-Catchment, City of Kigali, Rwanda.....	36
Impacts of Landslide Disasters on Community Livelihoods in Rutsiro District Rwanda.....	37
Idiosyncratic effects of climate change on co-occurring threatened Afromontane damselflies.....	38
The Role of Faith-Based Organizations in Tackling Food Loss and Waste in Rwanda: A Preliminary Study	39
The Impact of Maize Farming Support on Food Security of T2DM Smallholder Farmers In Rural Rwanda.....	40
An assessment of the role of climate-smart urban planning in reducing flood risks in Kigali city	41
Development and Evaluation of a Prototype Climate-Soil Decision Support Tool for Beans Production in Karongi District.....	42
Earth Observation-Based Causal Analysis of Soil Moisture Dynamics for Drought Monitoring in East Africa	43

Evaluating the Climate, Energy, and Urban Infrastructure Benefits of Shared Commuting: A Pilot Study in Kigali, Rwanda	44
Multi-Temporal LULC detection for climate impact assessment: Bird population as bioindicator in Karago lake ecosystem, Rwanda	45
A Low-Cost IoT and Mobile Based Urban Flood Early Warning and Response System	46
Directed Graph Neural Networks for Bus-Level Outage Prediction on Radial Distribution Grids	47
Adaptation Research for Impact: From Climate Evidence to Adaptation Enterprise - The Role of Science in Strengthening Rwanda's Adaptation Innovation Ecosystem	48
Warming Highlands, Changing Harvests: Four Decades of Climate Variability and Potato Production in the Santa-Babadjou Corridor, Cameroon	49
Modelling Heat Stress Impacts on Outdoor Workers' Health and Productivity in Kigali, Rwanda	50
Eco Watershed Intelligence Platform: A Unified Geospatial Decision-Support System for Watershed-Scale Ecosystem Management	51
Reforestation and Ecosystem Restoration by Native Tree Species for Climate Resilience and Water Resource Improvement in Rwanda	52
Spatiotemporal Assessment of Urban Heat Islands and the Cooling Effects of Nature-Based Solutions in Kigali City, Rwanda (2005–2025)	53
Integrating AI-Driven Satellite Earth Observation into Climate Disaster Risk Reduction: A Governance Framework for Rwanda	54
Sentinel-1 SAR Flood Extent Mapping of the Nyabarongo–Kigali Corridor, Rwanda: A Multi-Constraint Adaptive Framework for Highland Peri-Urban Environments	55
Climate-Sensitive Energy Demand Modelling in Togo Using LEAP Under IPCC AR6 Scenarios	56
Integrated optimization of biogas recovery and solar photovoltaic energy systems on Municipal Solid Waste Landfill hills in Rwanda: A Case Study of Nduba Municipal Solid Waste Landfill Hill, Kigali	57
Strengthening Climate Data and Monitoring Systems to Support Climate Resilience and Sustainable Development in Rwanda	58

Future Suitability of Arabica Coffee in Rwanda: Evidence from Coffee Suitability Modelling Using Downscaled Climate Data

Delice Izere^a, David Abigaba^b, Ananya Mazumder^b, Olivier Niyompuhwe^c, Janet Umuhiza^c, Kora Rösler^c, Sabine Undorf^b, Christoph Gornott^{b,d} & Sophie von Loeben^b

^aAIMS – Research & Innovation Center (AIMS-RIC), Rwanda; ^bPotsdam Institute for Climate Impact Research (PIK), Potsdam, Germany; ^cDeutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH; ^dUniversity of Kassel, Germany

DOI: <https://doi.org/10.48485/pik.2026.28>

CA: izeredelice@gmail.com / oniyompuhwe@gmail.com

Abstract

Arabica coffee is central to Rwanda's rural livelihoods and export economy, yet its climatic suitability is increasingly exposed to rising temperatures, changing rainfall patterns, and growing climate variability. This study assessed the current and future suitability of Arabica coffee across Rwanda using high-resolution climate projections and spatial modelling to support climate-resilient agricultural planning. Climate data derived from nine CMIP6 global climate models were bias-corrected and downscaled to approximately 1 km resolution, then combined with soil, elevation, and coffee occurrence data. Four machine-learning algorithms, Random Forest, Boosted Regression Trees, Support Vector Machines, and MaxEnt, were integrated in an ensemble modelling framework and applied under SSP1-2.6, SSP3-7.0, and SSP5-8.5 scenarios for periods centered on 2030, 2055, and 2080. Results indicate that approximately 71.06% of Rwanda is currently suitable for Arabica coffee, with highest suitability concentrated in the central, western, and northern highlands. Elevation was the strongest predictor of suitability, followed by dry-day frequency and seasonal precipitation. Future projections show relatively limited change under the low-emission pathway but increasing losses under higher-emission scenarios, especially in eastern and southern lowlands. By 2080 under SSP5-8.5, suitability losses reach about 3% of currently suitable areas, compared with gains of roughly 1.2%. These findings suggest a gradual shift toward cooler high-elevation zones, while underscoring land-use, conservation, livelihood, and gender considerations. Proactive, location-specific adaptation, including agroforestry, soil and water conservation, crop diversification, extension support, and gender-responsive planning, will be essential to sustain Rwanda's coffee sector. The study provides a baseline for future suitability assessments and evidence-based decisions across Rwanda's climate-sensitive agricultural systems.

Keywords: Arabica coffee; Climate suitability; Downscaled climate data; Machine learning; Climate adaptation

This report has been produced in collaboration between the Rwanda-German bilateral project Capacity Development for the Implementation of Rwanda's Nationally Determined Contribution (NDC), implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ), the Rwanda Meteorology Agency (Meteo Rwanda), and the Potsdam Institute for Climate Impact Research (PIK) through the Providing High-Resolution Climate Projections for Agricultural Impact Assessment (HiCIAP) initiative.

Trends and variability of rainfall and related extreme indices with implications for climate sensitive planning in Kirehe district of the eastern province of Rwanda

Alexis Nizeyimana¹, Ndakize Joseph Sebaziga^{1,2,3}, Jonah Kazora⁴, Eric. R. Mudakikwa¹, Herman Hakuzimana¹, Anthony Twahirwa⁴, Abdou Kagabo Safari², Bernardin Bavuge¹, David Ukwishaka¹, Bernard Niyigena^{2,4}, Onesphore Nduwimana¹, Olive Byukusenge¹, Pearl Nkunsi¹, Deborah Nibagwire¹, Pie Celestin Hakizimana¹, Clementine Nyiraneza¹, Anne Marie Rutabuzwa¹, Michel Rwema⁵

¹Rwanda Environment Management Authority, Kigali, Rwanda. ²College of Science and Technology, University of Rwanda, Kigali, Rwanda. ³Climate and Clean Air Coalition, Hosted By the United Nations Environment Program, Paris, France.

⁴Rwanda Meteorology Agency, Kigali, Rwanda. ⁵African Institute for Mathematical Sciences, Research and Innovation Centre, Kigali, Rwanda.

DOI: <https://doi.org/10.1007/s44274-025-00495-1>

CA: nizalex2004@gmail.com; ndakize88@gmail.com

Abstract

Rainfall variability and extremes critically influence ecosystems, agriculture, and livelihoods, particularly in climate-sensitive regions such as eastern Rwanda. This study investigates spatial and temporal patterns of rainfall and related extreme indices in Kirehe District using daily observational data from the Rwanda Meteorology Agency covering 1983–2021. Key rainfall characteristics-onset and cessation dates, seasonal length, and number of rainy days-were derived using rainfall-dry spell and evapotranspiration criteria. Extreme rainfall indices were computed following the Expert Team on Climate Change Detection and Indices (ETCCDI) methodology, while variability and trends were analyzed using the coefficient of variation, modified Mann–Kendall test, and Sen's slope estimator. Results reveal three near-homogeneous climatic zones across Kirehe District. Region 1 (R1) is characterized by an earlier onset, later cessation, longer growing season, and more rainy days, whereas Regions 2 (R2) and 3 (R3) exhibits later onset and cessation, shorter seasons, and fewer rainy days. Rainfall variability is highest in central and southern areas, particularly for onset dates, seasonal length, and number of rainy days. Extreme rainfall indices show strong spatial contrasts, with consecutive dry days (CDD) and heavy precipitation events (R10mm, R20mm, RX1day, RX5day) varying markedly across the district. Although no significant long-term trends are detected for total rainfall or seasonal parameters, localized increases in CWD, PRCPTOT, and R10mm in the north and declines in rainfall intensity indices in the south indicate growing climatic disparities. These findings highlight substantial intra-district rainfall heterogeneity and increasing exposure to both drought and flood risks. The results underscore the need for integrating localized climate information into district-level planning and adaptation strategies to enhance agricultural resilience and water resource management in Rwanda's eastern lowlands.

Keywords: Climate extreme indices, Rainfall characteristics, Kirehe district, Variability, Trends

Projected change in precipitation and temperatures under a changing climate in Rwanda

Ndakize Joesph Sebaizga^{1,2,3}

¹Rwanda Environment Management Authority, Kigali, Rwanda. ²Climate and Clean Air Coalition, Hosted By the United Nations Environment Program, Paris, France. ³School of Science and Technology, University of Rwanda, Kigali, Rwanda

DOI: <https://doi.org/10.1007/s44274-026-00547-0>

ndakize88@gmail.com

Abstract

Changes in rainfall and temperature influence community livelihoods by affecting agriculture, water availability, health, and overall economic stability. This study investigates the spatial patterns of observed seasonal mean rainfall and temperatures for the period 1983–2021 and the projected seasonal changes in temperatures and rainfall over Rwanda using CORDEX-CORE multi-model ensemble simulations under the RCP2.6 and the RCP8.5 scenarios for 2026–2060 and 2066–2100 periods relative to 1986–2020. For observational period, the analysis reveals a heterogeneous spatial distribution of rainfall across all seasons, with higher rainfall in the northern and southwestern highlands and lower amounts in the eastern lowlands. Maximum temperatures are generally higher in the eastern and southwestern lowlands, while minimum temperatures are lowest in the northern and western highlands. Significant reductions in rainfall are projected for MAM ([−1, 49, 59] mm) and JJA ([−62, 12] mm), while a significant increase is projected for SON ([173, 234] mm) under both scenarios. A significant increase in Tx under RCP2.6 is expected for JF (0.38 °C) and for SON (0.35 °C) during 2026–2066. Under RCP8.5, Tx is projected to increase for both periods during JF ([1.02, 3.20] °C), MAM ([0.94, 3.02] °C), and SON ([0.86, 2.68] °C). For JJA, Tx is anticipated to increase under both emission scenarios for both periods ([1.87, 4.54] °C). Minimum temperature is projected to statistically increase across all seasons under both emission scenarios and periods, with a higher magnitude under RCP8.5 than RCP2.6. Tn is projected to increase for JF ([1.84, 5.16] °C), MAM ([1.99, 4.96] °C), JJA ([1.28, 5.12] °C), and SON ([2.35, 4.82] °C). These expected changes suggest significant impacts for water resources, agriculture, ecosystem management, and energy, highlighting the need for adaptation strategies to enhance climate resilience in Rwanda's key socio-economic sectors.

Keywords: CORDEX-CORE, Projections, Rainfall, Rwanda, Temperature

Spatial variability of seasonal rainfall onset, cessation, length and rainy days in Rwanda

Ndakize Joesph Sebaizga^{1,2,3}, Bonfils Safari¹, Joshua Ndiwa Ngaina⁴, Didier Ntwali⁵

¹*School of Science and Technology, University of Rwanda, Kigali, Rwanda.*

²*Rwanda Environment Management Authority, Kigali, Rwanda.* ³*Climate and Clean Air Coalition, Hosted By the United Nations Environment Program, Paris, France.* ⁴*WMO Office for Eastern and Southern Africa- Regional Office for Africa, Nairobi, Kenya.* ⁵*Rwanda Space Agency*

DOI: <https://doi.org/10.1007/s00704-024-05086-3>

CA: ndakize88@gmail.com

Abstract

Changes in rainfall and temperature influence community livelihoods by affecting agriculture, water availability, health, and overall economic stability. This study investigates the spatial patterns of observed seasonal mean rainfall and temperatures for the period 1983–2021 and the projected seasonal changes in temperatures and rainfall over Rwanda using CORDEX-CORE multi-model ensemble simulations under the RCP2.6 and the RCP8.5 scenarios for 2026–2060 and 2066–2100 periods relative to 1986–2020. For observational period, the analysis reveals a heterogeneous spatial distribution of rainfall across all seasons, with higher rainfall in the northern and southwestern highlands and lower amounts in the eastern lowlands. Maximum temperatures are generally higher in the eastern and southwestern lowlands, while minimum temperatures are lowest in the northern and western highlands. Significant reductions in rainfall are projected for MAM ([−1, 49, 59] mm) and JJA ([−62, 12] mm), while a significant increase is projected for SOND ([173, 234] mm) under both scenarios. A significant increase in Tx under RCP2.6 is expected for JF (0.38 °C) and for SOND (0.35 °C) during 2026–2066. Under RCP8.5, Tx is projected to increase for both periods during JF ([1.02, 3.20] °C), MAM ([0.94, 3.02] °C), and SOND ([0.86, 2.68] °C). For JJA, Tx is anticipated to increase under both emission scenarios for both periods ([1.87, 4.54] °C). Minimum temperature is projected to statistically increase across all seasons under both emission scenarios and periods, with a higher magnitude under RCP8.5 than RCP2.6. Tn is projected to increase for JF ([1.84, 5.16] °C), MAM ([1.99, 4.96] °C), JJA ([1.28, 5.12] °C), and SOND ([2.35, 4.82] °C). These expected changes suggest significant impacts for water resources, agriculture, ecosystem management, and energy, highlighting the need for adaptation strategies to enhance climate resilience in Rwanda's key socio-economic sectors.

Rhizosphere Microbial Effect of Native Woody Species in Heavy Metal-Contaminated Soils: Pathways for Ecosystem Remediation

Agnes Uwimbabazi^{a,e}, Subbaiya Ramasamy^{a,b}, Theodore M. Mwamba^{a,c} & Stephen Syampungani^{a,d}

^a*Oliver R. Tambo Africa Research Chair Initiative (ORTARChI), Chair of Environment and Development, School of Natural Resources, The Copperbelt University, P.O. Box 21692, Kitwe, Zambia.*

^b*Department of Biological Sciences, School of Mathematics and Natural Sciences, The Copperbelt University, Riverside, Jambo Drive, P O Box 21692, Kitwe, Zambia*

^c*Faculty of Agriculture, University of Lubumbashi, P.O. Box 1825, Lubumbashi, Democratic Republic of the Congo*

^d*Department of Plant and Soil Sciences, Faculty of Natural and Agricultural Sciences, University of Pretoria, P.O. Box 0022, Pretoria, South Africa*

^e*Department of Nature Conservation, Rwanda Polytechnic -Kitabi College, Rwanda, P.O.Box 330, Huye, Rwanda.*

CA: agnesmbabazil@gmail.com / +250739978786 or +260774114260

Abstract

Legacy metal pollution from poorly managed mine waste continues to degrade soils, contaminate water and threaten ecosystem health with long-term impacts. In Sub-Saharan Africa, where climate emphasizes reliance, restoring metal-polluted soils using nature-based solutions such as microbial-assisted phytoremediation is not only an environmental necessity but also a climate priority, offering pathways to remediation. However, to fully realize the potential of microbial-assisted phytoremediation solutions, a deeper understanding is needed, including native plant rhizosphere-metal-microbes interactions in these contaminated environments. We targeted the rhizosphere of 3 indigenous woody species that dominate mine tailings in 3 tailings dams in the Copperbelt region of Central Africa to evaluate their roles in shaping physicochemical properties, microbial dynamics, and heavy-metal bioavailability in metal-contaminated soils. We measured microbial biomass, soil respiration, heavy metal concentrations, and physicochemical properties in the rhizosphere and bulk soils. In general, the results showed significant species-specific differences in the variation of measured parameters between the rhizosphere and bulk soils. Rhizosphere soils showed a consistent enrichment in lower bioavailable metals. Across the study sites, bulk soils were dominated by bacteria (72-90%), whereas rhizosphere soils exhibited greater fungal dominance, elevated microbial biomass, and higher soil respiration. *Senegalia polyacantha* exhibited improved microbial parameters and a stronger rhizosphere effect compared to other species. These findings highlight the potential of native tree species to enrich the rhizosphere, thereby supporting microbial-assisted phytoremediation of mine waste-contaminated soils. This offers an actionable guide for ecosystem restoration planning, strategies, and biodiversity-driven decisions on tree species selection across mining-impacted ecosystems in Sub-Saharan Africa.

Keywords: Bioavailability, Contaminated soils, Heavy metals, Microbial biomass, Native tree species, Rhizosphere

E-Motorbike Adoption in Kigali: Challenges, Opportunities, and Policy Pathways for Sustainable Urban Mobility

Albert Patrick Furaha, Jeanne Darc Mukashema, Jeannette Francine Ishimwe,
Fidele Mwizerwa, Emmanuel Muyombano, Dyna Uwambajimana

*Dept. of Spatial Planning, School of Architecture and Built Environment, College
of Science and Technology, University of Rwanda, Kigali, Rwanda*

CA: furahaapatrick@gmail.com | Published in *Built Form Journal*, Vol. 1, No. 2,
2025 | DOI: 10.63955/BuiltForm.25

Abstract

Urban transportation is a critical driver of greenhouse gas emissions in rapidly urbanizing African cities. In Rwanda, motorcycles dominate urban mobility, accounting for 52% of the 221,000 registered vehicles in Kigali, with the fleet growing at nearly 12% annually. Despite the Government of Rwanda's ambitious plans to phase out internal combustion engine (ICE) motorcycles and replace them with electric motorbikes (e-motorbikes), adoption remains critically low. This study addresses the gap between Rwanda's low-carbon mobility ambitions and actual adoption on the ground, directly relevant to Rwanda's Nationally Determined Contributions (NDCs) and National Strategy for Transformation (NST2). This study aimed to: (1) assess current awareness and use of e-motorbikes among motorcycle users in Nyarugenge District, Kigali; (2) examine the major challenges hindering widespread adoption; and (3) identify key opportunities and policy levers for promoting sustainable electric mobility in an urban African context. A mixed-methods approach was employed, integrating GIS spatial mapping of charging infrastructure using GPS field data and ArcGIS; structured surveys with 401 respondents (motorists, commuters, government officials, company representatives); field observation across all 10 sectors of Nyarugenge District; and stakeholder interviews with officials from CoK, MININFRA, RURA, RSB, and e-motorbike companies (Ampersand, Spiro, Gorilla). Sample size was determined using the Yamane formula. Data was analyzed to assess infrastructure coverage, user awareness, adoption barriers, and policy environments. Awareness of e-motorbikes was remarkably high (98%), and 97% of respondents had experienced them as users or commuters. Despite this, only 8% of motorbikes in Nyarugenge District are electric, compared to 20% in Kigali City overall. GIS analysis revealed that charging stations are concentrated in a few sectors, leaving most of the district poorly served. Key barriers include lack of charging infrastructure (cited by 41% of respondents), low battery range (27%), battery life concerns (61 respondents), and high upfront costs. However, 81.8% expressed willingness to switch to e-motorbikes given government incentives, and 85.6% acknowledged their environmental benefits. Nyarugenge District is in the early stages of adoption of e-motorbike, constrained by infrastructure gaps, affordability, and regulatory bottlenecks rather than lack of awareness. Evidence-based recommendations include expanding charging infrastructure through public-private partnerships; maintaining and strengthening tax exemptions and import duty reductions; improving battery standards and spare parts availability; and integrating e-mobility targets into Kigali's urban planning frameworks. These interventions directly support Rwanda's NDC commitments, the decarbonization of urban transport, and the NST2 sustainable development goals.

Keywords: electric motorbikes, sustainable urban mobility, GIS, climate policy, low-carbon transport

From Waste to Worth: NutriFarm's Circular Bioeconomy Model for Climate Mitigation, Green Jobs, and Nutrition Security in Rwanda

Alexis Musabirema

NutriFarm Ltd, Kigali, Rwanda

CA: alexmusabirema@gmail.com / +250788771736

Abstract

Rwanda faces compounding climate-related pressures, including rising organic waste generation, greenhouse gas emissions from unmanaged waste, strain on conventional livestock systems, and persistent malnutrition among vulnerable populations. This study presents NutriFarm's circular bioeconomy model, a climate-smart approach that converts agro-industrial by-products and organic waste into insect-based protein ingredients and fortified foods for human consumption. Using biotechnology-driven bioconversion, organic waste streams are transformed into protein powder rich in essential amino acids and Omega-3 nutrients, which are then incorporated into affordable fortified foods. To date, NutriFarm has repurposed over 120 tons of organic waste, avoided approximately 18 tons of CO₂-equivalent emissions, and created 21 green jobs, with strong inclusion of women and youth. By reducing dependence on conventional animal protein, the model lowers land, water, and feed demand while strengthening climate resilience through resource-efficient production. The research evaluates the climate mitigation potential of waste valorization pathways, emission reductions across the protein value chain, and contributions to sustainable food systems in Rwanda. Preliminary findings indicate that circular protein production reduces waste-disposal burdens, improves resource efficiency, and provides affordable, nutrient-dense food for communities facing nutritional insecurity. This paper argues that circular bioeconomy innovations, such as insect-based protein production, offer scalable pathways to advance Rwanda's climate ambitions while supporting food security and green industrialization. Policy support, investment in climate-smart agribusiness, and stronger research-industry collaboration are critical to scaling these innovations nationally and across Africa.

Keywords: Climate resilience; Circular bioeconomy; Organic waste valorization; Sustainable protein; Nutrition security; Green jobs; Rwanda.

Community Participation as a Pathway to Climate-Resilient Housing Development in Rapidly Urbanizing Municipalities: Evidence from Bafoussam II, Cameroon

Amuntum Blandine Afungdoh

Department of Geography and Planning, Faculty of Arts, The University of Bamenda, Cameroon

CA: afungdoh@yahoo.com, +237674232561

Abstract

Rapid urbanization, population growth, and climate variability are placing increasing pressure on housing and urban infrastructure in Bafoussam II Municipality, Cameroon. Inadequate drainage systems, informal settlement expansion, poor waste management, and limited community participation heighten vulnerability to climate-related hazards, underscoring the need for participatory and climate-responsive housing governance. This study examined the nature of community participation in housing development and assessed its contribution to sustainable and climate-resilient urban development in Bafoussam II Municipality. A mixed-methods research design was employed, combining household questionnaires administered to 156 respondents, key informant interviews, focus group discussions, field observations, and secondary data. Quantitative and qualitative analyses were conducted to evaluate housing conditions, participation levels, and institutional mechanisms influencing community engagement. Only 17.24% of respondents reported participating in housing development meetings, indicating limited public involvement in local planning and decision-making. Housing affordability emerged as the most significant challenge, cited by 40.91% of respondents in Djeleng II neighborhood. Additionally, 38.24% of respondents in Toungang Village neighborhood identified regular community consultations as the most effective strategy for strengthening community participation. These findings demonstrate that weak public engagement constrains sustainable housing governance and reduces local capacity to anticipate, adapt to, and respond to climate-related urban risks. Institutionalizing inclusive community participation within municipal housing planning can strengthen climate resilience, improve urban infrastructure governance, and promote sustainable urban development. The study recommends integrating participatory decision-making into municipal housing and climate adaptation policies to enhance resilience, improve service delivery, and foster inclusive governance in rapidly urbanizing municipalities.

Keywords: Community participation; Climate resilience; Sustainable housing; Urbanization; Cameroon.

Beyond Restoration: An integrated indicator assessment of social-ecological resilience restored river Sironko wetland, Eastern Uganda

Andrew Remmy Muwaza

Addis Ababa University, Ethiopia

CA: muwaza.andrew@aau.edu.et / +256753581762

Abstract

Uganda's freshwater ecosystems sustain biodiversity, livelihoods, and economic growth, yet are degrading under anthropogenic pressures and climate change. Restoration alone is insufficient without resilience to withstand shocks, maintain functionality, and adapt to changing conditions. This study assessed socio-ecological resilience in the restored Sironko river wetland. The objectives of this study are to: (i) assess spatial differences in macroinvertebrate and riparian tree species diversity, (ii) analyze wetland fragmentation and connectivity (2016-2026), (iii) assess community participation, traditional ecological knowledge integration, and institutional collaboration in restoration. Ten macroinvertebrate sites were sampled across restored and unrestored reaches; 15 riparian tree plots (10 × 50 m) were surveyed. A 10-year fragmentation assessment using GIS and FRAGSTATS. 292 household interviews across 12 villages and ego–alter institutional network analysis. Macroinvertebrate diversity was low with no significant difference between the restored and unrestored reaches ($H' = 1.61$ vs 1.66 , $p = 0.42$). Restored riparian forest was dominated by *Eucalyptus grandis*, with very low and varied tree diversity ($H' = 0.99$, $p = 0.015$). Wetlands fragmentation and isolation continued despite restoration. While respondents felt consulted, 0% reported influence over restoration decisions and 10.4% participated in the on-the-ground restoration activities. Respondents held valuable traditional ecological knowledge, but 86.7% opined it was not integrated into restoration. Institutional collaboration was weak (network density = 0.05, fragmentation index = 0.91) and centralized around the line Ministry. Despite EbA restoration, the current conditions in Sironko restored landscapes remain insufficient to deliver socio-ecological resilience. Future EbA restoration programmes should prioritize integration of social and ecological subsystems as one resilience-building agenda.

Keywords: Ecosystem-based Adaptation, Social-ecological resilience, Wetland restorations

A Progressive Approach Towards Postharvest Loss Reduction

Audrey Demafo

AIMS Rwanda

CA: audrey.demafo@aims.ac.rw / +250 798 971 382.

Abstract

Post-harvest loss remains a major global concern, with nearly one-third of the food produced worldwide being lost or wasted between production and consumption¹. While food waste occurs predominantly at the consumer level, food losses are encountered throughout post-harvest operations, including pre-cooling, packaging, storage, and transportation². The problem is particularly significant in developing countries such as Rwanda, where inadequate post-harvest handling and storage infrastructure can result in substantial economic losses³, thereby affecting smallholder farmers whose livelihoods depend on agricultural production⁴. In this study, we discuss different approaches to mitigating post-harvest losses using mathematical modelling and numerical simulations. These approaches span multiple stages of the postharvest chain, from the optimal design of food crates and optimization of cold room configurations to the development of optimal energy management strategies for cold storage systems. By integrating these approaches, we aim to establish a scientific foundation for informed decision-making, with the goal of reducing post-harvest losses and supporting more sustainable and economically viable food supply chains.

Keywords: Ecosystem-based Adaptation, Social-ecological resilience, Wetland restorations

¹ Jonathan Kaminski and Luc Christiaensen. "Post-harvest loss in sub-Saharan Africa—what do farmers say?" In: Global Food Security 3.3-4 (2014), pp. 149–158.

² Jenny Gustavsson et al. Global Food Losses and Food Waste: Extent, Causes and Prevention. Rome: Food and Agriculture Organization of the United Nations, 2011. <https://www.fao.org/docrep/014/mb060e/mb060e.pdf>.

³ World Bank. Rwanda Food Smart Country Diagnostic. Washington, DC: World Bank, 2020. <https://documents1.worldbank.org/curated/en/288911601302842762/pdf/Rwanda-Food-Smart-Country-Diagnostic.pdf>.

⁴ 4Clean Cooling Network. Sustainable Cooling and Cold-Chain Solutions Review 2024–25. Clean Cooling Network, 2025. <https://ozone.unep.org/system/files/documents/CCN%20Annual%20Review%202025.pdf>.

Effects of Irrigation and Crop Type on Soil Respiration (CO₂ emissions) in Rwanda's Tropical Marshland Agroecosystems

Therese Ave Maria ^{1*}, Marguerite Mukangango¹, Guillaume Nyagatare¹, Valens Nkundabashaka¹, Rose Niyonkuru¹, Simon Rukera-Tabaro¹, Örjan Berglund ², Abraham Joel²

¹*University of Rwanda, College of Agriculture, Forestry and Food Science (CAFF), Rwanda*

²*Swedish University of Agricultural Sciences (SLU), Sweden*

CA: avemarietherese@gmail.com / t.avemaria@ur.ac.rw / +250784377071

Abstract

Agricultural intensification is essential for improving food security in Rwanda but may alter greenhouse gas (GHG) emissions from agricultural soils. Understanding how irrigation and crop type influence soil respiration is important for developing climate-smart agricultural practices that increase productivity while minimizing environmental impacts. This study assessed the effects of irrigation and crop type on soil respiration (CO₂ emissions) in a tropical marshland agroecosystem and evaluated whether irrigation improves crop productivity without increasing soil carbon losses. A field experiment was conducted in the Tonga marshland, Rwanda, using a randomized complete block design comparing irrigated and rainfed management across multiple crop types (maize, Irish potato, soya bean, bean and brachiaria as a forage plant). Soil CO₂ emissions were measured over two cropping seasons using a portable infrared gas analyzer (Vaisala GMP343), while crop yield and environmental variables were simultaneously monitored. Mixed-effects models were used to evaluate the effects of irrigation, crop type, crop growth stage, and soil cover on soil respiration. Crop type, crop growth stage, fertilization, and soil cover significantly influenced soil CO₂ emissions, whereas irrigation had no significant effect on total soil respiration. Irrigation substantially increased crop yields and reduced yield-scaled CO₂ emission intensity for beans and Irish potato, demonstrating improved carbon-use efficiency without increasing absolute soil CO₂ emissions. The findings demonstrate that irrigation can enhance agricultural productivity without increasing soil carbon losses under humid tropical conditions. The study provides evidence supporting climate-smart irrigation and sustainable agricultural management in Rwanda and highlights the importance of using yield-scaled greenhouse gas indicators when evaluating agricultural mitigation strategies and informing climate policy.

Keywords: Climate-smart agriculture; Soil respiration; Irrigation; Greenhouse gas emissions; Rwanda

Assessing the Impact of Circular Economy Practices on Construction and Demolition Waste Management in Kigali, Rwanda

Bernard Tuyishimire

University of Lay Adventist of Kigali and City of Kigali, Rwanda

CA: tuyibern12@gmail.com /+250789841756

Abstract

Rapid urbanization and infrastructure development in Kigali have significantly increased construction and demolition waste (CDW) generation, creating environmental and resource management challenges. Although Rwanda has adopted circular economy (CE) principles through its Green Growth and Circular Economy strategies, empirical evidence on the effectiveness of CE practices in improving CDW management remains limited. This study assessed the impact of circular economy practices on construction and demolition waste management efficiency in Kigali City, Rwanda. A mixed-methods research design was employed. Data were collected from 250 stakeholders, including construction companies, engineers, waste collectors, recyclers, and regulatory institutions through questionnaires and key informant interviews. Quantitative data were analyzed using descriptive statistics, Pearson correlation, and multiple linear regression, while qualitative information was analyzed thematically. The findings revealed significant adoption of waste minimization practices, with 68.4% of respondents reporting accurate material estimation. Material recovery was highest for metals (67.8%) and timber (41.2%), while concrete recycling remained low (31.9%). Circular economy practices showed a strong positive relationship with CDW management efficiency ($R^2 = 0.551$, $p < 0.001$). Waste minimization ($\beta = 0.356$), material recovery and reuse ($\beta = 0.298$), policy support ($\beta = 0.241$), and stakeholder engagement ($\beta = 0.215$) significantly improved waste management outcomes. The study demonstrates that circular economy practices can substantially enhance resource efficiency, reduce landfill dependency, and support sustainable urban development in Kigali. Strengthening regulatory enforcement, expanding recycling infrastructure, and promoting stakeholder collaboration are essential for accelerating Rwanda's transition toward climate-resilient and circular construction systems.

Keywords: Circular Economy, Construction and Demolition Waste, Sustainable Construction, Resource Efficiency

Mapping the Drivers of Tomato Waste: Developing a Stakeholder-Informed Framework for Climate-Resilient Food Systems in Botswana

Boineelo Pearl Lefadola^{1,2}, Mohammad Naushad Emmambux³, Dikabo Mogopodi⁴,
Nwabisa Mehlomakulu³

¹Future Africa – University of Pretoria, South Africa

*²Department of Family and Consumer Sciences, University of Botswana,
Botswana*

³Department of Food and Consumer Sciences, University of Pretoria, South Africa

⁴Department of Chemistry, University of Botswana, Botswana

CA: nkelepb@ub.ac.bw / +267 74079418

Abstract

In Botswana, tomato loss and waste remains a major challenge to sustainable food systems, accounting for nearly 30% of the total agro-produce loss. As climate variability intensifies, reducing food waste becomes increasingly important for strengthening climate-resilient agricultural systems. The study aimed to explore stakeholder perspectives on the drivers of tomato waste in Botswana and develop a stakeholder-informed tomato waste driver framework to support climate-resilient food system interventions. Qualitative data was collected through stakeholder engagement using the World Café participatory method. The approach enabled a multi-actor dialogue among tomato value chain actors including farmers, distributors, food processors, retailers, researchers, policymakers, and civil society. Data was thematically analyzed using Qualitative Data Analysis Software; ATLAS.ti. The findings revealed that tomato waste is driven by interconnected systemic factors, including poor production practices, inadequate post-harvest infrastructure, limited access to cold storage and transportation, market instability, pest and disease outbreaks, weak policy support, and poor coordination among value chain actors. Climate variability particularly rising temperatures, drought, floods and increasing pest pressure, exacerbates tomato loss and waste. Stakeholders identified several mitigation strategies, including investment in cold chain infrastructure, strengthening farmer-market linkages, promoting value addition and processing of surplus tomatoes, improving market access, enhancing farmer training on post-harvest handling practices, and developing supportive policies and collaborative platforms to improve coordination across the value chain. These findings informed the development of a Tomato Waste Driver framework that illustrates how production, market, infrastructure, governance and climate related factors interact to influence waste across the supply chain. The findings underscore the need for supportive policies and investments to reduce tomato waste and promote sustainable food systems. They also provide practical strategies to improve post-harvest management, enhance resource efficiency, and strengthen value chain resilience. Theoretically, the findings of the study led to the development of the Tomato Waste Driver framework. By integrating waste reduction into climate adaptation strategies, the framework can support more resilient, resource-efficient, and sustainable tomato value chain in Botswana.

Keywords: Tomato waste; Stakeholder Engagement; World Café Method; Sustainability; Food Systems, Climate Resilience

Climatic origin shapes photosynthetic and growth sensitivity to water limitation in Rwanda native tree species

Brigitte Uwajeneza (*University of Rwanda*), Myriam Mujawamariya (*University of Rwanda*), Camille Ziegler (*University of Bordeaux, France*), Johan Uddling (*University of Gothenburg, Sweden*)

CA: brigineza94@gmail.com / Tel: 250784637292

Abstract

Climate change is altering temperature and water availability in tropical trees, not only driving shifts in forest community composition toward warm- and dry-affiliated species but also hindering tree plantation in Rwanda. Yet, the physiological mechanisms underlying species responses remain poorly understood. We tested whether tree species differing in climatic origin and successional strategy vary in their physiological sensitivity to warming and water limitation. We also assessed the linkage in tree physiological response and growth responses to these stressors. We used data from elevational transplant experiment in Rwanda, including 20 native species representing montane versus transitional rainforest origins and early- and late-successional strategies. Trees were grown at three sites spanning an elevation gradient with contrasting temperature and rainfall, and water availability was experimentally manipulated to recreate the precipitation regimes of all three sites across the elevational gradient. Low water availability led to a stronger decline in net photosynthesis (A_n) in montane compared to transitional rainforest species. Effects of low water availability and warming on A_n were primarily driven by stomatal conductance, although low water availability also imposed a non-stomatal limitation. Photosynthetic responses were consistent with those of tree growth, with stem height and basal diameter responding similarly to combined warming and water limitation. These results highlight the vulnerability of tropical montane tree species to warming and drought and suggest that shifts in photosynthetic performance may influence competitive interactions and ultimately reshape community composition under climate change. This also informs the choice of right tree in a right place for successful tree plantation ongoing in Rwanda.

Keywords: Climate change, climate of origin, photosynthesis, growth, native trees

Lepidoptera diversity within three remnant forests of Rwanda

Constantin Sibomana^{1*}, Brigitte Nyirarukundo¹, Jean de Dieu Uwizelimana^{1,2},
Venuste Nsengimana^{1,2}

¹*Center of Excellence in Biodiversity and Natural Resource Management (CoEB),
University of Rwanda, P.O. Box 117, Butare, Rwanda.*

²*Department of Biology, School of Science, College of Science and Technology,
University of Rwanda, P.O. Box 3900, Kigali, Rwanda*

CA: c.sibomana@ur.ac.rw

Abstract

Lepidoptera are among the most informative biological indicator groups for assessing environmental change because of their strong associations with vegetation structure, host-plant availability, and microclimatic conditions. However, little is known about the diversity and composition of butterflies and moths in remnant forest ecosystems, particularly in tropical regions. This study aimed to establish baseline data on the diversity, composition, and distribution of Lepidoptera in three remnant forests of Rwanda: Nyagasenyi, Ibanda–Makera, and Sanza. We assessed Lepidoptera assemblages using line transects and baited traps. In total, 1,502 individuals were recorded, comprising 1,420 butterflies representing 122 species and 82 moths representing 35 species. Species richness was highest in Nyagasenyi for both butterflies and moths, followed by Ibanda–Makera and Sanza. Species overlap among forest fragments was limited, with only eight butterfly species and one moth species recorded across all three forests, while many species were restricted to a single forest fragment. These findings highlight the complementary conservation value of individual remnant forests in maintaining regional Lepidoptera diversity and emphasise the importance of conserving multiple forest fragments to sustain biodiversity. This study provides important baseline information on the diversity, composition, and distribution of Lepidoptera in Rwanda's remnant forests and establishes a foundation for future biodiversity monitoring and conservation planning. Future research may extend the data collection period by considering the seasonality pattern and incorporating nocturnal light trapping, which is a promising technique likely to improve assessments of moth diversity in these ecosystems.

Keywords: Butterfly, moth, species diversity, remnant forest, Rwanda

Estimating the subnational burden of temperature-attributable under-five malaria cases in Rwanda using standards for official climate-health statistics

Etse Yawo Dzakpa^{1,2}, Mouhamadou Bamba Sylla¹, Lema Logamou Seknewna^{1,2},
Bolis Ishimwe², Vijendra Ingole³.

¹*African Institute for Mathematical Sciences Research and Innovation Centre
(AIMS RIC), Kigali, Rwanda*

²*National Institute of Statistics of Rwanda (NISR), Kigali, Rwanda*

³*Office for National Statistics (ONS), Newport, UK*

CA: edzakpa@aimsric.org; +250798923147 | +221774615658

Abstract

Climate change is a major threat to global public health, disproportionately affecting children under five in low- and middle-income countries. Malaria, a leading cause of under-five morbidity in sub-Saharan Africa, is sensitive to temperature via effects on mosquito development and transmission. Subnational estimates of climate-attributable malaria burden remain absent from official statistics, limiting evidence-based planning. This study applies the Standards for Official Statistics on Climate–Health Interactions (SOSCHI) framework to generate subnational, temperature-attributable under-five malaria burden estimates for Rwanda. Monthly district-level under-five malaria cases from 30 Rwandan districts (2016–2023) were analyzed using a Bayesian spatiotemporal hierarchical model with a distributed lag non-linear model, fitted via INLA (negative binomial likelihood). Temperature, rainfall, humidity, and runoff served as covariates; attributable numbers and rates were estimated across districts. Malaria risk increased in the month following exposure to maximum temperatures of 27–31°C (RR: 1.14, 95% CrI: 1.05–1.25). An estimated 205,637 under-five cases (95% CrI: 82,581–332,548) were attributable to nonoptimal temperature during 2016–2023 (attributable fraction: 6.0%; rate: 132 per 100,000 population/month). Northern and western districts showed greater climate sensitivity (cumulative RR: 1.12 and 1.09); eastern districts (Ngoma, Kayonza) carried disproportionately high absolute burdens (>26,000 cases each) despite lower relative risk (RR: 0.88). Burden peaked in August–February. Applying SOSCHI as a subnational climate–health burden framework, this study delivers policy-ready evidence. Divergent climate sensitivity (north/west) and burden (east) call for distinct policies: climate-resilient health systems where sensitivity is highest, and vector-control investment where burden is largest. The August–February peak flags a window for pre-emptive chemoprevention, shifting planning from reactive to anticipatory.

Keywords: Childhood malaria; Nonoptimal climate exposure; Attributable burden; Spatiotemporal Bayesian model; Rwanda

“The Floods are Moving with Us”: Vulnerability Transferability and the Limits of Relocation-Based Adaptation in Urban Informal Settlements

Edith Kemunto Rosasi

TU Dortmund and University of the Philippines Diliman

Edith.rosasi@tu-dortmund.de / +254705134736

Abstract

Across rapidly urbanizing cities in Africa, including Kigali and other cities facing compound flood risk in peri-urban and informal settlements areas, relocation-based climate adaptation programmes operate on consistent spatial logic: move flood-exposed households to lower-risk locations and vulnerability is reduced. This paper challenges that assumption directly, with findings relevant to how urban adaptation governance approaches peripheral communities in Rwanda and comparable contexts. The objective of the study was to examine the mechanisms that enable flood-exposed residents of urban informal settlements to stay in place despite recurrent flood risk, and to identify the mechanisms through which vulnerability persists across relocation, with implications for urban climate adaptation governance in the Global South. The study employed Qualitative comparative approach using the Most-Different systems design across two flood-prone urban informal settlements: Mukuru in Nairobi, Kenya, and Wawang Pulo in Valenzuela City, Philippines. Data collected through in-depth semi-structured interviews, focus group discussions, key informant interviews, and field observations. Qualitative data analyzed thematically to identify convergent processes across contrasting urban contexts. The results show that the central conceptual contribution is Vulnerability transferability: where vulnerability is produced through tenure insecurity, infrastructure deficits, and concentrated urban poverty, relocated households encounter structurally similar conditions at their destinations. Residents in Mukuru described this directly, “the floods are moving with us”. Two complementary findings deepen this argument. Vertical Refuge, the widespread construction of second floors and raised platforms, reveals a community-led adaptive strategy that existing planning frameworks, organized around binary of staying or leaving, cannot recognize or support. Provisional framing, the cognitive architecture through which residents narrate chronic flood risk as temporary, explains persistent low uptake of relocation programmes even where alternatives formally exist. Together, these findings call for reorientation in urban climate adaptation governance: away from place-based interventions towards position-based approaches that address the tenure, infrastructure, and economic conditions that make peripheral communities perpetually exposed regardless of where they are relocated. For rapidly urbanizing African cities, including Rwanda, where informal settlements growth continues to concentrate climate risk among the urban poor, the implication is that managed retreat programmes that do not address the social and economic production of vulnerability are likely to redistribute exposure rather than reduce it.

Keywords: Climate immobility, urban informal settlements, vulnerability transferability, managed retreat, adaptation governance

Assessing the impact of community awareness and adoption of climate adaptation strategies among residents on flood risk reduction in Rusizi district in Western Rwanda

ESAIE SIINDI

HoReCo YEA-R Project, SNV Rwanda & University Iy Adventist of Kigali, Rwanda

esaiesindi@gmail.com / +250788825439

Abstract

Flooding is among the most severe climate-related hazards affecting communities in Rwanda, particularly in Rusizi District, where high rainfall, steep terrain, and environmental degradation increase vulnerability. Enhancing community awareness and promoting the adoption of climate adaptation strategies are key priorities within Rwanda's climate resilience and disaster risk reduction agenda. This study aimed to assess the impact of community awareness and adoption of climate adaptation strategies on flood risk reduction among residents of Rusizi District, Western Rwanda. A descriptive cross-sectional study design was employed. Data were collected from 399 households using structured questionnaires and key informant interviews. Quantitative data were analyzed using descriptive statistics, correlation, and regression analysis, while qualitative information was analyzed thematically to complement the findings. The findings revealed high levels of awareness, with 80.2% of respondents having heard about climate change and 77.7% aware of flood risks. Commonly adopted adaptation strategies included tree planting, crop diversification, and improved drainage systems. Statistical analysis demonstrated significant positive relationships between community awareness, adoption of adaptation strategies, and flood risk reduction. Awareness and adoption jointly explained 56% of the variation in flood risk reduction outcomes. The study concludes that community awareness and adoption of climate adaptation measures significantly contribute to reducing flood risks. Strengthening climate education, institutional support, early warning systems, and community-based adaptation initiatives can enhance resilience and support Rwanda's climate adaptation and disaster risk reduction goals.

Keywords: Climate Adaptation; Community Awareness; Flood Risk Reduction; Climate Resilience; Rwanda

Greening Last-Mile Vaccine Delivery in Resource-Limited Settings: Acceptance of Drone-Based Vaccine Delivery and Associated Factors Among Healthcare Workers in Rwanda

Etienne NUMVIYUMUKIZA¹²³

¹ African School of Governance (ASG), Rwanda

² University of Rwanda (UR), Rwanda

³ University of Global Health Equity (UGHE), Rwanda

numviyumukizaetienne@gmail.com, +250 781 172 439

Abstract

Climate-resilient health systems require delivery models that maintain access to essential vaccines while reducing delays, transport burdens, and service disruptions in hard-to-reach settings. Drone-based delivery can support last-mile vaccine logistics, but implementation depends on acceptance by frontline healthcare workers. The study objective was to assess healthcare workers' acceptance of drone-based vaccine delivery and identify associated factors in hard-to-reach health posts in Rwanda. A cross-sectional analytical study was conducted among 104 healthcare workers, including Community Health Worker Supervisors and Nurses in Charge. Data were collected using a structured questionnaire and analyzed using descriptive statistics, bivariate tests, correlation analysis, and multiple linear regression. Acceptance was the primary outcome. Healthcare workers demonstrated high acceptance of drone-based vaccine delivery, with a mean score of 4.64/5 (95% CI: 4.56–4.72); 71.2% had high acceptance. Acceptance differed significantly by education level ($p=0.023$), but not by gender, role, or prior drone experience. Acceptance was positively correlated with perceived speed benefit ($r=0.72$), ease of use ($r=0.67$), environmental benefit ($r=0.52$), and leadership support ($r=0.49$), and negatively correlated with privacy risk ($r=-0.49$) and performance risk ($r=-0.34$). In adjusted regression, speed benefit ($\beta=0.481$, $p<0.001$) and ease of use ($\beta=0.409$, $p<0.001$) were positively associated with acceptance, while privacy risk was negatively associated ($\beta=-0.165$, $p=0.022$). The model explained 67.9% of acceptance variance. Drone-based vaccine delivery was highly accepted by healthcare workers in Rwanda's hard-to-reach health posts. Implementation should emphasize speed, ease of use, privacy safeguards, and operational confidence to support climate-smart last-mile vaccine delivery.

Keywords: Drone vaccine delivery; climate-smart health systems; last-mile delivery; healthcare worker acceptance; Rwanda

Growth and Biomass Responses to Warming in Afrotropical Native Trees

Etienne Zibera (*University of Rwanda & University of Gothenburg*), Donat Nsabimana (*University of Rwanda*), Lasse Tarvainen (*University of Gothenburg, Sweden*), Johan Uddling Fredin (*University of Gothenburg, Sweden*), Göran Wallin (*University of Gothenburg, Sweden*)

CA: ziberaetienne@gmail.com, +250780863333

Abstract

Nyungwe Forest, where *Macaranga kilimandscharica* (Mki) and *Syzygium guineense* (Sgu), together comprise 18% of tree individuals, exemplifies tropical montane ecosystems highly threatened by global warming. This study assessed warming effects on growth performance, and biomass production of *Macaranga kilimandscharica* (pioneer) and *Syzygium guineense* (late successional), dominant species in Nyungwe Forest. A mixed-species experimental plots were established across three sites along a ~6 °C warming gradient in Rwanda (Sigira_cool, Rubona_midlle warm, Makera_warmest). After 4.5 years, biomass harvest and tree size measurements of individual stems were conducted. Sgu maintained consistently high survival (94–100%) across all sites, demonstrating resilience to environmental stress, while Mki survival dropped sharply to 16.7% at the warmest site, highlighting its vulnerability to warming. Species showed different allometric responses: Mki experienced moderate declines in height (25%) and stronger reductions in DBH (58%) and base diameter (59%), whereas Sgu exhibited larger reductions in DBH (51%) and D5 (52%) but a 26% decline in height. Mki suffers uniform severe declines (77%) at both warmer sites, confirming its vulnerability while Sgu shows resilience at Rubona but collapses at Makera (75%), highlighting tolerance to moderate warming but vulnerability under extremes. Warming and drought strongly constrain Afromontane tree growth, with pioneer species more vulnerable than late-successional species. These findings support climate-smart restoration, species selection, and adaptive forest management in Rwanda's montane ecosystems.

Keywords: warming, native tree species, biomass production, restoration

Community Willingness to Participate in Innovative Ecosystem-Based Adaptation to Climate Change: Evidence from a Butterfly Farming Project in the Ibanda-Makera Forest, Eastern Rwanda

¹Dorine Intwarinkase Mutaganzwa

^{1,2}Jean de Dieu Uwizelimana (*University of Rwanda, CoEB Rwanda*)

¹Andrew Stainback (*CoEB Rwanda*)

¹Center for Environment and Natural Resources Management (*CoEB*)

²University of Rwanda

CA: intwarinkase.mutaganzwa@gmail.com / +250788899954

Abstract

Rwanda's smallholder farming communities face increasing climate vulnerability yet often lack the resources to implement conventional climate adaptation measures. Ecosystem-based adaptation (EbA) offers a more accessible alternative, and butterfly farming has emerged as a promising EbA strategy linking household income directly to forest conservation. This study examines the feasibility of an EbA butterfly farming project among communities surrounding Ibanda-Makera Forest, Kirehe District, Eastern Rwanda. The study aimed to assess the willingness of local communities surrounding the Ibanda-Makera Forest to participate in an EbA butterfly farming project, and to identify the underlying factors shaping that willingness. A mixed-methods design combined two focus group discussions with a semi-structured survey of 96 smallholder farmers, selected through a two-stage purposive and random sampling strategy. Quantitative data were analyzed using descriptive statistics and chi-square tests; qualitative data were analyzed thematically and triangulated with survey findings. Communities showed strong cultural and practical ties to the forest, alongside broad pro-conservation attitudes despite ongoing human-wildlife conflict. Though new to most participants, butterfly farming was welcomed with optimism, with most anticipating benefits for income, conservation, and enjoyment. Willingness to participate was driven by forest attachment, intrinsic interest, and the project's no-land-cost design. These findings demonstrate strong community readiness for an EbA butterfly farming project, offering a low-cost, community-led model that advances both biodiversity conservation and livelihood diversification. The study underscores the value of evidence-based, community-centered project design and offers a replicable approach for integrating EbA into Rwanda's climate adaptation agenda.

Keywords: Ecosystem-based adaptation, butterfly farming, community participation, climate change, Rwanda

Landslide-induced Displacement and Relocation Strategies in Rutsiro District, Western Rwanda.

Gaspard Rwanyiziri¹, Marie Alice Mukeshimana¹ & Mucyo Ndera Tuyizere²

¹*Department of Spatial Planning, School of Architecture and Built Environment, College of Science and Technology, University of Rwanda, P. O. Box 3900, Kigali, Rwanda;* ²*Vumbuzi Impact Africa Foundation, P. O. Box 6583, Kigali, Rwanda*

CA: Gaspard Rwanyirizi, grwanyiziri@gmail.com, +250788681438

Abstract

Climate change increasingly drives human displacement by intensifying climate-induced disasters around the world. In Rwanda's high-altitude regions, especially in the Northern and Western provinces, high rainfall patterns exacerbate landslide risks forcing communities to relocate from high-risk areas to safe places. This study focuses on Rutsiro district in the Western Rwanda, which receives intense rainfall on fragile landscape. It used mixed methods and techniques of collecting data (both qualitative and quantitative) including field observations, household surveys, and interviews. Collected data were analyzed thematically and quantitatively by using appropriate tools including geospatial technology.

Research findings showed that Rutsiro District is highly vulnerable to landslides, especially in Murunda and Mushubati sectors where slopes are very steep. This situation is exacerbated by unpredictable rainfall patterns and increasing temperatures. The study has also revealed that, beyond human and economic losses, some people were displaced due to the destruction of their homes and/or farmlands. In fact, 43.5% of them lost their crops and 25% lost their homes. Consequently, 23.7% of them were directly displaced from their home places. In terms of destination choices, most displaced people choose areas which are safe in terms of physical, socioeconomic and environmental safety. By using geospatial technology, the study recommended two suitable sites for future relocation plans in the study area. The recommended class 1 (highly suitable) has land availability, slope stability, good drainage, and access to public services (roads, health and education facilities); while the second class (suitable) remains a secondary relocation option where large contiguous land parcels are available.

Keywords: Landslide, Vulnerability, Displacement, Relocation, Rutsiro District

Optimizing stem cutting propagation of *Myrianthus holstii* for climate-resilient agroforestry

Gaudence Nishimwe^a, A. Sigrun Dahlin^b, Fidèle Niyitang^c, and Suzana Augustino^d

^aDepartment of agricultural engineering, Rwanda Polytechnic- Musanze College, Rwanda ^bDepartment of Crop Production Ecology, Swedish University of Agricultural Sciences (SLU) Uppsala, Sweden

^cDepartment of Rural Development and Agricultural Economics, University of Rwanda (UR), Musanze, Rwanda

^dThe Nelson Mandela African Institution of Science and Technology (NM-AIST), Arusha, Tanzania

CA: nigoshi121@yahoo.fr, +250785047365

Abstract

Myrianthus holstii is an underutilized indigenous multipurpose fruit tree with potential to enhance climate-resilient agroforestry, biodiversity conservation, and food security in Sub-Saharan Africa. However, its domestication is constrained by limited availability of quality planting materials due to poor natural regeneration and inadequate propagation techniques. The objective of the study was to optimize stem cutting propagation of *Myrianthus holstii* using appropriate rooting media and Indole-3-butyric acid (IBA) concentrations to develop an efficient propagation protocol for climate-resilient agroforestry. This study evaluated the effects of rooting media and Indole-3-butyric acid concentrations on the vegetative propagation of *M. holstii* stem cuttings under a non-misting propagator. A Completely Randomized Design was employed using three rooting media (sawdust with sand, sand, and forest soil) and three IBA treatments (0.6% w/w, 0.4% w/w, and a water-treated control). A total of 270 stem cuttings were established, and data on survival, callus formation, root and shoot development were analyzed using analysis of variance, with Tukey's test for mean separation at $P < 0.05$. Rooting media and IBA concentration significantly influenced all propagation parameters ($P < 0.05$). Stem cuttings treated with 0.6% w/w IBA and propagated in sawdust with sand achieved the highest propagation success, recording 76.7% survival, 63.3% callus formation, 56.7% rooting, and 86.7% shoot development. The combination of sawdust + sand and 0.6% (w/w) IBA proved to be the most effective propagation protocol for *Myrianthus holstii*, significantly enhancing survival, rooting, and shoot development. Promoting this low-cost technique can accelerate domestication of the species, increase the availability of quality planting materials, and support climate-smart agriculture, agroforestry expansion, biodiversity conservation, and sustainable food security initiatives.

Keywords: Climate smart agriculture, *Myrianthus holstii*, rooting media, stem cuttings, vegetative propagation

Financing Africa's Net-Zero Transition: A Systematic Review and Integrated Framework of Climate Finance, Green Bonds, and Carbon Markets

Jeannette Mukangango

AIMS Research & Innovation Center, Kigali, Rwanda

jmukangango@aimsric.org

Abstract

Africa's transition towards net-zero and climate-resilient development requires substantial investment across multiple sectors. This is particularly important for agriculture and food systems, where climate-resilient investment is critical to strengthening food security and livelihoods. Yet climate finance remains insufficient and unevenly distributed across countries, sectors and climate objectives. Although green bonds, carbon markets, concessional finance and blended finance provide additional financing channels, less attention has been given to how financial barriers, institutional conditions and financing mechanisms interact within the wider climate finance system. This study examined these relationships through systematic review. Evidence extraction and thematic synthesis were complemented by knowledge graph analysis to examine relationships among financing constraints, institutions, financial mechanisms, investment processes and climate outcomes. Soft Systems Methodology (SSM) was used to structure the wider problem situation, while Financial Integration Theory (FIT) provided a lens for interpreting financial segmentation and connectivity. The findings show that Africa's climate finance challenge extends beyond the availability of capital. High financing costs, risk exposure, limited market access, institutional capacity constraints, information gaps and weak project readiness shape whether finance can effectively connect with climate investment opportunities. Concessional capital, guarantees, blended finance, development finance intermediation and green bonds can address constraints, but their contribution to financial connectivity depends on the context in which they operate. Article 6 also presents potential cooperation and financing pathways whose financial implications depend on governance, accounting, institutional capability and market integrity. Integrating SSM and FIT, the study develops a conceptual framework that distinguishes financial availability from effective connectivity and positions financial integration as an intermediate property of the climate finance system. These findings have important implications for financing climate-resilient agricultural transformation in Africa. Strengthening agricultural resilience and food security requires not only mobilizing climate finance but also improving the institutional and financial conditions that enable capital to reach viable climate-resilient investments.

Assessing the Role of Agroforestry in Landscape Restoration for Building Climate Resilient Livelihoods in Rwanda: Case Study of Rutsiro District, Western Rwanda.

Joel Ndayisaba¹, Aime Tsinda², Gaspard Rwanyiziri²

¹Albertine Rift Conservation Society (ARCOS), P. O. Box 1735, Kigali, Rwanda;

²Department of Spatial Planning, School of Architecture and Built Environment, College of Science and Technology, University of Rwanda, P. O. Box 3900, Kigali, Rwanda.

CA: joelindayisaba@gmail.com & +250781288579

Abstract

Land degradation and household vulnerability to climate variability remain major challenges in Rwanda's highland regions, where steep slopes, high population density, and unsustainable land use contribute to soil erosion and declining agricultural productivity. This study assessed the role of agroforestry in restoring degraded landscapes and enhancing climate-resilient livelihoods in Rutsiro District, Western Rwanda. It used mixed-methods and techniques of collecting data (both qualitative and quantitative) including household surveys, field observations and interviews. Collected data were analyzed by using appropriate tools including geospatial technology, and the Catchment Restoration and Opportunity Mapping Decision Support System (CROM-DSS). The findings indicated that declining soil fertility, changes in soil colour, and loss of topsoil were the most perceived indicators of land degradation, while drought, erratic rainfall, and dependence on climate-sensitive agriculture were identified as the main sources of household vulnerability. After a long period of agroforestry campaign, land use/land cover analysis showed notable landscape improvement (between 2010 and 2025) with an increase of forest cover by 49.6% (2,789.51 to 4,173.09 ha) and a decrease of degraded lands by 32.9% (from 5,781.03 to 3,876.10 ha). Nevertheless, more than 95% of the study area remained within high or very high soil erosion susceptibility classes. The CROM-DSS identified agroforestry as the most suitable restoration intervention (4,517.18 ha; 29.18%), followed by contour bank terraces (3,495.35 ha; 22.58%). The study concludes that agroforestry is a key strategy for restoring degraded landscapes and strengthening climate-resilient livelihoods, but wider adoption requires improved access to quality planting materials, financial support, secure land tenure, and strengthened agricultural extension services.

Keywords: Land degradation, agroforestry, landscape restoration, climate-resilient livelihood, Rutsiro District

Planning Irrigation Electrification and its Impact on Electric System

Pierre Damien Uwitije^{1,2}, Jimmy Ehnberg¹, J.M.V. Bikorimana², Umutoniwase Ernestine³

¹*Department of Electrical Engineering, Chalmers University of Technology, Sweden*

²*School of Engineering, College of Science and Technology, University of Rwanda, Rwanda*

³*Unipod Rwanda, College of Science and Technology, University of Rwanda, Rwanda*

CA: uwitije@chalmers.se / Tel: +250784102238

Abstract

Irrigation expansion is essential for improving agricultural productivity and food security, yet its electricity-system implications remain insufficiently represented in infrastructure planning. Irrigation is commonly treated either as a farm-scale sizing problem or as exogenous electricity demand, obscuring the synergies and constraints that emerge across food and energy systems. This study develops a planning framework to determine where irrigation becomes electricity-system relevant, when pumping demand becomes compatible with grid operation, and how storage, on-farm solar generation, and electricity-export rules reshape system outcomes. A five-stage methodology links local solar-powered irrigation mechanisms, geospatial demand formation, hourly pumping profiles, power-system dispatch, and solar-storage pathways. Cropland, surface-water access, terrain-conditioned lift, and irrigation planning envelopes are combined to form electricity demand. Alternative service configurations (morning and evening pumping, coordinated daytime pumping, grid-charged water storage, and photovoltaic-assisted storage) are evaluated using dispatch feasibility, system cost, grid imports, unmet irrigation service, photovoltaic exports, storage duration, charging limits, and feed-in-tariff arrangements. The results show that irrigation is an irrigation-electricity system-shaping load rather than an end-use fixed electricity demand. Moderate demand can become infeasible when concentrated during peak-coincident pumping windows, while coordinated scheduling and storage buffering can restore feasibility without reducing irrigation service. Storage shifts constraints toward charging capacity and reliability. Larger photovoltaic deployment creates structural surplus whose system value depends on export arrangements. The framework bridges irrigation engineering and national electricity planning. It shows that irrigation can support food production while creating opportunities for demand coordination, solar integration, storage flexibility, and informed joint land–water–energy–tariff planning in Rwanda.

Keywords: irrigation planning; food–energy systems; demand formation; solar irrigation

Mid-Season Machine Learning Prediction of End-of-Season Water Requirement Satisfaction Index (WRSI) for Maize in Kirehe District, Rwanda (Season B, 2001–2023)

Pierre NDORIMANA

Department of Spatial Planning, University of Rwanda, Rwanda

pierrendorimana16@gmail.com / +250798790115

Abstract

Kirehe District, Eastern Rwanda, faces a greater than 30% probability of severe Season B drought (WRSI below 70% of the long-term median), reaching 42% in the worst-affected areas. The Rwanda National Risk Atlas WRSI record stops in 2013–2014, and the only mid-season alternative, Extended WRSI, overestimates end-of-season WRSI by 2–23% in East Africa, masking severe crop failure until after harvest. To develop and validate a machine learning model that predicts End-of-Season WRSI drought severity class for Season B maize in Kirehe District using mid-season climate and satellite inputs, providing operationally actionable early warning at least six weeks before harvest. EOS-WRSI was recomputed for Kirehe for 2001–2023 using GeoWRSI, CHIRPS rainfall, and ERA5-Land evapotranspiration, producing a 158,920-observation pixel-level dataset. A 500-tree Random Forest classifier was trained on 16 raw and year-relative features (rainfall, soil moisture, NDVI, VCI, land surface temperature) available by dekad 8, evaluated via leave-one-year-out cross-validation, interpreted with SHAP, and tested in a rolling-horizon experiment at dekads 4, 6, and 8. The model achieved $F1 = 0.661$, $AUC-ROC = 0.853$, and drought recall = 0.719 at dekad 8, with comparable skill ($AUC = 0.846$, recall = 0.754) already evident at dekad 6, an eight-week lead time. Year-relative soil moisture (SM_D8_rel, SM_D4_rel) emerged as the dominant predictors, outperforming rainfall-based variables. This is the first district-scale machine learning mid-season WRSI prediction system developed in Rwanda, offering MINEMA and district planners a 6–8-week early warning tool for irrigation support, input distribution, and contingency planning, and a replicable method for extending the National Risk Atlas to other drought-prone districts.

Keywords: Drought early warning; WRSI; Random Forest; soil moisture; Rwanda

Can Africa's Bioeconomy Remain Sustainable Under Climate Change? Evidence from Emerging Bioeconomy Initiatives in East Africa

Rael Teresa Adhiambo¹ and Fortunate Muyambi²

¹*National Commission for Science, Technology and Innovation (NACOSTI), Kenya*

²*East African Commission for Science and Technology (EASTECO), Rwanda*

CA: rael.adhiambo@nacosti.go.ke

Abstract

The bioeconomy is increasingly recognized as a strategic pathway for sustainable development, enabling countries to utilize renewable biological resources to enhance food security, industrial development, environmental sustainability, and green economic growth. In East Africa, countries such as Rwanda, Kenya, and Uganda have initiated bioeconomy strategies and policy frameworks to harness biological resources for socioeconomic transformation. However, these ambitions depend on resilient ecosystems that are increasingly threatened by climate change through altered rainfall patterns, biodiversity loss, droughts, floods, and declining ecosystem productivity. Despite the close relationship between climate resilience and bioeconomy, limited attention has been given to how climate change may undermine the sustainability of emerging bioeconomy pathways. The objective was to critically examine how climate change may influence the sustainability of emerging bioeconomy initiatives in East Africa and identify key climate risks, knowledge gaps, and policy priorities for developing climate-resilient bioeconomies. The study employs a critical narrative review of peer-reviewed literature, regional policy documents, and national bioeconomy strategies from East Africa, including Rwanda, Kenya, and Uganda. The review synthesizes evidence on climate impacts across major bioeconomy sectors, including agriculture, forestry, fisheries, and biodiversity, and evaluates the extent to which climate risk and adaptation are integrated into current bioeconomy planning. The review found that although emerging bioeconomy strategies in East Africa consistently emphasize sustainability, innovation, and green economic growth, the integration of climate risk into bioeconomy planning remains uneven across countries and sectors. Existing policy frameworks generally acknowledge climate change as a cross-cutting challenge but provide limited guidance on assessing climate-related risks to the biological resources that underpin agriculture, fisheries, forestry, and other bio-based industries. The synthesis further highlights that climate-induced changes in ecosystem productivity, biodiversity, and natural resource availability have significant implications for bioeconomy value chains, with potential consequences for food security, livelihoods, and economic resilience. Common gaps identified include limited integration of climate risk assessments, inadequate consideration of ecosystem resilience, and weak linkages between climate adaptation and bioeconomy implementation. The review demonstrates that climate resilience is fundamental to the long-term sustainability of Africa's emerging bioeconomy. Integrating climate risk assessments, ecosystem resilience, and adaptation measures into bioeconomy policies and investment decisions will be essential for safeguarding biological resources and sustaining bio-based value chains. The findings provide evidence to inform the development and implementation of climate-resilient bioeconomy strategies in Rwanda, East Africa, and across the continent.

Keywords: Bioeconomy, Climate Change, Climate Resilience, East Africa, Climate Adaptation

Microclimatic Drivers of Malaria Vector Distribution and Transmission in Ghana: Implications for Climate-Informed Disease Surveillance and Control

Shadrack Amankwah¹, Kingsley Badu¹

¹Department of Biological Sciences, School of Sciences, University of Energy and Natural Resources (UENR), Sunyani, Ghana

CA: shadrackamankwah101@gmail.com / +233256883306

Abstract

Climate variability significantly influences the ecology and transmission dynamics of vector-borne diseases, particularly malaria. Despite substantial malaria control efforts in Ghana, transmission remains high in the Western North Region. Understanding how microclimatic conditions shape vector abundance and infection patterns is essential for developing climate-informed surveillance and targeted interventions. The study is relevant to Rwanda and other African countries seeking to strengthen climate-resilient health systems and evidence-based strategies for managing climate-sensitive diseases. This study aims to characterize members of the *Anopheles gambiae* complex across agricultural and residential land-use types and determine the influence of environmental factors on vector abundance and malaria transmission dynamics. A total of 569 adult female mosquitoes were collected from agricultural and residential communities using CDC light traps, BG-Sentinel 2 traps, and human landing catches. Morphological identification was followed by species-specific polymerase chain reaction (PCR) and nested PCR targeting the 18S rRNA gene to identify sibling species and detect *Plasmodium falciparum* sporozoites. Generalized Linear Models and Logistic Regression Models were used to evaluate the effects of environmental variables on mosquito abundance and infection probability. *Anopheles coluzzii* constituted 98.8% of the *Anopheles gambiae* complex, while *Anopheles gambiae* sensu stricto represented 1.2%. *Plasmodium falciparum* infection was detected in 23.6% of mosquitoes, indicating active transmission. Relative humidity significantly increased infection probability ($\beta = 0.2562$, $p < 0.001$), whereas residential areas exhibited significantly higher mosquito abundance ($\beta = 3.505$, $p < 0.001$). Entomological inoculation rates ranged from 2.33 to 20.25 infective bites per person per night. The findings demonstrate that microclimatic factors, particularly humidity, are important determinants of malaria transmission dynamics. Integrating molecular diagnostics with environmental and spatial surveillance can strengthen climate-informed vector monitoring and support precision malaria interventions. Such approaches can improve climate-resilient public health planning and guide evidence-based adaptation strategies for malaria control across Africa.

Keywords: Malaria; Climate Change; Vector Ecology; *Anopheles coluzzii*; Environmental Surveillance

Impact of social economic factor to the adoption of liquefied petroleum gas among households in the city of kigali - kimironko and bumbogo sectors

Sylvain NDAGIJIMANA, Prof Ediagbonya Faraday Thompson

University of Lay Adventists of Kigali

CA: sylvaindagije@gmail.com / +250786448538

Abstract

Access to clean cooking energy remains a critical challenge for sustainable development in urban Rwanda. This study examined the impact of socio-economic factors on the adoption of Liquefied Petroleum Gas (LPG) among households in Kimironko and Bumbogo sectors of Kigali City. A mixed-method cross-sectional design was employed, combining structured household surveys with key informant interviews and focus group discussions. Primary data were collected from 787 households selected through multi-stage sampling. Descriptive statistics, chi-square tests, and binary logistic regression were used to analyze the data. Results indicate that 62.2 percent of households use LPG for cooking, reflecting moderate progress alongside persistent barriers to universal adoption. Income and education emerged as the strongest positive predictors of LPG adoption, with each incremental increase in income category raising the odds of adoption by a factor of 2.33 ($p < 0.001$) and higher education increasing odds by 1.86 ($p < 0.001$). Household size demonstrated a significant negative association ($\text{Exp}(B) = 0.81$, $p = 0.003$), suggesting larger families face distinct economic and practical constraints. Access to electricity also correlated positively with LPG use, indicating the role of broader infrastructure in enabling clean energy transitions. The study further documented widespread fuel stacking behavior, where households combine LPG with traditional biomass rather than fully transitioning. These findings underscore that LPG adoption is shaped by a complex interplay of economic capacity, human capital, household demographics, and infrastructural access. The study recommends targeted subsidies, flexible financing mechanisms, expanded distribution networks, and context-specific awareness campaigns to accelerate sustained LPG adoption.

Keywords: LPG adoption, socio-economic factors, clean cooking, household energy transition, Kigali Rwanda

**Potato tuber moth (*Phthorimaea operculella* (Lepidoptera: Gelechiidae)
farmers' perception and seasonal occurrence in Burera and Rutsiro districts of
Rwanda**

Uwiringiyimana Thacienne^{1*}, Ndereyimana Assinapol², Bigirimana Vincent de Paul¹, Bizoza Runezerwa Alfred⁴

¹University of Rwanda, College of Agriculture, Forestry and Food Science,
Department of Crop Sciences, P.O. Box 210, Musanze, Rwanda

²Rwanda Agriculture and Animal Resources Development Board, Horticulture
Program, P.O. Box 516, Kigali, Rwanda

³University of Rwanda, College of Agriculture, Forestry and Food Science,
Department of Agricultural Economics and Rural Development, P.O. Box 210,
Musanze, Rwanda

CA: thacienne20@yahoo.fr / +250788694380

Abstract

Potato tuber moth is a worldwide pest from the Andean regions of South America. Farmers' knowledge of potato tuber moth management, related constraints, and documentation on seasonal occurrences are very fundamental. Potato moth reduces potato yield in the field and in storage. However, there was a shortage of information on farmers' knowledge and the seasonal occurrence of potato moth in Burera and Rutsiro districts of Rwanda. Such awareness is useful for designing suitable interventions and successful integrated management approaches. Farmers were interviewed from April to June 2023. Thirty potato farms in each district were evaluated over three consecutive seasons from 2023 to 2024. In each field, five quadrats of 2 x 2m and an "X" shaped transect were used, and data were collected from 25 plants randomly selected. The reported major constraints to potato production were inaccessibility to credits (58.8 %, 53.9 % of respondents), pests and diseases (55.9 %, 49 % of respondents), and limited access to pesticides and fertilizers (43.1%, 45.1% of respondents) in Burera and Rutsiro, respectively. Moreover, pesticides were the major control method, and 69.6% of respondents applied a mixture of pesticides. Reported moth symptoms are leaf mine (38.2%) and white larvae in storage (8.8%). Significant differences (<.0001) in moth occurrence were across seasons and between districts. High occurrence was in Burera (0.30 mean) and in Season C (0.27 mean) due to high temperatures promoting the moth population. PTM management should be done by growing potatoes in season A, using clean tubers, and adopting Integrated Management approaches.

Keywords: *Solanum tuberosum*, participatory technology, *Phthorimaea operculalle*, seasonal occurrence, Rwanda

Fluorinated Greenhouse Gases and Climate Change: A Critical Review of Emissions, Impacts, and Regulatory Gaps

Thompson Faraday Edigabonya

*Faculty of Environmental Studies, University of Lay Adventists Kigali, Kigali,
Rwanda*

thompson.faraday@unilak.ac.rw / +250 7953 53090

Abstract

While carbon dioxide (CO₂) remains the dominant focus of global climate policy, fluorinated greenhouse gases (F-gases), including hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆), pose a significant yet often underestimated threat because of their exceptionally high global warming potentials and prolonged atmospheric lifetimes. Increasing industrialization, expanding refrigeration demand, and inadequate regulatory attention have accelerated F-gas emissions, highlighting the need for a broader climate mitigation framework. This review critically evaluates the comparative climate impacts of CO₂ and fluorinated greenhouse gases by examining their physical properties, emission sources, atmospheric behavior, regulatory frameworks, monitoring systems, technological mitigation options, and existing policy gaps. The study further explores opportunities for integrating F-gas management into global climate governance. A structured narrative review was conducted using peer-reviewed literature, technical reports, and international policy documents published between 2000 and 2023. The literature was sourced from major scientific databases and authoritative organizations, including the IPCC, UNEP, USEPA, European Environment Agency, and Montreal Protocol Secretariat. Publications were systematically screened using predefined inclusion criteria and synthesized through thematic analysis focusing on emissions, climate impacts, policy effectiveness, technological innovations, and monitoring challenges. The review demonstrates that although F-gases contribute a smaller proportion of total greenhouse gas emissions than CO₂, their global warming potentials are hundreds to tens of thousands of times greater, while atmospheric lifetimes range from decades to several millennia. Current international climate policies remain predominantly CO₂-centered, resulting in fragmented regulation, weak monitoring systems, inconsistent reporting, and inadequate inclusion of F-gases in many national climate strategies. Emerging low-global-warming-potential refrigerants, improved recovery technologies, stronger monitoring systems, and enhanced policy coordination present viable pathways for reducing F-gas emissions. Achieving long-term climate goals requires integrating fluorinated greenhouse gases into mainstream climate policy alongside CO₂ mitigation. Strengthening monitoring and reporting systems, expanding Nationally Determined Contributions to include explicit F-gas targets, accelerating the transition to low-GWP alternatives, and harmonizing international regulations will substantially improve global climate mitigation efforts. This review provides evidence-based recommendations to support policymakers, researchers, and environmental practitioners in developing comprehensive greenhouse gas management strategies capable of addressing both conventional and emerging climate threats.

Keywords: Fluorinated greenhouse gases; Climate change; Global warming potential; Climate policy; Greenhouse gas mitigation; Hydrofluorocarbons; Environmental sustainability

Risk Assessment and Seasonal Variation of Greenhouse Gases in Agricultural Farmland in Nigeria

^{1,2}Thompson Faraday Edigbonya, ¹Ilemobayo Ifedayo Oguntimehin

¹ *Department of Chemical Sciences, Olusegun Agagu University of Science and Technology, Okitipupa, Ondo State, Nigeria*

² *Faculty of Environmental Studies, University of Lay Adventists of Kigali, Kigali, Rwanda*

CA: thompson.faraday@unilak.ac.rw +2348086809323, +250795353090

Abstract

Agricultural activities are significant sources of greenhouse gas emissions, which contribute to climate change and pose potential health risks to farm workers. While studies exist in Nigeria, comparative insights are vital for Rwanda to inform climate-smart agriculture and occupational health adaptation strategies in similar agro-ecological zones. This study aims to assess the atmospheric concentrations of carbon dioxide and methane across agricultural farmlands and evaluate their potential non-carcinogenic health risks in relation to meteorological parameters. Measurements of carbon dioxide and methane were conducted using a calibrated multi-gas detector across six locations during both wet and dry seasons. Health risk assessments were performed using the hazard quotient and total hazard quotient indices based on United States Environmental Protection Agency guidelines. Seasonal variation revealed lower mean concentrations of both gases during the wet season compared to the dry season. The average hazard quotient for carbon dioxide was 0.905, exceeding the threshold of 1 only at the rice farm in Ogbese. The total hazard quotient exceeded 1 at the rice farm and the cattle farm in Ondo City, indicating localized potential health concerns for combined exposure. The findings highlight the critical need for site-specific air quality assessments and continuous monitoring of greenhouse gas exposure in agricultural environments. These results provide actionable data for developing climate-smart agricultural policies and occupational health guidelines to protect farming communities and mitigate emissions.

Keywords: Greenhouse gases, Health risk assessment, Seasonal variation, Agricultural emissions, Climate-smart agriculture

A Predictive Climate Model for Africa Capable of Identifying Precise Extreme Event Periods, Recommending Adapted Crops and Generating Targeted Institutional Alerts

Valère Mazoya

Founder & Principal Researcher — AgriPredict5, Burkina Faso, West Africa

niyomazav@gmail.com

Abstract

Africa accounts for less than 4% of global greenhouse gas emissions yet bears a disproportionate share of climate change impacts. Despite IPCC AR6 projections indicating accelerating thermal anomalies and precipitation disruptions through 2030, institutional actors, agricultural banks, ministries, cooperatives and development organizations, continue making critical decisions without tools capable of translating climate projections into precise, actionable intelligence. This study develops and validates a predictive model capable of: (1) identifying the precise temporal period of onset, peak and decline of extreme climate events across 20 African countries; (2) generating adapted crop recommendations based on predicted climate conditions; and (3) producing differentiated operational alerts for competent institutions without requiring prior climate expertise. The model employs a Quantum-enhanced Machine Learning pipeline trained on over 30 years of consolidated African field data. A supervised ensemble with a quantum optimization layer for temporal precision is calibrated against three IPCC AR6 scenarios (SSP2-4.5, SSP3-7.0, SSP5-8.5) across seven climatic zones and 20 countries. Five-fold cross-validation yields $R^2 > 0.87$. Preliminary results indicate a mean thermal anomaly of $+1.2^{\circ}\text{C}$ by 2030 for Sahelian countries under SSP3, with cumulative severe drought probability reaching 88–95% over 2026–2030. The model identifies precise event periods, recommends adapted crops by season and generates institution-specific alerts for five actor types. AgriPredict5 is the first African system to operationally link climate prediction, crop recommendation and differentiated institutional alerting in a single engine, with direct implications for agricultural credit risk, national food planning, humanitarian preparedness and climate resilience across Africa.

Keywords: Climate change Africa, extreme event prediction, crop recommendation, institutional alerts, Quantum ML, Sahel, food security, IPCC AR6

Integrated Radiative Index for the Sahel (IRIS): A Multivariate Satellite-Based Framework for Monitoring Hydroclimatic Variability

Younousse BIAYE¹, El Hadji DEME^{1,2}, Bouya DIOP¹

¹Laboratory of Atmospheric and Ocean Sciences, Materials, Energy and Devices (LSAO-MED), Unit of Applied Sciences and Technology (UFR SAT), Gaston Berger University, BP 234, Saint-Louis, Senegal.

²Laboratory for Studies and Research in Statistics and Development (LERSTAD), Unit of Applied Sciences and Technology (UFR SAT), Gaston Berger University, BP 234, Saint-Louis, Senegal.

CA: biaye.cherifyunus@gmail.com / biaye.younousse@ugb.edu.sn

Abstract

The Sahel is one of the world's most climate-sensitive regions, where recurrent droughts, extreme rainfall events, and strong interannual variability threaten ecosystems, food security, and socio-economic resilience. Despite substantial advances in satellite observations and numerical climate modeling, accurately representing the coupled interactions among land surface processes, atmospheric dynamics, moisture transport, and radiative forcing remains a major scientific challenge. Most existing climate indicators rely on a limited number of variables and therefore inadequately capture the multidimensional nature of Sahelian climate variability. This study presents the Integrated Radiative Index for the Sahel (IRIS), a novel physically based climate indicator designed to characterize the dominant state of the coupled land-atmosphere system. IRIS is derived from a Principal Component Analysis (PCA) applied to a multidimensional observational space combining passive microwave brightness temperatures (19–92 GHz), atmospheric temperature, relative humidity, and wind fields at the surface (2 m), 700 hPa, and 200 hPa over the 1992–2025 period. By integrating radiative, thermodynamic, and dynamical information into a single state variable, IRIS provides a physically interpretable representation of regional climate variability. The first principal component explains 72.1% of the total coupled variance, revealing a remarkably coherent dominant mode across the Sahel. The index objectively identifies three physically distinct hydroclimatic regimes corresponding to dry radiative conditions, transitional states, and deep convective environments. Spatial analyses demonstrate exceptional regional consistency, with explained variance remaining within $\pm 0.3\%$ across the western, central, and eastern Sahel. Independent validation confirms strong relationships with vegetation dynamics (NDVI, $r = 0.71$) and precipitation variability (GPCP, $r = -0.63$), supporting the physical robustness of the proposed framework. Beyond climate diagnosis, IRIS provides an operational framework for drought monitoring, seasonal monsoon assessment, and early detection of hydroclimatic regime transitions several weeks before conventional indicators. By bridging satellite microwave radiometry and atmospheric dynamics within a unified multivariate framework, IRIS offers a transferable methodology for climate monitoring in semi-arid environments and represents a promising contribution toward strengthening climate services, early warning systems, and climate adaptation strategies across Africa.

Keywords: Sahel; Climate Variability; Passive Microwave Remote Sensing; Principal Component Analysis; Land-Atmosphere Interactions; Hydroclimate; Drought Monitoring; West African Monsoon

Nature-Based Flood Adaptation Measures in Mpazi Sub-Catchment, City of Kigali, Rwanda

Tuyikunde Gloria Divine

Rwanda Young Water Professional (RYWP), Rwanda

divine.tuyikunde@gmail.com

Abstract

Rapid urbanization has intensified flood risk in the Mpazi sub-catchment, a densely settled 8.45 km² tributary of the Nyabugogo River in Kigali. Although flood management has largely relied on channel enlargement, nature-based solutions offer opportunities to complement grey infrastructure by reducing runoff and improving catchment resilience. This study conceptualized and assessed nature-based flood adaptation measures for Mpazi based on the catchment's hydrological behavior. Upstream inflows were estimated using a rainfall-runoff model, while flood maps were developed across the sub-catchment. Extreme rainfall events were derived by combining a Gumbel distribution with intensity-duration-frequency curves at sub-daily time steps. Input data included rainfall records from Gitega station for 1981–2019, digital terrain and channel-geometry information collected using GPS, and land, soil, and geological datasets. Proposed interventions included reforestation, green spaces, permeable paving, rainwater harvesting, conservation agriculture, bioretention basins, river buffer zones, flow-control structures, and drainage filters. Modelling showed that the Mpazi Upper Middle Unit generated the greatest runoff contribution, followed by the Upstream Unit. Combined nature-based measures reduced modelled discharge by almost 28 m³/s across the catchment, including approximately 20 m³/s attributed to rainwater harvesting and 8 m³/s to infrastructure-related measures. Flood simulations also identified overtopping near Avenue de Nyabugogo and highlighted the influence of the Mpazi–Nyabugogo confluence. The findings support integrated flood management combining nature-based and conventional infrastructure, alongside 5–10 m river buffers, refined LiDAR-based modelling, and further investigation of downstream flood origins. This approach can strengthen climate adaptation planning and guide practical, locally grounded investments for resilient urban drainage and flood-risk management.

Impacts of Landslide Disasters on Community Livelihoods in Rutsiro District Rwanda

Salim Kabano^{1*}; Thompson Faraday Ediagbonya¹; Christopher Mupenzi¹

¹*Faculty of Environmental Studies, University of Lay Adventists Kigali, Kigali, Rwanda*

CA: salimkabano5@gmail.com / +250788741580

Abstract

Landslides represent chronic geomorphological hazards that systematically compromise human safety, structural integrity, and ecological stability. In the Western Province of Rwanda, specifically within the Rutsiro District, high-frequency landslide events have resulted in significant population displacement and the destabilization of rural livelihoods. This study employed a mixed-methods research design, integrating qualitative thematic analysis with quantitative data derived from 400 household survey respondents, to evaluate the frequency, causality, and socio-economic ramifications of these events. The investigation examined primary geophysical and anthropogenic drivers including steep topographic gradients, high-intensity precipitation, deforestation, and unsustainable land-use practices alongside their resultant impacts on community health and economic resilience. Findings demonstrate a profound correlation between landslide activity and livelihood instability. Notably, the loss of farmland (72%) serves as a primary driver of food insecurity, while water source contamination (81%) exacerbates regional public health vulnerabilities. While the study recorded a high baseline of perceived community preparedness (98%), the functional efficacy of localized mitigation such as afforestation (63%) and bench terracing (18%) is frequently constrained by technical and maintenance deficiencies. Furthermore, despite a 97% reach in government outreach initiatives, a critical "support gap" persists, with 38% of affected households reporting a total lack of post-disaster assistance. These results underscore an urgent requirement for integrated disaster risk reduction (DRR) frameworks that prioritize sustainable land management, standardized community education, and synchronized institutional response mechanisms. Strengthening these pillars is essential for fostering long-term climate resilience and safeguarding vulnerable populations against escalating environmental threats.

Keywords: Landslides, Community Livelihoods, Geomorphological Hazards, Mitigation Efficacy, Disaster Impact, Coping Mechanisms, Food Security

Idiosyncratic effects of climate change on co-occurring threatened Afromontane damselflies

Samuel Thuita^{1*}, Anthony Karani¹

¹*School of Pure and Applied Sciences, University of Embu, Kenya*

CA: dhuita@gmail.com, +254728041274

Abstract

Damselflies (*Odonata: Zygoptera*) are sensitive bioindicators of freshwater ecosystem health, making them useful models for examining how shifting stream conditions threaten co-occurring species. Recent studies have shown that the Kenya Jewel (*Platycypha amboniensis* Martin 1915) and the Giant Sprite (*Pseudagrion bicoerulans* Martin 1908) inhabit the same montane forest streams but occupy contrasting microhabitats. We aimed to establish the variation in abundance of larval damselflies in wet and dry seasons in Mt. Kenya forest. We estimated the abundance using replicated counts in the wet and dry seasons. We further measured functional traits of larvae, environmental parameters, substrate availability and tested for associations using a generalized linear model. We found that, while the abundance of adults was not affected, the abundance of larvae differed significantly between seasons. We established that substrate availability and turbidity was associated with larval abundances, consistent with the expected effects of stream flow conditions in the dry season. These results show that habitat loss and altered stream flow linked to a changing climate threaten both species through distinct pathways tied to their microhabitat requirements. We recommend further studies using experimental manipulation of drying conditions to understand how these associations will affect species under future climate change.

Keywords: *Platycypha amboniensis*, *Pseudagrion bicoerulans*, Mount Kenya, climate change, Afromontane streams

The Role of Faith-Based Organizations in Tackling Food Loss and Waste in Rwanda: A Preliminary Study

S. Sanniti (*World Resources Institute, WRI*), Jules Kazungu (*Regional Research Centre for Integrated Development (RCID, Rwanda)*), C. Reddin (*WRI*), E. Ruzigamanzi (*WRI*), B. Lipinski (*WRI*), and J. Wangu (*WRI*)

CA: jules.kazungu@rcidcentre.com / +25078858922

Abstract

Rwanda loses approximately 40% of its food supply annually, a challenge that undermines food security, economic prosperity, and climate resilience. Faith-based organizations (FBOs) are integral to Rwandan society, managing 75% of the nation's schools and 30% of its health facilities, yet their potential role in addressing food loss and waste (FLW) remains largely underexplored. This study investigates the current and potential contributions of FBOs to FLW reduction in Rwanda, identifying key barriers and opportunities to align their activities with national food system sustainability goals. The research utilized a mixed-methods approach, comprising a desk review, a quantitative survey of 236 FBO representatives in Kigali and Rwamagana, 20 key informant interviews with government and private sector stakeholders, and two case studies involving a farmers' cooperative and a faith-based hotel. Findings reveal that while 83% of FBOs recognize FLW as a relevant problem, 94% lack formal reduction programs. The primary barriers to engagement include limited technical skills, lack of awareness, and a need for better understanding of food policy. However, FBOs possess unique mission-driven infrastructure and trusted networks that can facilitate community behavior change and improved post-harvest handling. Highlight FBOs can serve as powerful agents for food system transformation. The study recommends integrating FBOs into the national food systems agenda, enhancing their technical capacity, and establishing multifaith strategic advisory groups to bridge the gap between religious social missions and national sustainability targets.

Keywords: Faith-based organizations (FBOs), Food loss and waste (FLW), Food security, Rwanda, Sustainability

The Impact of Maize Farming Support on Food Security of T2DM Smallholder Farmers In Rural Rwanda

Desire Dushimimana^{1,2}, Vestine Mukandayisenga², Pacifique Hagenimana²,
Celestin Bigirimana¹, Eularie Mutamuliza¹, Jean d'Amour Manirere¹, Antoine
Karangwa¹

¹*University of Rwanda*

²*Partners in Health/Rwanda*

CA: ddushimimana4@gmail.com; d.dushimimana@ur.ac.rw +250788527135

Abstract

Food insecurity remains a persistent challenge among rural smallholder farmers, particularly those facing climate shocks, poverty, financial instability, and chronic diseases such as Type 2 Diabetes Mellitus (T2DM). This study assessed the impact of maize farming support on food security among smallholder farmers with T2DM in Kayonza and Kirehe districts, Rwanda. A sequential quasi-experimental design was used. T2DM patient records from Rwinkwavu and Kirehe district hospitals were screened to identify farmers, then linked with socio-economic programme records to determine maize farming support status. A standardized questionnaire was administered to 254 participants: 127 beneficiaries and 127 non-beneficiaries. Data covered food availability, access, and utilization. Descriptive statistics, Factorial Analysis for Mixed Data (FAMD), bivariate analysis, and binary logistic regression were conducted in RStudio. Among participants, 70.1% were female and 29.9% male. In Kayonza, 45% received maize farming support, compared with 55% in Kirehe. Mean age was 50.8 years among beneficiaries and 59.9 years among non-beneficiaries. For food access, 29.13% of supported participants were food secure compared with 55.9% of non-recipients. Age (OR=0.97; 95% CI: 0.95–0.99; p=0.004) and monthly clinical visits (OR=2.06; 95% CI: 1.12–3.91; p=0.02) were associated with food security.

The findings highlight the need to better integrate nutrition, healthcare, and livelihood support for smallholder farmers with T2DM, while informing agricultural and health policies responding to evolving rural socio-economic pressures in Rwanda.

Keywords: Livelihoods, Food Security, Smallholder Farmers, Type 2 Diabetes Mellitus, Maize Farming Support

N.B: ONGOING

An assessment of the role of climate-smart urban planning in reducing flood risks in Kigali city

Aline CYUZUZO

University of Rwanda, Rwanda

CA: cyuzuzoaline43@gmail.com / +250798204312

Abstract

Kigali City is increasingly exposed to recurrent flooding due to rapid urbanization, wetland encroachment, expansion of impervious surfaces, informal settlements, and inadequate stormwater management infrastructure. These challenges threaten urban resilience, public safety, and sustainable development. Despite Rwanda's commitment to climate adaptation and resilient urban development, limited empirical evidence exists on the effectiveness of climate-smart urban planning approaches in reducing flood risks within Kigali's rapidly growing urban environment. This study aims to assess the role of climate-smart urban planning in reducing flood risks and enhancing urban resilience in Kigali City. Specifically, it seeks to: (i) analyze land-use change patterns and their relationship with flood-prone areas; (ii) evaluate the effectiveness of existing urban planning policies and climate-responsive interventions; and (iii) identify climate-smart planning strategies with the greatest potential for flood risk reduction. The study employs a mixed-methods approach combining Geographic Information Systems (GIS) spatial analysis, policy document review, and key informant interviews with urban planners, environmental authorities, and community stakeholders. Spatial data are used to assess land-use change and flood exposure, while qualitative information provides insights into policy implementation and institutional coordination. Preliminary findings indicate that uncontrolled land-use change, wetland degradation, and fragmented institutional coordination significantly increase flood vulnerability in Kigali. The study further highlights the potential of green infrastructure, sustainable urban drainage systems (SUDS), and ecosystem-based wetland conservation to reduce flood risks and improve urban resilience when integrated into planning and land governance frameworks. The study provides evidence-based recommendations for integrating climate-smart planning into Kigali's urban development strategies. Findings will support policymakers, urban planners, and climate adaptation stakeholders in strengthening flood risk management, promoting sustainable urban growth, and advancing Rwanda's climate resilience objectives.

Keywords: Climate-smart urban planning; Flood risk reduction; Urban resilience; GIS; Wetland conservation

N.B: ONGOING

Development and Evaluation of a Prototype Climate-Soil Decision Support Tool for Beans Production in Karongi District

Benitus NIYOMPANO^{1*}, Tibebu Belete¹

¹*Rwanda Institute for Conservation Agriculture, Kagasa Rweru Rd, Off RN 15, Bugesera, Rwanda*

CA: benitusniyompano@gmail.com / +250 786046233

Abstract

Common bean (*Phaseolus vulgaris*), grown by approximately 92% of Rwandan households, is critical to national food security but highly vulnerable to climate variability in rain-fed farming systems. Despite the availability of climate and soil data, a gap persists between data generation and the delivery of localized, actionable advisory information, limiting climate-informed decision-making among farmers. The main objective of the study is to develop and evaluate a prototype Climate-Soil Decision Support Tool for common bean production in Karongi District, enabling extension agents and cooperative leaders to generate context-specific management recommendations. Historical climate data from Meteo Rwanda, soil information from the Rwanda Soil Information System (RwaSIS), and agronomic requirements from RAB and CIAT were integrated into an interactive dashboard using evidence-based decision rules. The prototype was evaluated through expert validation, and usability testing will be assessed on 10 selected participants experienced in bean production and advisory services, using structured assessments to test its accuracy, clarity, and usability. A prototype Decision Support Tool and accompanying user guide were successfully developed. The tool incorporates 20 evidence-based decision rules to generate recommendations on planting, weeding, and harvest timing under rain-fed conditions. Expert review validated 92% of the rules as scientifically sound and contextually appropriate. Based on the evaluation design, approximately 90% of participants are expected to correctly interpret the recommendations, while 90% and 85% are anticipated to rate the tool as useful and easy to use, respectively. This prototype demonstrates the feasibility of a low-cost, data-driven advisory system for smallholder bean production in Rwanda. Its framework provides a scalable model for delivering climate-informed recommendations, supporting Rwanda's climate-smart agriculture agenda and strengthening evidence-based advisory services in rain-fed farming systems.

Keywords: Decision support tool, climate-smart agriculture, common bean in Rwanda, smallholder advisory systems

N.B: ONGOING

Earth Observation-Based Causal Analysis of Soil Moisture Dynamics for Drought Monitoring in East Africa

Douanla Alotse Yaulande (*AIMS RIC*), Mouhamadou Bamba Sylla (*AIMS RIC*), Rob Parker (*University of Leicester (UoL)*), Cristina Ruiz Villena (*University of Leicester (UoL)*), Vicky Kondi Akara (*AIMS RIC*)

CA: yalotse@aimsric.org

Abstract

Understanding land-atmosphere interactions is essential for improving drought monitoring and climate prediction across East Africa. This study investigates depth-dependent precipitation-to-soil-moisture coupling using multiple Earth Observation datasets, including CHIRPS precipitation, ERA5-Land soil moisture, ESA Climate Change Initiative Soil Moisture, and MODIS vegetation indices. We integrate complementary causal inference methods-Granger causality, Convergent Cross Mapping (CCM), and Transfer Entropy-to distinguish linear, nonlinear, and directional relationships between precipitation and soil moisture across multiple depths. Results reveal a clear depth-dependent transition in coupling behavior. Linear causality strengthens with increasing soil depth, whereas nonlinear coupling weakens, indicating that shallow soils exhibit rapid state-dependent responses while deeper soils integrate precipitation over longer timescales. The strongest convergence of linear, nonlinear, and directional causal evidence occurs at approximately 100 cm depth, identifying the root zone as the dominant layer for precipitation-soil moisture feedback. Spatial analyses further show coherent coupling hotspots across semi-arid transition zones in East Africa. By combining multiple causal frameworks, this research demonstrates that reliance on a single statistical method can misrepresent hydroclimatic interactions. The proposed multi-method framework provides a more robust interpretation of land-atmosphere coupling while quantifying uncertainty through surrogate testing and spatial validation. These findings offer an observation-based benchmark for climate and hydrological models and support the development of improved drought monitoring and early warning systems across East Africa.

Keywords: Soil Moisture; Precipitation; Causal Inference, East Africa

N.B: ONGOING

Evaluating the Climate, Energy, and Urban Infrastructure Benefits of Shared Commuting: A Pilot Study in Kigali, Rwanda

François Régis Hirwa

College of Science and Technology, University of Rwanda, Rwanda

hirwa.regis@sdsnyouth.org / +250 781 568 385

Abstract

Rapid urbanization in Kigali has increased traffic congestion, fuel consumption, greenhouse gas emissions, and demand for parking infrastructure. Rising fuel costs continue to place pressure on households, students, and public institutions while contributing to transport-sector emissions. Shared mobility systems offer a potential pathway toward more climate-resilient and energy-efficient urban transport. However, limited local evidence exists on their effectiveness within the Rwandan context. This study aims to evaluate the potential of a synchronized shared-commuting model to reduce fuel consumption, greenhouse gas emissions, congestion, and parking demand while generating evidence to support sustainable urban transport policies in Kigali. The study utilizes the Green Commute Rwanda pilot initiative involving approximately 300 participants from the University of Rwanda – College of Science and Technology and the City of Kigali. Data collection includes commuter surveys, route mapping, parking occupancy assessments, fuel-use analysis, and GPS-based monitoring. Comparative analysis will assess mobility patterns before and during implementation of a peak-hour shared transport system operating on selected commuting corridors. Expected outcomes include reduced single-occupancy vehicle use, improved fuel efficiency per passenger, lower transport-related emissions, decreased parking demand, and enhanced commuter reliability. The study will also generate operational data to inform future urban mobility planning and regulatory decisions. Findings will contribute evidence on the role of shared mobility in achieving Rwanda's climate resilience, sustainable urbanization, and low-carbon development objectives. The results may support transport policy reforms, fuel-efficiency strategies, and investments in climate-smart urban mobility systems.

Keywords: Shared Mobility; Climate Action; Urban Transport; Energy Efficiency; Kigali

N.B: ONGOING

Multi-Temporal LULC detection for climate impact assessment: Bird population as bioindicator in Karago lake ecosystem, Rwanda

^{1,2}Josiane NIYONKURU

¹*University of Rwanda, Rwanda*

²*Rugezi Ornithology Center*

josiane@rugeziornithology.org, +250784571646

Abstract

Land Use and Land Cover (LULC) change is a significant driver of ecosystem degradation and biodiversity loss in Rwanda's lake watersheds, directly challenging the country's National Biodiversity Strategy & Action Plan (NBSAP 2025–2030). Karago Lake, in the Northern Province, is undergoing agricultural expansion, wetland encroachment, and vegetation loss, processes linked to climate variability and land-use pressures. These changes threaten aquatic and terrestrial ecosystems and reduce natural systems' capacity to buffer climate impacts. Birds are sensitive bioindicators of environmental change and shifts in avian community composition and abundance provide early signals of ecosystem stress. Despite their value, the relationship between LULC dynamics and bird population variation at Rwandan lake ecosystems remains poorly documented and underutilized in climate monitoring. This study aims to: (1) map and quantify multi-temporal LULC changes in the Karago Lake ecosystem, (2) assess their impact on bird population composition and abundance, and (3) evaluate bird communities as bioindicators for ecosystem-based climate monitoring. Landsat and Sentinel-2 imagery will be classified using ArcMap across three periods (2005, 2015, 2025), while bird data will be collected through point count surveys, complemented by eBird and waterbird records. Correlation and regression models will examine relationships between LULC trajectories and bird species richness, abundance, and community composition. The study expected to reveal LULC transformation, particularly agricultural encroachment into wetland buffers and riparian vegetation loss, correlating with declines in waterbird and forest-dependent species. Findings will inform land-use planning, wetland protection, and ecosystem-based climate monitoring replicable across Rwanda and the East-African region.

Keywords: LULC change, bird bioindicators, climate monitoring, KARAGO Lake, remote sensing

N.B: ONGOING

A Low-Cost IoT and Mobile Based Urban Flood Early Warning and Response System

Ahumuza Kelvin

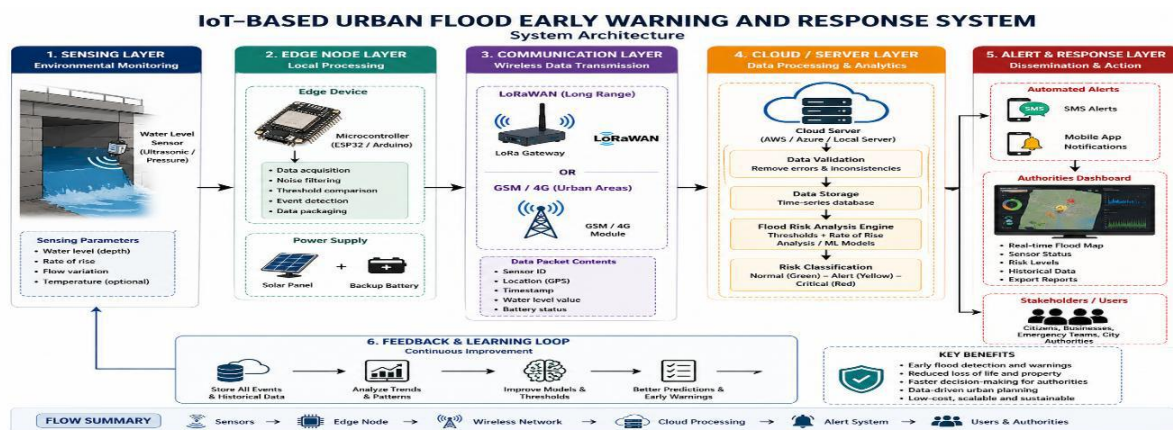
Bachelor of Civil Engineering, Kabale University

ahumuzakelvin42@gmail.com / +256755099759

Abstract

Climate change is increasing the frequency of extreme rainfall events across East Africa, exposing rapidly growing cities to recurrent urban flooding. In Uganda, cities like Kampala experience frequent flood related disruptions due to inadequate drainage infrastructure and the absence of real time monitoring systems, highlighting the need for affordable, technology driven approaches that strengthen climate resilience and disaster preparedness. This study aims to develop a low-cost internet of things (IoT) and mobile based urban flood early warning and response system that improves flood monitoring and enables timely alerts, supports evidence-based decision making for climate resilient urban management.

Methodology



The proposed framework integrates low-cost water level sensors, Arduino base edge processing, LoRa WAN/GSM communication technologies, GIS based visualization and an automated mobile alert. Continuous monitoring and threshold-based analysis are used to detect rising water levels and trigger early warnings for communities and city authorities. The ongoing study is expected to deliver a scalable early warning framework capable of improving flood detection, reducing emergency response time, supporting real time risk communication and generating historical datasets. The proposed system demonstrates how affordable digital technologies can strengthen climate adaptation and urban resilience in resource constrained settings. Its implementation can support climate informed infrastructure planning, disaster risk reduction and smart city development to rapidly urbanizing cities across Africa

Keywords: Climate resilience, IoT, smart cities

N.B: ONGOING

Directed Graph Neural Networks for Bus-Level Outage Prediction on Radial Distribution Grids

Kwame Donkor, Dr. June Lukuyu

University of Washington, Seattle, USA

CA: Kwame Donkor, kdonkor@uw.edu; +1 206-941-2233

Abstract

Across Sub-Saharan Africa, electricity distribution networks are expanding under universal-access goals. Under-investment leaves these grids predominantly radial, so a single upstream fault disconnects every downstream customer, and moderate storms disrupt essential services. Yet, operations remain reactive: weather forecasts are seldom integrated, and crews are dispatched only after faults occur. Moreover, the asset records that conventional prediction methods rely on are often unavailable. This study develops a graph neural network (GNN) framework to predict weather-driven outages at the bus level, enabling crew pre-positioning. Its central contribution is a prediction method whose structure mirrors how outages spread on radial feeders, paired with an evaluation protocol that tests not just accuracy but whether predicted outage probabilities stay reliable across differing outage frequencies. Using a synthetic pipeline on a standard radial test feeder, we simulate weather scenarios and the bus-level outages they produce. A graph attention model predicts these outages while representing how an upstream failure disconnects the buses below it; because the setting is synthetic, the true outage probabilities are known serving as evaluation ground truth. We assess whether directed, propagation-aware message passing improves bus-level prediction over undirected baselines, and whether any gains concentrate on downstream buses far from the failure. We further characterize how prediction calibration behaves as outages shift from rare to frequent. By grounding both method and evaluation in the physics of radial outage propagation, the framework offers researchers a reproducible route toward proactive resilience planning for utilities in the sub-region, supporting climate-adaptation investment without reliance on proprietary data.

Keywords: Graph neural networks; outage prediction; climate resilience; radial distribution grids; Sub-Saharan Africa

N.B: ONGOING

Adaptation Research for Impact: From Climate Evidence to Adaptation Enterprise - The Role of Science in Strengthening Rwanda's Adaptation Innovation Ecosystem

Martin Rokitzki

Founder and Managing Director of PlanAdapt, and Climate Adaptation Research & Consulting (CARC) Rwanda, a PlanAdapt Affiliate

m.rokitzki@plan-adapt.org / info-carac@plan-adapt.org / +250 (0)798580603

Abstract

Rwanda's climate adaptation ambitions increasingly depend on micro, small and medium enterprises (MSMEs) that innovate, test and provide locally relevant products, services, practices, processes that strengthen the adaptive capacity of climate vulnerable communities. Yet adaptation and resilience (A&R) innovators often operate within fragmented entrepreneurship support and innovation ecosystems and lack usable climate-risk evidence, adaptation impact measurement frameworks, patient capital and links to research institutions. This study examined how science, knowledge and learning can strengthen innovation ecosystems for A&R enterprises in Rwanda, drawing lessons from other Least Developed Countries and Small Island Developing States. A mixed approach using a combination of (a) AI-agent based systematic literature review of scientific and gray literature; (b) key information interviews and (c) field visits to adaptation enterprises, provided evidence as to how these MSMEs can be best supported to establish reliable, sustainable and measurable adaptation outcomes. The study was embedded in the Climate Adaptation Innovation and Learning initiative (by Climate-KIC, UNIDO and GEF etc.). The analysis covered incubators and accelerators, Living Labs, the Quintuple Helix model, innovation ecosystem intermediaries, blended finance instruments, indigenous and local knowledge, and locally rooted scaling mechanisms. Conventional business incubation and acceleration alone is insufficient. Effective A&R ecosystems require systemic integration of climate science, community knowledge and governance approaches, real-world experimentation, investment-readiness support, technical assistance, market access and enabling policy. Living Labs can connect researchers, communities, businesses and government to co-design, test and evaluate solutions. Scientists are essential for climate-risk assessment, baseline development, adaptation indicators, outcome evaluation and evidence translation. Intermediaries help bridge policy and implementation, while blended finance addresses the persistent "missing middle." Rwanda can further strengthen its adaptation and resilience ecosystem through coordinated, context-responsive support systems that engage research institutions throughout enterprise development. This would help enhance scientific credibility, locally grounded innovation, and the generation of measurable adaptation and resilience outcomes.

Keywords: Adaptation and resilience; Innovation ecosystems; Climate science; MSMEs; Rwanda

Warming Highlands, Changing Harvests: Four Decades of Climate Variability and Potato Production in the Santa-Babadjou Corridor, Cameroon

Mary Lum Fonteh Niba^{1*} and Besende Didien Njumba²

¹*Department of Geography, Higher Teachers Training College Bambili, The University of Bamenda, Bamenda, Cameroon*

²*Department of Geography and Planning, The University of Bamenda, Cameroon.*

CA: mariefontehniba3@gmail.com, +237 679200196

Abstract

The Santa-Babadjou Corridor in Cameroon's Western Highlands is one of the country's most productive potato-growing areas, yet its agricultural systems are increasingly exposed to long-term climate variability. This study assessed the influence of climate variability on potato production using historical crop records and high-resolution climate datasets for 1980–2026. Annual production anomalies were calculated using standardized procedures. Rainfall and temperature trends were assessed with the Mann–Kendall test and Sen's slope estimator at annual, seasonal and monthly scales, while five-year moving averages and standardized anomalies characterized climate variability and hydroclimatic extremes. Pearson correlation, multiple linear regression and principal component analysis were used to evaluate the influence of rainfall, rainfall distribution, maximum and minimum temperatures, and growing-season thermal conditions on potato production. Results showed a significant warming trend of approximately 0.98 °C per century (0.0098 °C yr⁻¹; R² = 0.79; p < 0.001), while annual rainfall increased only slightly and non-significantly by about 24 mm per century (R² = 0.03; p = 0.21). Potato production rose from about 11,800 tons in 1980–1985 to nearly 15,000 tons in 2001–2005, then declined to around 8,000 tons during 2016–2020 before modestly recovering. Growing-season maximum temperature emerged as the strongest climatic determinant, with rainfall distribution also important. The findings highlight the need for climate-smart practices, including heat- and drought-tolerant cultivars, climate-informed planting calendars, improved soil and water conservation, supplementary irrigation and stronger seasonal climate services.

Keywords: Climate-variability, Potato Production, Cameroon

N.B: ONGOING

Modelling Heat Stress Impacts on Outdoor Workers' Health and Productivity in Kigali, Rwanda

Kone Moussa¹, Victoire (Vicky) Ghafi KONDI-AKARA¹, Mouhamadou Bamba Sylla¹

¹*AIMS Research & Innovation Center*

CA: mkone@aimsric.org, +250 796 895 586 /+226 74 74 32 56

Abstract

Outdoor workers in sub-Saharan Africa face one of the most direct, and least quantified, health effects of climate change. Rising global temperatures affect outdoor workers such as those in construction, a sector that employs mostly men and where survival depends on the ability to carry out high-intensity work under often extreme heat. Constant heat exposure threatens both workers' health and their productivity. To date, no spatially explicit assessment exists for Rwanda. In our study, we quantify past, present and projected occupational heat stress in Kigali, focusing on the construction sector. We compute daily heat indices, Wet Bulb Globe Temperature (WBGT, Liljegren et al., 2008), Universal Thermal Climate Index (UTCI) and Thermal Work Limit (TWL), from ERA5-Land over 1991–2020 and from n bias-corrected NEX-GDDP-CMIP6 models under the SSP2-4.5 and SSP5-8.5 scenarios. We then delineate thermal zones by classifying monthly and seasonal WBGT distributions, and within each zone we quantify (i) the number of working days posing a health risk by work-intensity class (light, moderate, heavy) following ISO 7243, and (ii) labor productivity losses using established exposure–response functions. Projected changes are assessed for 2021–2050 relative to the 1991–2020 baseline. This work will deliver a spatio-temporal framework that turns gridded climate information into operational occupational-risk indicators and will give Rwandan labor and health authorities the first baseline quantification of heat stress and heat-related productivity losses in the construction sector.

Keywords: WBGT UTCI, TWL, occupational heat stress, health, labor productivity, Rwanda, Kigali, climate change, Labor Response Functions

N.B: ONGOING

Eco Watershed Intelligence Platform: A Unified Geospatial Decision-Support System for Watershed-Scale Ecosystem Management

Noa NDACYAYISENGA

GIS & Remote Sensing Engineer, CAVM, University of Rwanda, Rwanda

noahamza64@gmail.com / +250798586978/+250781321726

Abstract

Deforestation, declining water quality, and poorly sited infrastructure are interlinked threats to Rwanda's watersheds, yet they are typically monitored in isolation, limiting evidence-based catchment management and undermining national climate resilience and low-carbon development priorities. To develop an integrated, cloud-based geospatial decision-support platform that jointly analyzes forest change, water infrastructure suitability, and water quality at the watershed scale. The Eco Watershed Intelligence Platform was built on Google Earth Engine, combining Hansen Global Forest Change data (2001–2023) for deforestation tracking, SRTM terrain and CHIRPS rainfall data for irrigation, borehole, and solar-pump siting, and Sentinel-2/MODIS time series for turbidity, chlorophyll, total suspended solids, pH, and temperature monitoring. The platform is expected to map deforestation hotspots, generate ranked Water infrastructure-siting recommendations, and produce time-series water quality trends, revealing linkages between upstream land-cover change and downstream water health. By linking SDG 6, 13, 14, and 15 within one tool, the platform supports ecosystem-aware planning and offers a scalable model for watershed governance, REDD+ reporting, and climate-resilient infrastructure decisions in Rwanda and the wider East African region.

Keywords: Watershed management, Google Earth Engine, forest change detection, water quality monitoring, geospatial decision-support

N.B: ONGOING

Reforestation and Ecosystem Restoration by Native Tree Species for Climate Resilience and Water Resource Improvement in Rwanda

Olivier IRADUKUNDA

Rwanda Young Water professional (R-YWP)

olivier.iradukunda@rywp.org / +250787784624

Abstract

Climate-driven floods and droughts threaten ecosystem services and water security in Rwanda. Nature-based solutions, particularly reforestation with native tree species, offer cost-effective strategies for enhancing biodiversity, improving water retention, and building climate resilience across the landscape. This study aims to assess the efficacy of native tree species in ecosystem restoration, focusing on their role in biodiversity enhancement, soil conservation, and water resource improvement under changing climate conditions in Rwanda. A mixed-methods approach combining field ecological surveys, remote sensing data, and hydrological modelling is utilized. Data on tree survival rates, canopy cover, soil moisture retention, and biodiversity indices were collected from restored and degraded sites across the Eastern and Western provinces. Expected results indicate that native species significantly outperform exotic plantations in soil moisture retention and biodiversity support. Preliminary data show a substantial improvement in local water table recharge rates and enhanced resilience to drought-induced thermal stress in restored catchments. Restoring ecosystems with native tree species is critical for climate adaptation. The findings will guide the Ministry of Environment in scaling up nature-based solutions, prioritizing native afforestation in national climate policies to secure water resources and enhance ecosystem resilience.

Keywords: Ecosystem restoration, Native tree species, Water resource management, Climate resilience, Nature-based solutions

N.B: ONGOING

Spatiotemporal Assessment of Urban Heat Islands and the Cooling Effects of Nature-Based Solutions in Kigali City, Rwanda (2005–2025)

Patience NSHIMIYIMANA

*Department of Spatial Planning, School of Architecture and Built Environment,
College of Science and Technology, University of Rwanda, Rwanda*

patienceshimiyimana57@gmail.com / +250725847617

Abstract

Urban Heat Islands (UHIs) are intensifying across rapidly urbanizing African cities, threatening human comfort, increasing energy demand, and exacerbating public health risks. In Kigali City, rapid urban expansion has transformed natural landscapes into built-up surfaces, contributing to rising Land Surface Temperatures (LST). Despite Kigali's strategic role in Rwanda's Green City Initiative, Vision 2050, and Nationally Determined Contributions (NDCs), the drivers and spatial dynamics of urban heat remain insufficiently quantified. Understanding the cooling potential of Nature-Based Solutions (NBS) is therefore essential for climate-resilient urban development. This study aims to assess the impacts of land cover change on LST and UHI formation in Kigali City between 2005 and 2025 and to evaluate the effectiveness of Nature-Based Solutions, including urban forests, parks, wetlands, and riparian vegetation, in mitigating urban heat. Google Earth Engine and Python are being used to process multi-temporal Landsat and Sentinel imagery. Land cover is classified into four categories: built-up, water, green space, open land and wetland using a Random Forest classifier. NDVI and LST are derived for each study period, while Pearson correlation and regression analyses are employed to examine relationships between vegetation cover, built-up surfaces, and temperature patterns. The study is expected to reveal significant expansion of impervious surfaces, fragmentation of green spaces, increasing mean LST, and intensification of UHIs between 2005 and 2025. Areas dominated by vegetation and wetlands are anticipated to exhibit lower temperatures and measurable cooling effects. A negative correlation between NDVI and LST and a positive relationship between Built-up surfaces and LST are expected. The findings will demonstrate the importance of protecting and enhancing urban vegetation and wetlands as climate adaptation infrastructure. The study will provide evidence-based recommendations for zoning, green corridor development, urban greening strategies, and heat mitigation policies to support sustainable and climate-resilient urban planning in Kigali City.

Keywords: Urban Heat Island, Land Surface Temperature, Nature-Based Solutions

N.B: ONGOING

Integrating AI-Driven Satellite Earth Observation into Climate Disaster Risk Reduction: A Governance Framework for Rwanda

Serge Ishimwe

University of Tourism, Technology, and Business Studies, Rwanda

sergeishimwe18@gmail.com / +250783274561

Abstract

Climate change is increasing the frequency and intensity of floods, landslides, and other hydro-meteorological hazards in Rwanda. Although advances in satellite Earth Observation and Artificial Intelligence (AI) offer significant opportunities for climate monitoring and early warning, their integration into national disaster risk reduction systems remains limited. To develop a governance framework for integrating AI-driven satellite Earth Observation into Rwanda's climate monitoring and disaster risk reduction systems. The study employs a policy review and analysis of climate information systems, Earth Observation applications, and institutional frameworks to identify governance, technical, and capacity gaps limiting operational AI adoption. The proposed governance framework is expected to strengthen climate monitoring, improve AI-enabled early warning systems, enhance disaster preparedness, and support evidence-based climate policy and adaptation planning in Rwanda. It is also expected to improve institutional coordination, promote the responsible use of satellite Earth Observation and Artificial Intelligence, and provide practical guidance for integrating climate information into national disaster risk reduction strategies. The framework may serve as a scalable model for other African countries facing similar climate-related challenges. Integrating AI-enabled satellite analytics into national climate information systems can strengthen climate resilience, improve disaster preparedness, and support evidence-based climate policy, adaptation planning, and sustainable development in Rwanda.

Keywords: Climate Change; Artificial Intelligence; Earth Observation; Disaster Risk Reduction; Rwanda

N.B: ONGOING

Sentinel-1 SAR Flood Extent Mapping of the Nyabarongo–Kigali Corridor, Rwanda: A Multi-Constraint Adaptive Framework for Highland Peri-Urban Environments

Stephen Nyaranga^{1,3*}, Prof. Dr. Mouhamadou Bamba Sylla¹, Dr. Ben Howard², Prof. Dr. Wouter Buytaert², Dr. Mercy Mwaniki²

¹*AIMS Research and Innovation Centre (AIMS-RIC), Kigali, Rwanda*

²*Imperial College London, London, United Kingdom*

³*Jomo Kenyatta University of Agriculture and Technology (JKUAT)*

CA: snyaranga@aimsric.org

Abstract

Briefly describe the problem addressed and its relevance to Rwanda's climate priorities (or Flooding is Rwanda's most frequent natural hazard. The Nyabarongo River corridor (8,478 km²) passes through Kigali's southern and eastern fringes, combining persistent cloud cover, steep terrain adjacent to valley floors, and rapid urban expansion onto floodplains. The May 2023 event inundated farmland, wetland, and informal settlements. The objective of the study is to develop and validate the Multi-Constraint Adaptive Flood Mapping (MCAFM) framework for the May 2023 flood across 165,637 ha of the Nyabarongo–Kigali corridor at 10 m resolution, using only open-access data and no labelled training samples. MCAFM applies five sequential constraints to Sentinel-1 C-band SAR: (i) VV backscatter change and local texture features; (ii) Height Above Nearest Drainage (HAND) terrain masking; (iii) slope filtering; (iv) urban-adaptive VV thresholding using ESA WorldCover 2021; and (v) DBSCAN spatial coherence filtering. Scenes from 21 April and 3 May 2023 were processed via ASF HyP3 RTC GAMMA. TAMSAT v3.1 provided rainfall context. Validation used the UNOSAT Sentinel-1 emergency reference. The DBSCAN-filtered product mapped 1,396.9 ha (UNOSAT reference: 1,332.8 ha; bias +4.8%), achieving F1 = 64.9%, IoU = 48.0%, κ = 0.646. HAND masking reduced false positives by 2.3–3.1×; the urban-adaptive threshold reduced commission errors approximately 1.8× in peri-urban zones. TAMSAT confirmed 72.9 mm antecedent rainfall (26 April– 2 May 2023). Random Forest analysis (AUC = 0.998) ranked post-flood VV backscatter, backscatter change, and HAND as the top three discriminative features. MCAFM provides reproducible flood mapping in Rwanda's highland environment without labelled training data, enabling integration into national disaster risk reduction workflows. The terrain masking and land-cover-adaptive approach is transferable to other East African highland corridors, supporting scalable regional early warning.

Keywords: Sentinel-1 SAR, flood mapping, HAND terrain masking, DBSCAN, disaster risk reduction, Rwanda

N.B: ONGOING

Climate-Sensitive Energy Demand Modelling in Togo Using LEAP Under IPCC AR6 Scenarios

Yao Peacson Adamadou

yaopeacsonadamadou@gmail.com

Abstract

Climate information is increasingly important for understanding how changing climatic conditions may affect future energy demand and infrastructure needs. However, energy demand assessments often rely predominantly on socioeconomic drivers, with limited integration of climate information. This study addresses this gap by developing a climate-sensitive energy demand modelling framework for Togo that integrates climate data and IPCC AR6 scenarios into the Long-range Energy Alternatives Planning (LEAP) system. The approach demonstrates how climate information can be incorporated into energy demand assessment to support more climate-informed decision-making. The study aims to: (i) demonstrate how climate information can be integrated into LEAP-based energy demand modelling; and (ii) assess how climate change influences long-term energy demand in Togo under different IPCC AR6 climate scenarios. A climate-sensitive LEAP modelling framework was developed by incorporating climate information and IPCC AR6 scenarios as additional demand drivers alongside socioeconomic assumptions. The framework was applied to project energy demand in Togo to 2060 and to assess differences between climate-sensitive and socioeconomic-only demand pathways, with particular attention to cooling-related electricity consumption. The results demonstrate that climate information can materially affect long-term energy demand projections. Climate change increases electricity demand by 18% by 2060 compared with the socioeconomic-only LEAP scenario. In contrast, non-cooling energy demands remain largely unchanged across the scenarios, indicating that the principal climate-related effect is concentrated in cooling-related electricity consumption. These findings highlight the importance of incorporating climate information into energy demand assessments to avoid underestimating future electricity requirements. The study demonstrates the value of integrating climate data and scenario-based climate information into energy demand modelling. The proposed framework provides a transferable approach for linking climate information with energy-system assessment and can support climate-informed infrastructure planning, grid resilience, and energy policy decisions. By making climate change an explicit demand driver, the approach strengthens the capacity of energy planners and policymakers to anticipate climate-related changes in electricity demand and associated infrastructure needs.

Keywords: Climate data, climate scenarios, energy demand modelling, LEAP, IPCC AR6, climate-informed planning

N.B: ONGOING

Integrated optimization of biogas recovery and solar photovoltaic energy systems on Municipal Solid Waste Landfill hills in Rwanda: A Case Study of Nduba Municipal Solid Waste Landfill Hill, Kigali

¹Vedaste HABAGUHIRWA, ¹Denyse ISHIMWE, ¹Dr. Janvier MUNYANEZA, ²Elyse DUSHIMIRIMANA

¹RP-Musanze College, ²Genius Environmental Ltd, Rwanda

CA: dishimwe@rp.ac.rw/denyseishimwe8@gmail.com / +250783445075

Abstract

Municipal Solid Waste (MSW) landfills are major greenhouse gas sources but also offer renewable energy potential. Rwanda's Nduba Municipal Solid Waste Landfill receives large quantities of organic waste that generate methane through anaerobic decomposition and has extensive open areas suitable for solar energy generation. This project proposes the development, optimization, and validation of a hybrid renewable energy system integrating landfill biogas recovery with solar photovoltaic technologies. The study will combine environmental engineering, renewable energy systems, remote sensing, artificial intelligence, Internet of Things (IoT), economic analysis, and sustainability science. It will assess methane generation potential, solar energy resources, environmental impacts, socio-economic benefits, and financial feasibility. The methodology will include baseline assessment and resource characterization; hybrid biogas-solar system design; system optimization and intelligent energy management; development of an IoT-enabled digital twin for real-time monitoring and decision support; and environmental, economic, and social sustainability assessment. The project aims to establish a scalable landfill-to-energy model tailored to Rwanda. Expected outcomes include a validated hybrid biogas-solar energy model, increased national capacity in renewable energy and environmental monitoring, greenhouse gas mitigation, improved energy access, green job creation, and policy recommendations for landfill-to-energy strategies. The project will also support replication across Rwanda and contribute to national climate mitigation objectives, SDG 7 and SDG 13. Overall, it positions Nduba Landfill as a potential national demonstration site for renewable energy innovation and circular economy development.

Keywords: Municipal Solid Waste, Landfill Gas, Biogas, Solar Photovoltaic, Renewable Energy Waste Management

N.B: PLANNED

Strengthening Climate Data and Monitoring Systems to Support Climate Resilience and Sustainable Development in Rwanda

Jean Marie Vianney NKULIKIYUMUKIZA

Independent Researcher / Atmospheric and Climate Science Graduate Rwanda

nkulikiyumukiza3@gmail.com / +250787198490

Abstract

Climate change is increasingly affecting Rwanda through more frequent floods, prolonged droughts, landslides, and changing rainfall patterns, threatening agriculture, water resources, infrastructure, and livelihoods. Achieving Rwanda's climate resilience and sustainable development goals requires reliable climate information to support evidence-based planning and decision-making. Strengthening climate data and monitoring systems is therefore essential for improving climate services, disaster preparedness, and adaptation strategies. This study aims to examine the role of climate data and monitoring systems in strengthening climate resilience in Rwanda. Specifically, it explores available climate monitoring technologies, identifies existing challenges in climate data management, and proposes strategies for improving climate information systems to support national climate adaptation and disaster risk reduction. The study adopts a qualitative review approach based on published scientific literature, national climate policy documents, technical reports, and case studies from Rwanda and other African countries. It analyzes the application of automated weather stations, remote sensing, Geographic Information Systems (GIS), satellite observations, and climate databases in climate monitoring and environmental management. The study is expected to demonstrate that integrated climate monitoring systems significantly improve weather forecasting, climate risk assessment, early warning services, and environmental planning. It also identifies challenges such as limited observation networks, data gaps, technical capacity constraints, and restricted access to climate information. The findings are expected to highlight opportunities for strengthening institutional collaboration, expanding observation infrastructure, and adopting modern digital technologies for climate data management. Strengthening climate data and monitoring systems is fundamental to achieving Rwanda's climate resilience objectives and supporting evidence-based policy implementation. Investments in climate observation infrastructure, data sharing, technical capacity development, and advanced climate information technologies will improve climate services, disaster preparedness, and sustainable natural resource management. The study provides practical recommendations that can support policymakers, researchers, and climate practitioners in enhancing national climate adaptation and resilience.

Keywords: Climate Data, Climate Monitoring, Climate Resilience, Rwanda, GIS

N.B: PLANNED