

African Climate Risks Conference 2019: 7-9 October 2019

Held under the theme ‘Dismantling barriers to urgent climate change adaptation actions,’ the first African Climate Risks Conference (ACRC), provided an open platform for sharing the latest climate research in Africa among researchers, policy makers, practitioners, and development partners. Recognizing that adapting to climate variability and change is key for the African continent, the conference aimed to facilitate a synergistic approach to climate adaptation from a diverse range of actors across sectors, as well as to enable a better understanding of the drivers of risk and vulnerability.

The ACRC featured a variety of sessions, all aimed at holistically addressing the opportunities and challenges related to climate change adaptation action in Africa. It promoted the uptake of new data, tools, and knowledge, and facilitated network creation and research collaborations. The conference was structured across eight themes:

- latest research on climate science of Africa;
- latest research on the science and projections of future climate change in Africa;
- climate change risk analysis;
- delivering resilience in the face of climate change uncertainty;
- co-production of knowledge;
- information distillation and communication;
- mobilizing investment in climate and weather services; and
- the water-energy-food-health nexus.

During the conference, participants discussed *inter alia*: the status of climate research in Africa and the success stories of bringing this research into use while also investigating the challenges to have climate information integrated into decision and policy making for a resilient Africa; the future of climate research on the continent; the Intergovernmental Panel on Climate Change (IPCC) Special Reports on the Oceans and Cryosphere in a Changing Climate, and on Climate Change and Land; climate services initiatives in Africa; urban challenges related to climate change adaptation; multi-level governance in enabling climate-resilient development; multidisciplinary approaches to climate change risk analysis; and links between climate adaptation and the agriculture and water sectors.

Participants also:

- showcased the latest climate-related research on the continent;
- discussed uncertainty and ways to respond to it;



A view of the room during ACRC 2019 held at UN ECA in Addis Ababa, Ethiopia

- addressed climate change risk analysis;
- exchanged ideas on mobilizing investment for climate and weather services; and
- discussed the water-energy-food-health nexus.

The conference further allowed the dissemination of up-to-date results and the sharing of research insights, linking researchers and enabling multi-disciplinary approaches that may prove crucial in finding ways to address the imminent challenges posed by climate change.

The ACRC convened from 7-9 October in Addis Ababa, Ethiopia. It was hosted by the Future Climate for Africa programme in partnership with the World Meteorological Organization (WMO), the Global Framework for Climate Services (GFCS), the World Climate Research Programme (WCRP), West African Science Service Center on Climate Change and Adapted Land Use (WASCAL), the African

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Filipe Lúcio, Director, GFCS

Academy of Sciences (AAS), the UN Economic Commission for Africa - African Climate Policy Center (UNECA-ACPC), and the University of Addis Ababa. The Department for International Development (DFID), UK, and the Natural Environment Research Council (NERC), UK, funded the conference. The meeting attracted more than 350 participants.

This report provides an overview of discussions held in plenary and in selected dialogue sessions.

Report of the African Climate Risks Conference 2019

Plenary Sessions

High-Level Opening Session: On Monday, 7 October, Filipe Lúcio, Director, GFCS, opened the conference, drawing attention to the devastation of extreme climate events, including the damage caused by Tropical Cyclone Idai. He noted that drainage systems provided by mangroves and wetlands to Beira, Mozambique, had been lost due to human settlements and charcoal production. Stating that Beira did not have an evacuation plan or an updated flood mapping, Lúcio highlighted the lack of appropriate mechanisms to incorporate risk into planning, policy making and decision making.

Julius Kabubi, on behalf of Kirsi Madi, Director, UN Office for Disaster Risk Reduction (UNDRR), urged for the implementation of the Sendai Framework for Disaster Risk Reduction and the Programme of Action for the Implementation of the Framework in Africa. He called for investment in climate change adaptation and disaster risk reduction, in order to build societies that are resilient to climate and socio-economic change.

Joseph Mukabana, on behalf of Amos Makarau, Director, WMO Regional Office for Africa, noted that Africa is the most vulnerable continent to climate change impacts, and stressed the importance of adaptation. He highlighted the conference as a space for coordinating efforts to optimize resources and avoid duplicating efforts, and noted the need for technology, capacity building and finance.

Rosalind West, Climate Science Theme Leader, DFID, UK, said understanding climate risk, especially in Africa, is a great challenge, and pointed to the conference as an opportunity to:

listen and learn; collaborate; and scale up efforts by transitioning from research into action.

Highlighting various climate change-related challenges affecting Africa, Fetene Teshome Tola, Director General, National Meteorology Agency (NMA), Ethiopia, noted that climate variability is a threat to agricultural production, which, in turn, compromises development. He stressed the need to monitor, analyze and predict climate so that corrective adaptation and resilience measures can be put in place.

Fekadu Beyene, Commissioner, Environment, Forest, and Climate Change Commission, Ethiopia, noted that while Africa contributes negligibly to greenhouse gas (GHG) emissions, it is heavily impacted by climate change, thus rendering climate adaptation a necessity. He called for: innovative solutions to avert climate risks and eradicate poverty; development of a holistic system aimed at building resilience; increased private sector engagement; and improved multi-disciplinary research to produce key knowledge.

Suzanne Carter, Future Climate for Africa Programme Manager, SouthSouthNorth (SSN), emphasized that by bringing together those working towards climate resilience in Africa, the conference would spark new ideas and collaborations.

Latest climate and climate change research in Africa - findings from the Future Climate for Africa Programme: On Monday, presenting on lessons learned about climate in West Africa from the African Monsoon Multidisciplinary Analysis (AMMA-2050) project, Christopher Taylor, Centre for Ecology and Hydrology, UK, highlighted: worsening impacts of extreme rain events and flooding; links between rain events and global warming; and the underestimation of adverse impacts by conventional climate models. He suggested using models that can realistically depict individual storms.

Catherine Senior, Met Office, UK, presented highlights from the Improving Model Processes for African Climate (IMPALA) project, saying that its new high resolution (4.5 km grid) Pan-African Convection Permitting simulations (CP4-Africa) better simulates rainfall variability and extremes, and that the new understandings gained are expected to feed back into the improvement of global models.



Suzanne Carter, Future Climate for Africa Programme Manager, SSN



John Marsham, University of Leeds, UK

John Marsham, University of Leeds, UK, reported results from the Integrating Hydro-Climate Science into Policy Decisions for Climate-Resilient Infrastructure and Livelihoods in East Africa (HyCRISTAL) project, including: narrowed projections from the fifth phase of the Coupled Model Intercomparison Project (CMIP5); findings that extreme wet events will increase more than in CMIP5 and increases will be more widespread; and new understandings of uncertainty from future aerosols, the East African rainfall paradox, and changes in future onset and cessation dates of wet events.

Chris Jack, Climate Systems Analysis Group (CSAG), University of Cape Town (UCT), South Africa, discussed key lessons from the Future Resilience for African Cities and Lands (FRACTAL) project, implemented in nine Southern African cities and aimed at strengthening scientific knowledge on regional climate responses. He emphasized the need to: build connections, trust and relationships; distil information and identify its value contribution; do science differently; and collectively manage risk.

Focusing on rainfall in Southern Africa, Richard Washington, University of Oxford, UK, concluded that the Future Climate for Africa UMFULA ('river' in Zulu) project has contributed to the fundamental understanding of climate and climate change in Central and Southern Africa. He projected land-based rainfall decreases, explaining the case of early summer (September to November) drying over Southern Africa; and stressed that global climate models represent rainfall well.

During discussions, participants addressed the need for capacity-building to be an integral part of research initiatives and the availability of baseline data for Africa.

State of climate research for development in Africa – challenges and opportunities: The session was held on Tuesday. Moderator Christopher Jack, CSAG, South Africa, stressed the importance of reflecting on “our achievements, our mistakes, and our challenges.”

In his keynote speech, Joseph Mukabana, WMO, addressed the reasons for shortcomings of science and research in Africa. He highlighted inadequate funding for scientific research and insufficient research infrastructure, as well as the lack of strong intra-regional collaboration. Mukabana further focused

on the Climate Research for Development (CR4D) in Africa initiative, highlighting its structure, research capacity, long-term interventions, structural goals, and thematic areas of work, emphasizing the CR4D Research Grant.

During the panel discussion, Oluyede Ajayi, Technical Centre for Agricultural and Rural Cooperation, the Netherlands, addressed achievements and challenges related to the CR4D. He highlighted the increasing recognition of the development aspect of the initiative, emphasizing the co-production of knowledge by different disciplines. He called for strengthening the linkage between research and policy, and creating an enabling environment that attracts private sector funding.

Judy Omumbo, African Academy of Sciences, Kenya, focused on the academy's capacity development efforts, aimed at filling critical gaps in African research. She highlighted programmes on raising research leaders, supporting innovation, and strengthening a science-driven entrepreneurial culture.

Jane Olwoch, Executive Director, Southern Africa Science Service Center for Climate Change and Adaptive Land Management (SASSCAL), provided an overview of SASSCAL, including its strategic objectives. She focused on engagement with stakeholders; advocated multi-disciplinary research teams; and presented SASSCAL's ongoing and past research projects.

Bruce Hewitson, Head of CSAG, UCT, South Africa, stressed that one of the critical constraints to climate change research in Africa is that there are limited resources to sustain capacities that have already been developed. He highlighted the need to prioritize knowledge gaps, scaling the research to match capacities, and emphasized that knowledge products should also reach relevant stakeholders, who cannot access face-to-face engagements.

Meron Teferi Taye, Addis Ababa University, Ethiopia, provided an outline of the REACH project, which aims to improve water security for the poor, emphasizing social research performed by the project to inform climate risk metrics; climate change impacts on hydrological variables; and collaborative water allocation considering groundwater and regulation on irrigation. She called for aligning research with users' needs, while considering large-scale and local influences.



Meron Teferi Taye, Addis Ababa University, Ethiopia

In the ensuing discussion, delegates addressed: the linkages between researchers and end users; the post-construction aspect of irrigation schemes; and how to introduce new ways of thinking for early-career scientists in order to allow them to grow beyond the business as usual trajectory.

Linking new science to application - piloting new ways of supporting climate relevant decisions: On Tuesday, Tazen Fowe, International Institute of Water and the Environment (2iE), Burkina Faso, provided an overview of a pilot flood risk management project in Ouagadougou. He explained that climate change and urbanization trends will increase flooding in the city and therefore, a range of innovative approaches are being deployed, including a flood knowledge database to provide information on urban hydrology in Ouagadougou.

Emma Visman, King's College London, UK, highlighted an AMMA-2050, pilot pearl millet project in Niakhar, Senegal, developed because climate change is affecting crop yields, and millet tolerates higher temperatures. She explained that work had been done on linking genetic vulnerability to crop yields, and that a wide range of approaches for overcoming challenges around dialogue had been deployed including plateau games, participatory modeling, and theatre forum.

Alice McClure, CSAG, South Africa, highlighted the city learning lab approach in Lusaka, Zambia, consisting of a series of multi-stakeholder events that aim to co-define the problem and co-produce solutions, noting that the focus was on water in peri-urban areas, particularly groundwater and flooding.

Brenda Mwalukanga, Embedded Researcher in Lusaka City Council, noted that the FRACTAL process had helped to inform decision making, adding that the design of the city drainage system recognizes that rainfall is likely to increase in the future.

Declan Conway, London School of Economics and Political Science, UK, outlined the challenges in constraining model uncertainty in rainfall projections for the Lake Malawi and Shire River systems in Malawi and the Rufiji River Basin in Tanzania. He stressed the need to focus on adaptation responses that work well across a range of future scenarios.

Mercy Mwaniki, Jomo Kenyatta University of Agriculture and Technology, Kenya, outlined a study that examined the potential



Judy Omumbo, African Academy of Sciences

impacts of flood events in Kisumu, Kenya, on sanitation systems in terms of the health burden and infrastructure damage.

The ensuing discussion focused on how the models and process innovations covered in the presentations have been used to make decisions subsequent to the researchers' interactions, and how to scale-up these processes to support decision-makers. Participants identified challenges to scaling-up, including large investments of time and interaction, and the uniqueness of each case.

State of climate information – services for development support in Africa: On Wednesday, introducing the session, moderator Judy Omumbo, African Academy of Sciences, noted that, despite significant investment in climate information services, a sizeable gap remains.

Filipe Lúcio, Director, GFCS, highlighted results from the '2019 State of Climate Services Report' including that most countries' basic climate systems (observing, data and data management, monitoring, and forecasting systems) only reach a "basic" level of capability. He stressed the need to strengthen countries' capacity to provide climate services, highlighting the urgency of action for Africa and the need to improve monitoring and evaluation.

James Murombedzi, UNECA, underscored issues including: limited policies in Africa that define data sharing in the context of a broader discussion of benefits; a trend towards commercialization and privatization of climate information services without proper coordination and ethical guidelines; and fragmentation of climate information services.

Stephen Mooney, DFID, underscored the need for African ownership of climate services, emphasizing co-production and "last mile delivery" to reach those who really need the information. He also called for donors to be more proactive and reach out to other sectors and for consideration of how to better engage the private sector.

Rosalind Cornforth, University of Reading, UK, highlighted the success story of RainWATCH, a web application enabling people to access rainfall data in a way that makes sense for them. She explained that it is a collaboration of 15 African



Mercy Mwaniki, Jomo Kenyatta University of Agriculture and Technology, Kenya



Andre Kamga, African Centre of Meteorological Application for Development

national meteorological services, providing contextualized information and linking producers and users.

Andre Kamga, African Centre of Meteorological Application for Development, emphasized the need to strengthen research and innovation, and to support experimentation and piloting of prototypes. Drawing on collaboration between the aviation sector and meteorological services as an example, he noted the need to institutionalize routine collaboration and build the capacity to provide better climate services.

In the ensuing discussion, delegates addressed: ways to build demand for climate services; data accessibility and related challenges; youth involvement; and monitoring and evaluation of the economic value of climate services.

Mobilizing investment in climate services: On Wednesday, Paul Watkiss, Paul Watkiss Associates, addressed, in his keynote presentation, the value of weather and climate services. He emphasized the economic value of these services, stressing that they have social and environmental benefits, in addition to financial ones. He highlighted that the benefit-to-cost ratio for weather and climate services investments is typically 5:1. Watkiss further called for the quantification of economic benefits of weather and climate services to attract investments, noting that climate adaptation offers new funding sources for weather and climate services.

Tom Downing, Global Climate Adaptation Partnership, highlighted two examples of financial models for climate services provision, and noted challenges including providing long-term support to rapidly changing markets and developing future services.

Dumisani Chirambo, Seeds of Opportunity, Malawi, stressed the potential of social innovation and community science to support weather and climate services, saying that communities can collect weather and climatic data using mobile phone applications and SMS services. He noted the potential of South-South climate finance to fund climate services.

Daniel Tsegai, UN Convention to Combat Desertification (UNCCD), explained that drought insurance is critical for protecting against uncertainty of crop and livestock yield in



Daniel Tsegai, UNCCD

times of drought, but that insurance is expensive and requires support. He outlined options for financing premiums and incentives through: carbon credits; international donors; beneficiaries of ecosystem services; farmers; and catastrophic bonds issuances by governments.

Mouhamadou Lele, Consultant, Adaptive Social Protection - Information for Enhanced RESilience (ASPIRE)/Norwegian Refugee Council (NRC) outlined the ASPIRE programme that aims to explore how climate information can inform social protection programming in the Sahel. He stressed: challenges in identifying clear entry points for climate information; and limited understanding of adaptive social protection by climate experts and of climate by social protection stakeholders.

During discussions, delegates addressed: the maintenance of automatic weather stations; the pros and cons of private companies taking up climate services; who will bear the costs of increasing insurance premiums; and the need for quantifiable economic indicators and climate-smart economists.

Climate Services Initiatives in Africa: On Wednesday, a session focusing on climate service initiatives in Africa was moderated by Joseph Mukabana, WMO.

In his keynote presentation, Buruhani Nyenzi, Climate Consult Ltd, Tanzania, focused on challenges and opportunities related to the sustainability of climate services and adaptation initiatives in Africa. Providing an overview of the historic development of climate services in Africa over the last decades, he highlighted a variety of climate services initiatives and called for urgent action to address: the gap in raising awareness; the gap in climate risk management for strategic planning and disaster risk reduction; the need for climate services support to governments, the private sector, and civil society; and the need to improve observations data management and infrastructure.

Zachary Atheru, Intergovernmental Authority on Development (IGAD) Climate Prediction and Applications Centre (ICPAC), highlighted ICPAC's activities related to climate services, including agriculture monitoring, natural resources degradation monitoring, regular regional early warning systems, and actions under its disaster risk management programme.

Richard Graham, Met Office, UK, focused on lessons, challenges, and opportunities derived from, *inter alia*, the Weather and Climate Information Services for Africa (WISER) and the Sciences for Humanitarian Emergencies and Resilience (SHEAR) programmes. He emphasized that a diverse range of services emerged, offering various benefits, including less tangible ones.

Afroza Mahzabeen Anannya, NRC - Norwegian Capacity (NORCAP), provided an overview of NORCAP's work on climate services. She highlighted the initiative's focus on Africa, noting that it aims to bring climate information to the most vulnerable and enable them to act. She emphasized the provision of climate communication support to organizations, as well as technical support through deployment of NORCAP climate experts working in Africa.

Kanta Kumari Rigaud, World Bank, highlighted the launch of the Action Plan on Climate Change Adaptation and Resilience, under which the World Bank Group will ramp up direct adaptation climate finance to reach USD 50 billion over the next five years. She further highlighted 200 projects in Africa, stressing that the situation is not improving and called for coupling climate challenges with other mega-trends, such as demographics, urbanization, biodiversity loss, and technology advancement.

Daisy Mukarakate, UN Development Programme (UNDP), presented UNDP's resilience portfolio, highlighting: support for the enhancement of 100 Nationally Determined Contributions (NDCs) by 2020; mapping and aiding governments to understand climate finance flows; and support for mainstreaming adaptation planning. She further underscored the Africa Adaptation Initiative, identifying relevant challenges and opportunities.

Benjamin Lamptey, University of Leeds, UK, focused on the Global Challenges Research Fund (GCRF) African Science for Weather Information and Forecasting Techniques (SWIFT) programme. He highlighted main achievements so far, including the first operational convection-permitting forecast ensembles for Africa, collaborations, and planned activities for the year to come.

Delegates discussed how to boost climate risk narrative approaches and ways to promote the uptake of climate change information needed for risk assessment.

Parallel Thematic Sessions

Latest research on climate science of Africa: On Monday, Sonja Folwell, Centre for Ecology and Hydrology, UK, presented a study of land-atmosphere feedbacks comparing two 10-year simulations, one parameterized regional model with 25km resolution (P25) and one Pan-African high resolution (4.5km) convection permitting (CP4-Africa). She found that the more intense, less frequent rain in the convection permitting model leads to lower rates of rainfall intercepted by the canopy and returned to the atmosphere as compared with the parameterized model.

Moustapha Tall, University of Dakar, Senegal, presented a study which integrated satellite data with land surface models to estimate land surface variables including leaf area index and soil wetness index for Burkina Faso, finding that this methodology is ready for use in various applications.

Martin Addi, Ghana Space Science and Technology Institute, identified three main drought periods for coastal Ghana—January to March, August, and November to December—highlighting that droughts on the East coast are linked to the El Niño Southern Oscillation, whereas those on the West coast are directly associated with tropical Atlantic oceanic indices.

Richard Jones, Met Office, UK, presented on climate process chains, which link an initial driver to a sequence of climate processes and system states and an eventual outcome, saying these can help simplify complex systems, support process-based evaluation of models, and conduct attribution studies.

Callum Munday, University of Oxford, UK, said the transport of water vapor from the Indian Ocean into the African interior primarily occurs via topographically constrained low-level jets, which are not well captured by CMIP5 models; rather, higher resolution models are needed.

Sinclair Zebaze, University of Yaoundé I, Cameroon, presented findings including that the main synoptic variability of precipitation is located along the Guinean coast with an extension over Central Africa.

Richard Graham, Met Office, UK, described a research problem where the long rains season in East Africa is less predictable than the short rains season, and outlined strategies for better predictions, including improving models to better represent drivers and their teleconnections, and developing a hybrid dynamical and statistical model.



Moustapha Tall, University of Dakar, Senegal



Martin Addi, Ghana Space Science and Technology Institute



Elizabeth Kendon, Met Office, UK

Latest research on the science and projections of future climate change in Africa: On Tuesday morning, during a session moderated by Mouhamadou Bamba Sylla, WASCAL, Chris Jack, CSAG, South Africa, focused on an ensemble of Regional Climate Models (RCMs) to explore the future precipitation characteristics over Africa and compare them with information from the driving Global Climate Models (GCMs). He stressed that RCMs and GCMs give consistent results, which are often robust regardless of the model choice. He said more work is needed on subsampling methods to reduce underlying uncertainty.

Denis Sonkoué, University of Yaoundé I, Cameroon, addressed projected changes in daily rainfall characteristics over Central Africa. Based on a multi-model ensemble (MME) mean of the CMIP5 simulations, he stressed that although uncertainties may exist between observation datasets, MME consistently outperformed individual models and reasonably reproduced the observed pattern rainfall indices over the region.

Elizabeth Kendon, Met Office, UK, presented future climate projections across Africa using the CP4-Africa model that covers the whole region. She noted that the high resolution enables the model to better represent convection compared to the 25km model (P25), concluding that future changes in both wet and dry extremes in Africa may be more severe than previously considered.

Rachel James, University of Oxford, UK, addressed how climate change might influence rainfall-generating weather systems over Southern Africa. She noted that, despite substantial differences in the number, intensity, and location of events produced by the models, they all generated Tropical Temperate Troughs (TTTs) with similar circulation features, and consistently showed future declines during the onset of the summer rainfall season.

Richard Washington, University of Oxford, UK, assessed several strands of coupled model process-based evaluation, developed by the UMFULA project, to see which is more successful in constraining divergent climate futures. He stressed that no process-based method can be routinely applied across Central and Southern Africa, underscoring that regional characteristics need to be strongly considered.

Torsten Weber, Climate Service Center, Germany, presented on the impact of regional atmosphere-ocean coupling on rainfall characteristics, using a regionally coupled atmosphere-ocean model. He stressed that the results show an improvement in the rainfall characteristics over West Africa and most African coastal regions, while the sea surface temperature (SST) bias in the South-East Atlantic Ocean is reduced leading to a more realistic annual rainfall cycle.

Seshu Kolusu, University of Sussex, UK, discussed how uncertainty affects climate projections. Focusing on uncertainty around future projections of rainfall, he addressed the implications for long-term water resources management, further exploring ways to justifiably constrain uncertainty in projections.

Izidine Pinto, CSAG, South Africa, discussed process-based model evaluation and projections over southern Africa from regional and global climate models. He noted that the atmospheric circulation was well simulated in both RCMs and GCMs and similar changes in atmospheric states were projected. Thus, she said, the climate change signal over Southern Africa could be a local response dynamic rather than a circulation dynamic.

Herbert Misiani, IGAD ICPAC, focused on circulation patterns associated with current and future rainfall over Ethiopia and South Sudan. Using two different models—the P25 model that parameterizes convection and the CP4-Africa model that permits convection—he stressed that the CP4 model outperforms the P25 in simulating rainfall characteristics.

During discussions, delegates focused on, *inter alia*: ways to harmonize models that have different results; evaluation of circulation processes; ways to constrain uncertainty and communicate uncertain results to policymakers and investors; robustness of models; and performance metrics.

On Tuesday afternoon, Luis Garcia-Carreras, University of Manchester, UK, highlighted that airborne mineral dust affects the climate, biosphere and human health, but that capturing dust in climate models is a challenge. He pointed out that the CP4-Africa model can capture the seasonal cycle in dust-generating winds, while parameterized models, like P25, miss the summertime maximum generated by cold pools.



Luis Garcia-Carreras, University of Manchester, UK



Siny Ndoye, Cheikh Anta Diop University, Senegal

Naomi Kumi, WASCAL, Ghana, presented a study of the potential impacts of 1.5°C and 2°C global warming on rainfall onset dates, cessation dates and the length of the rainy season in West Africa, highlighting that under RCP4.5 and RCP8.5 the rainy season will be shorter in the Western and Eastern Sahel, as well as the Western coast of Guinea.

Ponnambalam Rameshwaran, Centre for Ecology and Hydrology, UK, highlighted that most hydrological simulations using CMIP5 models agree that peak river flows will increase across West Africa, except in Senegal and neighboring rivers, where most simulations agree that peak river flows will decrease.

Siny Ndoye, Cheikh Anta Diop University, Senegal, reported on a study of the Southern Canary Upwelling System, highlighting that the meridional wind stress is projected to decrease during the 21st century due to the northward shift of the Azores anticyclone, but that these projected changes of wind conditions are modest and will not result in a significant reduction of upwelling. However, he said, changes in temperature could have significant impacts on the system.

Dave Rowell, Met Office, UK, presented a study which examined an outlier in model projections of the East African long rains in the 2080s, demonstrating that the model concerned (Institut Pierre Simon Laplace Climate Model 5A, IPSL-CM5A) resulted in long rains projections that were likely to be unreliable, which he said means that the plausible range of future projections is reduced by one third.

On Wednesday, a session moderated by Chris Gordon, University of Ghana, addressed the IPCC Special Report on Oceans and the Cryosphere in a Changing Climate.

James Kairo, Kenya Marine and Fisheries Research Institute, summarized key messages from the IPCC Special Report, including that smaller glaciers in Eastern Africa will lose more than 80 percent of their current ice mass by 2100 if emissions keep increasing, stressing the urgency of early action.

Anne Wanjiru, Mikoko Pamoja Project, Kenya, outlined a community-led project to conserve and restore mangroves, which sells 3,000 tons of carbon per year earning USD 10,000 invested back into the community. She attributed the project's success to government support, community engagement, and volunteer support.

Lillian Mugi, Edinburgh Napier University, UK, stressed the need to consider vulnerability disaggregated by gender in policy making, outlining a case study of gender differences in access to ecosystem services.

Genito Maure, Eduardo Mondlane University, Mozambique, presented a case study of Maputo, Mozambique, saying it is a coastal, low-lying city affected by droughts, floods, salt water intrusion, storm surges, and coastal erosion, and noted that the municipality has established a climate change unit.

Jacqueline Uku, Kenya Marine and Fisheries Research Institute, highlighted the contradiction between urging investment in the blue economy, and diminishing ocean resources, lamenting that five-year planning cycles do not adequately account for climate change processes occurring on 100-year timescales.

Chris Gordon, University of Ghana, noted the need to: implement nature-based solutions, highlighting mangroves as a blue carbon ecosystem with mitigation potential; check how oceans can contribute to the water-energy-food nexus; and address the disproportionate effects on women of coastal erosion.

Edna Odhiambo, University of Nairobi, Kenya, said existing legal frameworks can be leveraged to address climate risks, highlighting potential under the law of negligence, human rights, the law of contract, and shareholder responsibility.

In the ensuing discussion, questions focused on, *inter alia*: ensuring that the next IPCC report incorporates more comments from the African region; how governments can be held accountable for commitments, including the role of citizens and journalists in ensuring this; and local community engagement in the making of the Special Report.

On Wednesday, a seminar focused on the IPCC Special Report on Climate Change and Land. The session was chaired by Robi Redda, Director, SouthSouthNorth, Ethiopia, who in opening the session, noted that the Special Report resonates with Ethiopia's strategy to reduce GHG emissions by addressing land degradation.

Tony Knowles, The Cirrus Group, South Africa, presented key messages from the Special Report, including that land management can play a pivotal role in tackling climate change by reducing up to 25 percent of emissions, but that land is not a "silver bullet" and reducing fossil fuel combustion is also



Robi Redda, Director, SouthSouthNorth, Ethiopia



Janet Ngombalu, East African Grains Council, Kenya

needed. He stressed the need to halt land degradation across all landscapes as a priority.

Bernice Heloo, Member of Parliament, Ghana, highlighted the impact of illegal mining on land degradation, saying illegal mining covers 3794 square miles in Ghana and creates a large amount of waste. He urged politicians to do more on this issue.

Bernice Mpere-Gyekye, Pro-Link Ghana, underscored the contributions of women to sustainable land management, and called for advocacy to ensure women have the right to own land.

Janet Ngombalu, East African Grains Council, Kenya, said the grain sector in East Africa is being adversely affected by land degradation and climate change, and outlined measures being taken such as proper storage facilities, investments in machinery and equipment for smart agriculture, new seed systems, and management of new pests.

Zewdu Eshetu, Addis Ababa University, Ethiopia, listed several matters that he said had been omitted from the Special Report, including losses of large water bodies, challenges from land conflicts, and reducing emissions by decreasing fossil fuel combustion.

In the ensuing discussion, questions focused on the need to address both adaptation and mitigation in order to increase resilience, the impact of livestock, and how to mobilize funding to address land degradation.

Evidence for action – climate change risk analysis: On Monday morning, Tom Downing, Global Climate Adaptation Partnership (GCAP), presented on the Partnership's experience over 10 years in building climate risk assessment systems for fund managers, saying that while the market for climate risk assessment is booming due to investor pressure and reporting requirements, there are large risks such as challenges to providing robust asset-level information and malpractice leading to maladaptation.

Joyce Kimutai, UCT, South Africa, presented on the first stage of a study on whether climate change affected extreme rainfall events in Kenya in 2018, 2016 and 2012, highlighting the methodology used to define the study area.

Kaitano Dube, Vaal University of Technology, South Africa, presented a study aiming to investigate the relationship between

sea surface temperature and tropical cyclone trends in the South Eastern Africa coastal area, highlighting that increased global warming is a threat to coastal communities.

Yvan Nono Noutchie, University of Yaoundé 1, Cameroon, presented the results of a study showing that the Congo Basin has experienced much more frequent severe and extreme droughts since 1970, as compared with the period from 1905 to 1970.

N'tcha M'po, National Water Institute, Benin, reported that the Ouémé River Basin at Bétérou in Benin will experience increased discharge and surface runoff, which will be exacerbated if more natural vegetation is converted to agricultural land.

Melanie Lück-Vogel, Council for Scientific and Industrial Research (CSIR), South Africa, presented a portfolio of tools aimed at tackling climate risk for coastal areas, including an online flood hazard viewer to inform the public of coastal flood risk, a national coastal assessment to assist in prioritizing local action, and a planning tool for local municipalities.

Musonda Ng'onga, Ministry of Agriculture, Zambia, presented the results of a study comparing the vulnerability of two areas in Zambia, and finding that the area where livelihoods are based on fisheries is more vulnerable to climate change.

Zied Haj-Amor, Sfax University, Tunisia, reported the results of a study of soil in an arid Tunisian oasis, finding that by 2050, climate change will lead to serious degradation of soil carbon content, pH, and concentration of macronutrients, properties that affect soil fertility.

Questions concerned, *inter alia*: the importance of communicating results of research to coastal communities, including through online maps and videos; and the need for finance for climate change adaptation and disaster risk reduction.

On Monday afternoon, in a session moderated by Joyce Kimutai, UCT, South Africa, Cheikh Kane, French Research Institute for Development, discussed the occurrence of flash floods in Bamako, Mali, focusing on geomorphometric analysis, participatory mapping with affected communities, and assessment of different mechanisms to address the problem.

Ifeoma Quinette Anugwa, University of Nigeria, Nsukka, Nigeria, focused on farmers' adaptation strategies to address climate change impacts on rice production in Anambra State, Nigeria. She said that in a survey, farmers highlighted late



Joyce Kimutai, UCT, South Africa



Ifeoma Quinette Anugwa, University of Nigeria, Nsukka, Nigeria

onset of rainfall, high sun intensity, flooding, and drought as evidence of climate change having a devastating impact on rice production. She highlighted that farmers derive most climate-related information from their peers, and adaptation strategies used include drainage management, furrow-irrigated raised bed planting, minimum tillage, direct seeded rice, integrated nutrient management, and crop diversification.

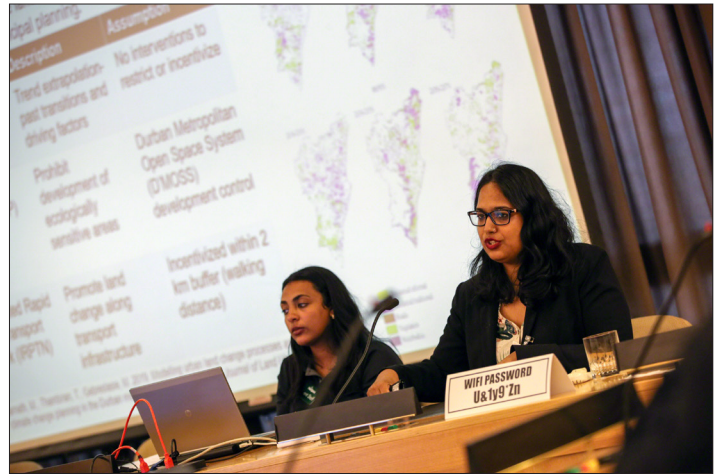
Dong-Gill Kim, Hawassa University, Ethiopia, addressed the land-water-nutrient nexus to enhance food security and mitigate GHG emissions in smallholder crop farming systems in sub-Saharan Africa. He suggested a combined conventional conservation agricultural model that may increase yields and mitigate GHG emissions, and also proposed focusing on yield-scaled rather than area-selected GHG emissions.

In the ensuing discussion, participants considered, *inter alia*: details of the process of participatory mapping; examples of programmes and policies to increase rice production; institutionalized proactive rather than reactive initiatives on climate change; the tangible differences between conventional and conservation agriculture, including in terms of GHG emissions; sustainable intensification methods; and the existence of empirical data on the advantages of combined conventional-conservation agriculture.

On Monday evening, Franklin Mabe, University for Development Studies, Ghana, presented a study on climate change adaptation strategies undertaken by inland artisanal fishers along the Volta River in Ghana. He noted findings indicating that the most commonly used adaptation strategies are increasing fishing efforts, fishing further away, and fishing at different times.

Richard Jones, Met Office, UK, highlighted the application of the CP4-Africa model to refine estimates of future extreme rainfall relevant to drainage infrastructure resilience in Lusaka. He pointed out that initial analysis showed global models under-predicting and CP4-Africa over-predicting daily rainfall. He noted indications that drainage currently protecting against 50-year events will only protect against 5- to 10-year events in the future.

Meryl Jagarnath, University of KwaZulu-Natal, South Africa, presented a case study from Durban, South Africa, on integrating urban land change and climate change data to inform spatial



Meryl Jagarnath, University of KwaZulu-Natal, South Africa

planning decisions. She explained and developed three land use change scenarios overlaid with climate change projections.

Rofida Abd El-Wahab, Institute of Graduate Studies and Research (IGSR), Egypt, discussed the implications of land use/land cover changes on the vulnerability of coastal regions to sea level rise. She noted the need to minimize the vulnerability of the Western region of the Nile Delta to sea level rise impacts by controlling current urbanization patterns and guiding development away from vulnerable areas.

Sylvia Dorbor, UCT, South Africa, highlighted the Africa Risk Facility, an attribution-based parametric insurance mechanism that aims to compensate farmers for weather-related events, and which envisages using attribution science to apportion insurance risk.

Tazen Fowe, International Institute of Water and the Environment (2iE), Burkina Faso, provided an overview on estimating flood damage for housing in flood-prone areas in Ouagadougou, Burkina Faso, noting that the objective was to establish a relationship between flood depth, likely damage, and cost.

Delivering resilience in the face of climate change uncertainty: On Tuesday morning, Dominic Boateng-Gyambiby, Center for Agribusiness and Development Research, Ghana, presented the results of a study aiming to determine the ideal drought index insurance policy for cereal farmers in the Northern region of Ghana, and how much cereal farmers are willing to pay. He highlighted findings that farmers prefer policies that have such characteristics as cash-in-hand mode of payment, and credit interlinked with insurance.

Caroline King, Centre for Ecology and Hydrology, UK, highlighted that to deliver drought resilience in the face of uncertainty: there are still major knowledge and implementation gaps in climate information; there is a need to share and improve national hydrological capabilities; and a major opportunity exists to boost international knowledge sharing and exchange.

Hugo Retief, Association for Water and Rural Development, South Africa, presented on systemic adaptive governance practices for climate change adaptation in the Olifants River catchment in South Africa, highlighting the need to understand

catchments systemically, support strategic and adaptive management, and co-design measures collaboratively with stakeholders.

Phil Graham, Swedish Meteorological and Hydrological Institute, stressed that hydrological and meteorological services provide important inputs to resilience building, and that capacity development is crucial. He outlined a knowledge partnering programme between his organization and Ethiopian meteorological and hydrological services.

Zerihun Weldegebriel, Addis Ababa University, Ethiopia, presented study results that show that the Productive Safety Net Programme, a social protection programme in rural Ethiopia, has a positive impact on income diversification for smallholder farmers, and in the short term, contributes positively to autonomous climate change adaptation, although in the long term requires strengthening.

Kanta Kumari Rigaud, World Bank, highlighted results from a study of internal climate migration scenarios between 2020 and 2050, including that: by 2050, over 143 million people in three regions could be climate migrants; and the number of migrants ramps up over time. She stressed the need to embed climate migration into resilient development planning.

Felix Olorunfemi, Nigerian Institute of Social and Economic Research, Nigeria, presented a flood risk index, combining physical, social, economic and institutional dimensions, used to assess selected flood prone communities in Ibadan, Nigeria, with findings indicating that none of the selected communities had a good level of resilience to flooding. He said the method could be adapted for use in larger cities.

Martha Kidemu Negassa, Haramaya University, Ethiopia, presented on climate-smart agriculture practices that increase soil carbon sequestration potential while also increasing food production. She highlighted challenges including the costs of adopting the practices, competition of crop residue for multiple use, and lack of knowledge on appropriate cropping systems.

Happison Chikova, Kupakwashe Cattle Fattening Cooperative, Zimbabwe, outlined the Kupakwashe beef value chain model, whereby smallholder beef producers are directly linked with retailers and beef consumers, meaning farmers gain 228 percent more revenue than in the typical value chain, revenue which is reinvested in breeding, cattle management, and pasture production. He said this can improve climate change adaptation and mitigation by smallholder farmers.

On Tuesday afternoon, during a session moderated by Japhet Kashaigili, Sokoine University of Agriculture, Tanzania, Constansia Musvoto, CSIR, South Africa, addressed climate change resilience through resource efficiency in smallholder vegetable production in South Africa. She noted inefficient use of inorganic and organic fertilizers and limited water conservation practices, stressing that after one year of interventions, water consumption and electricity costs declined, while yields and gross income increased.

Illa Elhadji Iro, Abdou Moumouni University, Niger, assessed the factors of food insecurity and general vulnerability due to climate and socio-economic shocks, using multi-nominal logistic



Illa Elhadji Iro, Abdou Moumouni University, Niger

regressions. Presenting methodologies on the vulnerability resilience indicator and on food insecurity, he summarized relevant results, focusing on actions that can improve food security, such as expenses on agricultural tools and seeds, while lowering exposure and sensitivity to climate risk.

Tara Southey, University of Stellenbosch, South Africa, focused on aspects of the climatic profile affecting grapevine production, focusing on environmental interactions at high resolution over six growing seasons in the Western Cape. She emphasized the need for an online spatial decision-making tool, hosting high-resolution spatial and temporal datasets, to aid adaptive strategies at farm and field level in the face of climate uncertainty.

Zerihun Amare Yohannes, Bahir Dar University, Ethiopia, focused on crop management strategies to combat climate change in Dejen District, Nile Basin of Ethiopia, addressing barriers and choice determinants. Using logistic regression, he identified small farmland size, farmland location, financial constraints, and lack of skills as main barriers to the adoption of crop management strategies. He further stressed that socio-economic and institutional factors determined rural communities' ability and willingness to choose adaptation strategies.

In the ensuing discussions, delegates addressed: use of multivariate probit models versus logistic regression ones; data



Tara Southey, University of Stellenbosch, South Africa

handling and availability; and challenges related to climate-resistant crops.

On Tuesday afternoon, during a panel discussion on multi-level governance in enabling climate resilient development, Kate Strachan, ICLEI Africa, highlighted that local and regional governments have an important role to play in global climate action, and outlined the concept of multi-level governance and the role of ICLEI Africa.

Mzime Murisa, START International, outlined challenges including rural-urban migration and politics between national and local governments when different political parties are in control of each, and stressed the need for organic bottom-up approaches to ensure organic and holistic solutions.

Genito Maure, Eduardo Mondlane University, Mozambique, spoke about water management in the Maputo region, particularly the Umbeluzi basin which spans three countries and involves many stakeholders. He highlighted that municipal authorities have a negligible role in water governance in the region.

Musonda Ng'onga, Ministry of Agriculture, Zambia, outlined a pilot project for climate change resilience in Zambia, which included governance actors at the global, national, provincial, district and local levels. He noted challenges including variability in governance approaches, unequal capacities in institutions and structure, and weak science-policy linkages.

John Mfune, University of Namibia, highlighted some of the opportunities, such as establishing appropriate partnership arrangements and improving capacity to integrate across social, environmental, economic and political backgrounds, and stressed that capacity building is important for stakeholders.

José Puppim de Oliveira, Fundação Getúlio Vargas, Brazil, stressed that any effective action for tackling climate change needs strong local capabilities, noting that multi-level governance will only work when local capabilities exist.

In the audience discussion, questions focused on, among other things: how to design processes to correct for power imbalances in the room; whether there are examples in Africa where multi-level governance is working to support equitable, climate-smart development beyond the project level; and understanding the roles of shadow actors in governance systems.

Mary Thompson-Hall, START International, noted a case study of governance of seed cooperatives and cotton cooperatives, where the entities that implemented policies at the national level had no way to identify issues in policy implementation or obtain feedback from those most affected.

On Tuesday evening, during a workshop on ways to make social protection services more adaptive, moderator Rosalind Cornforth, University of Reading, UK, highlighted the ASPIRE project designed to identify how climate information could inform social protection.

Mouhamadou Issa Lele, Met Office, UK, discussed seasonal forecasting and its relevance to social protection services. He noted that there is no standardized method and highlighted the need to understand the requirements of the users of climate information. He emphasized that: probability forecasts need to be translated to effective decisions; and the relationship between weather impacts and vulnerability must be clearly understood.

Celia Petty, Walker Institute, University of Reading, UK, reflected on why forecasts need additional livelihoods information, pointing out that social protection has to respond to extreme and unexpected events that disrupt livelihoods. She added that adaptive social protection is designed to respond to a specific event but to be effective, information is required on the nature of the threat and a mechanism is required to bring all the information together.

Cheikh Kane, Red Cross Red Crescent Climate Centre, discussed World Bank and DFID support to six countries in the Sahel to develop strategies and policies on social protection to counter shocks, explaining that climate shocks are a primary cause of food insecurity. He explained that seasonal forecasting is used because the Sahel economies are rain-fed and interventions consist of several modalities, including school feeding programmes and livelihood protection.

Luisa Ciampi, Walker Institute, underscored communication as a vital component of adaptive social protection, emphasizing the need to translate information between disciplines, bring different stakeholders together and build capacity. She described communication as a two-way process that takes time, involves understanding key actors, and requires consideration of 'noise factors' such as power structures and professional jargon.

In an interactive café format, participants then addressed two questions: whether climate services help build resilient livelihoods; and how silos between policy implementers, information producers and communities can be bridged.

Co-production of knowledge between science, business, policy, practice, and local communities: On Monday, Alice McClure, CSAG, South Africa, presented a FRACTAL project aimed at theorizing rich learning cultures of transdisciplinary research, which documented a full range of transdisciplinary co-production methods. She explained that the methods and learnings result in ownership of issues, and develop relational capacities and the expertise to deal with the cross-cutting problem of "know-who, alongside know-how and know-what."

Bruce Currie-Alder, International Development Research Centre (IDRC), elaborated lessons on membership, organization, and partnership from the Collaborative Adaptation Research in Africa and Asia (CARIAA), a multi-consortia research



Alice McClure, CSAG, South Africa



Delegates during the session on 'Co-production of knowledge between science, business, policy, practice, and local communities'

programme. He highlighted the need for: nested levels of coordination through thematic working groups; keeping the size of consortia manageable; and using collaborative spaces to interconnect consortia.

Emmanuel Nyadzi, Wageningen University, the Netherlands, highlighted a project aimed at integrating indigenous and scientific weather forecast and climate services to improve forecast reliability and acceptability in Ghana. He discussed findings that show that a combination of scientific and indigenous forecast is generally reliable and that farmers prefer integrated forecast information.

Idowu Kunlere, National Environmental Standards and Regulations Enforcement Agency (NESREA), Nigeria, discussed the role of strengthened public participation in combating climate change in Africa. He explained that the high failure rate of projects could be attributed to a lack of effective public participation in conceptualization and implementation due to factors including colonialism, dictatorship, and military rule. Kunlere advocated an inclusive, strategic shared risk concept.

Inga Menke, Climate Analytics, introduced ISIPedia, an online, open-access climate impacts encyclopedia, that aims to deliver climate impact assessments. She explained that the portal is targeted at people who would not usually use scientific information.

Neha Mittal, University of Leeds, UK, explained how climate information has been tailored for tea producing regions in Kenya and Malawi through engaging and partnering with key stakeholders to help them prioritize adaptation options and identify long-term adaptation pathways based on site-specific risk profiles.

Richard Graham, Met Office, UK, presented on building global-regional-national partnerships to strengthen seasonal forecasts and service co-production for the Greater Horn of Africa. He pointed to an increased uptake in co-produced, seasonal forecast services operating in Kenya via the Kenya Red Cross and KenGen, the electricity generation company.

Richard Jones, Met Office, UK, discussed the role of Climate Risk Narratives, aimed at translating climate data into coherent

stories, written in the present tense and exploring a range of plausible futures, with the main value being knowledge generation and deliberation.

Oluwatoyin Adejonwo-Osho, University of Lagos, Nigeria, highlighted the protection of reproductive rights as a pathway to environmental sustainability and climate-compatible development in Africa. She pointed to challenges in linking reproductive rights and population growth to environmental degradation, which is further hampered by cultural and religious beliefs, particularly in Africa.

On Tuesday, during a seminar, Kathrin Hall, Met Office, UK, and Josephine Wilson, WMO, presented the Lake Victoria Basin WISER programme for the HIGH impact Weather lAke sYstem (HIGHWAY) project designed to deliver increased use of weather information to improve resilience and reduce loss of life and damage to property. They outlined several outputs aimed at: enhancing existing institutional frameworks for early warning in East Africa; improving access to operational data sources; and strengthening integration among producers and users.

On lessons learned from HIGHWAY, they noted that co-production begins with the design and planning of the programme



Kathrin Hall, Met Office, UK



Anna Steynor, CSAG, South Africa

and in spite of an 18-month consultation process, there were still many questions at the beginning of the project around proposed activities. They highlighted that: defining terms was an important process to get everyone on the same page regarding the scope of the project; and managing partners' expectations of what can be delivered in a short project cycle is crucial. They further observed that complexity is not linear, many actors have to be coordinated, and that with a regional project, there are no economies of scale since it includes diverse actors at many levels.

Information distillation and communication: On Monday morning, in a workshop exploring differing priorities of actors engaged in collaborative resilience-building through Theatre Forum, Christopher Taylor, Centre for Ecology and Hydrology, UK, explained that using Theatre Forum to convey climate information is a powerful way to view different perspectives and provide insights.

Emma Visman, Kings College London, UK, provided the background to Theatre Forum where: actors play a story inspired by real facts and existing tensions; a moderator or joker then promotes discussion among participants and judges each of the characters in turn; and then spectators are invited by one of the characters to play out solutions. Participants then watched a screening of a piece by Kaddu Yarakha, a Senegalese theatre group, following which, Mamadou Dioi, Senegal, moderated a discussion.

Responding to the issues raised in the piece and ways to overcome them, Tufa Dinku, International Research Institute for Climate and Society (IRI), USA, explained how scientific information in Ethiopia is provided to relevant ministries such as agriculture, which is then developed into advisories for local communities.

Rose Ochieng, NIRAS, provided an intermediary perspective, emphasizing the need to: develop products that the local community will use; and to collaborate and open up spaces for scientists and communities to work together.

Ken De Souza, DFID, UK, pointed to power dynamics where people get stuck in roles and have very little incentive to change their behavior, emphasizing the need for behavioral change incentives.

On Monday afternoon, Anna Steynor, CSAG, South Africa, reported on a study of risk perceptions among policy decision influencers in East Africa, highlighting that the greatest predictor of action on climate change was social norms, and the most important predictor of concern about climate change was psychological distance to the threat. She outlined how an audience's risk perceptions can inform the content and format of climate information products.

Amy Pieterse, CSIR, South Africa, presented on the experience of developing the Green Book, an online planning support tool to provide municipalities with information on their specific needs. She identified benefits of the tool, including that it is modular and can be easily updated and expanded; and challenges such as aligning data approaches and formats and developing shared understandings.

Christopher Jack, CSAG, South Africa, outlined a framework for climate information distillation, consisting of: framing and questions, ensuring a common foundation; evidence and contradictions, gathering multiple perspectives and examining assumptions; and uncertainty and risk, where reducing uncertainty creates a trade off with the risk of being wrong.

Grigory Nikulin, Swedish Meteorological and Hydrological Institute, presented a comparison of GCMs, RCMs, and Earth System Models for seasonal mean rainfall in Africa, stressing the need for careful evaluation and analysis of models.

Hassana Gambo, Regional Centre of Expertise on Education for Sustainable Development Minna, Nigeria, reported that programmes communicating through traditional leaders, media influencers, religious leaders, entertainers, and youth leaders gained much higher numbers of participants, rates of grassroots participation, and participants from lower educational



Delegates attend the panel discussion entitled 'Collaborative engagement of public, private, and academic sectors for the next generation of weather and climate intelligence.'

backgrounds than those communicating through academic experts, environmentalists and government officials.

Tufa Dinku, IRI, USA, outlined the Enhancing National Climate Services (ENACTS) initiative, which he said strives to simultaneously improve the availability of, access to, and use of climate data and information by, for instance, developing online tools for data access and visualization and subjecting station data to quality control.

On Wednesday, a panel discussion addressed the collaborative engagement of public, private, and academic sectors for the next generation of weather and climate intelligence. Opening the session, Boram Lee, WCRP, highlighted WMO's goal regarding public-private academic exchange as a means to help members adopt a business environment by implementing high-level policies, aligning systems, and developing guidance and best practices. She outlined the Open Consultative Platform approved under the WMO Geneva Declaration in 2019, which aims to provide a vehicle for sustainable and constructive dialogue between sectors to help articulate a common vision for the future of the weather enterprise.



Boram Lee, WCRP

Panelists then addressed two topics on: weather and climate services driving decision-making; and addressing the capacity gap. On weather and climate services, Irene Amuron, Red Cross Red Crescent Climate Centre, highlighted the Towards Forecast-based Preparedness Action (ForPac) research project implemented in Kitui, Eastern Kenya, and Nairobi, aimed at improving forecasting extreme rainfall and flooding. She mentioned forecast co-production-based action as a success, noting however that the system, particularly in Kitui, is reactive and rigid. Elaborating further, Emmah Mwangi, Kenya Red Cross Society, pointed out that information metrics provided are probabilistic and therefore not actionable under the system.

Anna Steynor, CSAG, South Africa, emphasized the need for trust, noting that academics find it difficult to trust the private sector and work together in a way that is mutually beneficial. Observing that the FRACTAL project was able to overcome this, she explained that this resulted in sustained engagement between the project and city partners, leading to the establishment of networks.

Andre Kamga, African Center for Meteorological Applications for Development (ACMAD), underlined the need for collaboration between early warning risk assessors, risk warning services, risk communication experts, and civil protection agencies, pointing to the 2015 southern African drought, which was not adequately managed due to a lack of collaboration.

Kathrin Hall, Met Office, UK, highlighted a multi-hazard early warning service for Tanzania under the WISER impact-based forecast service, aimed at the marine sector and local communities. Pointing to its success, she noted that it has been adopted countrywide. Suzanne Carter, SSN, discussed a co-produced joint publication, the 'Manual on Coproduction in African Weather and Climate Services', which distils learning from 18 case studies on approaches to co-production of climate services, and pulls together six building blocks and 10 principles for co-production.

Judy Omumbo, African Academy of Sciences, reflected on the lack of transformative knowledge, whereby academics

see themselves as custodians of knowledge, and do not share knowledge until it is peer-reviewed and published. She stressed the need for academics to engage on how to share knowledge and take the lead.

On the capacity gap, Boram Lee noted that this prevents full access to the abundance of data and information. Anna Steynor pointed out that meteorological services are primarily funded through the sale of data, meaning that free access is difficult to implement. She further noted internet bandwidth constraints as a major barrier.

Kathrin Hall discussed the Strengthening Climate Information Partnerships (SCIPEA) project on improving reservoir management for effective hydropower supply in Kenya. She explained that seasonal forecast information is required for hydropower planning and that the key to this was co-production, which has resulted in a seasonal bulletin issued to the Kenya electricity generating company, KenGen, which enables them to plan ahead.

Irene Amuron explained that a focus on forecast-based financing requires impact-based methodology and a robust risk analysis, as well as linking to or complementing existing early warning systems, adding that meteorological services have limited resources and capacities.

Andre Kamga highlighted institutional gaps, noting: lack of return on capacity development; the need to use tools and products designed with weather features of the region in mind; and the need for forecast training.

Judy Omumbo observed that capacity building has been sector- rather than problem-focused. She emphasized the need: to address equity in partnerships: for Africa to speak with one voice; and for academia to focus on producing the right kind of scientists.

Suzanne Carter advocated strengthening collective ownership and value for all involved and delivering what people really want.

Cross-cutting issues – the water-energy-food-health nexus: On Monday morning, a panel discussion addressed agriculture in the context of climate adaptation. Declan Conway, LSE, UK, moderated the session. Addressing Adapting Agriculture to Climate Today for Tomorrow (ACToday), Sylwia Trzaska, IRI, emphasized climate information and services as a climate change

adaptive strategy, outlining the four pillars of climate services: information generation, translation, transfer, and use. She further presented ACToday's main objectives and work programme in six countries with different capacities and political systems, and highlighted multi-disciplinary approaches.

Tufa Dinku, IRI, discussed the implementation of ACToday in Ethiopia, addressing its focus, approach, accomplishments, and integration in the broader national efforts on climate. He emphasized: the ENACTS Initiative providing rainfall and temperature data; the importance of developing capacities to generate and use climate information products; and the need to create climate services solutions that take account of national contexts.

Fetene Teshome Tola, Director General, NMA, Ethiopia, addressed ACToday's support to NMA. He addressed: meteorological infrastructure in the data delivery systems, focusing on NMA's support to the Ministry of Agriculture; weather and climate monitoring, forecasts, and early warning systems; and collaboration with IRI on ACToday, including building capacities.

Jemal Seid Ahmed, Ethiopian Institute of Agricultural Research (EIAR), discussed EIAR's mission, vision, and mandates, focusing on research centers and research themes, including climate vulnerability and impact, adaptation and mitigation responses, and agricultural modelling.

In the ensuing discussion, participants focused on, *inter alia*: the rationale for country selection in ACToday; the role of partnerships in SDG implementation; the interlinkages between different agencies and sectors, including the contribution of ACToday to the Ministry of Agriculture in Ethiopia; and results in terms of measurable achievements in the implementation of ACToday in Ethiopia, together with major obstacles.

On Monday afternoon, a panel discussion focused on increasing capacity for water-related climate adaptation, identifying opportunities and lessons learned in Ethiopian river basins. Meron Teferi Taye, Addis Ababa University, Ethiopia, moderated the session, noting that the importance of water resource management increases with climate change. She underscored the importance of interdisciplinary work and posed questions to which the panelists responded in an interactive session.



Sylwia Trzaska, IRI



Jemal Seid Ahmed, EIAR

Regarding the benefits arising through the collaboration of water and climate scientists, Kinfe Hailemariam Beyene, NMA, Ethiopia, underscored that the climate-water nexus involves services provided to different sectors, including early warning systems that allow for better decision making.

Katrina Charles, University of Oxford, UK, emphasized that improving water security for the poor is cross-sectoral and inter-disciplinary in nature, stressing the need to broaden understandings of how to interpret climate risks.

On the quality of meteorological data and the potential to analyze climate-related information, Eyob Abebe, Ministry of Water, Irrigation, and Energy, Ethiopia, stressed the need for accurate information, especially on rainfall and temperature, to determine the crop water requirements in dry seasons. He called for more detailed forecasts, noting that the three-month forecast is not adequate for water allocation decisions.

Regarding tools that would make work easier in water-climate processes, Getachew Gizaw, Basin Development Authority, Ethiopia, underscored that most hydrometeorological stations are conventional and need to be upgraded and automated. He called for capacity building in modelling regarding water allocation.

Ayele Atlaw, Awash Basin Development Office, Ethiopia, emphasized that most meteorological stations only generate a limited number of parameters, such as rainfall or temperature, calling for real-time meteorological information.

During discussions, participants addressed: climate change and long-term water availability; cross-sectoral collaboration in relation to national disasters; data-sharing policies; and uncertainty around future water availability and demand.

On Tuesday, during a session moderated by Judy Omumbo, African Academy of Sciences, Ajay Bhawe, University of Leeds, UK, explained a co-production approach aimed at addressing fluctuating levels on Lake Malawi by focusing on developing a lake-level simulation using AMMA-2050 projections to run future simulations, adding that co-production trust building enabled stakeholders to understand the value addition, and that iteration helps to build long-term relationships.

Bianca Van Bavel, University of Leeds, UK, highlighted a project in South West Uganda aimed at detailing existing local



Ajay Bhawe, University of Leeds, UK

climate and health knowledge. She explained that key knowledge holders were identified and provided entry points for climate information, which could be tailored to suit their needs.

Maïmouna Traoré, 2iE, presented an analysis of occupancy practices in areas at risk of flooding in Ouagadougou, Burkina Faso, noting that recurrent floods affect population health and sanitation management. She outlined recommendations including: providing flood drainage systems to areas at risk of flooding; and regularly maintaining the storm drainage network.

Martin Todd, University of Sussex, UK, discussed the resilience of groundwater resources to climate variability and change in Africa, observing that groundwater will be heavily developed in the future as climate change threatens surface water and agriculture. Highlighting a comprehensive Pan African analysis of groundwater, he noted the need for: better models and data on hydrological modelling; and for climate, a better understanding of likely changes in climate variability, rainfall intensity, and simulations of inundation risk.

Matthew Ascott, British Geological Survey, UK, outlined how explicit modelling of convective storms affects predictions of future water resource availability in the Lake Victoria basin, noting that a lumped catchment model was developed to address shortcomings with the conventional climate model.

Joseph Sang, Jomo Kenyatta University of Agriculture and Technology, Kenya, provided an overview of the hydrological implications of tea sector adaptation to future climatic scenarios in the Sondu Miriu River, Kenya. He highlighted findings that tea growing in the future might require supplemental irrigation and that mid- and end-century growing of tea bushes will reduce flows from the Sondu Miriu basin.

Siyabusa Mkuhlani, CSAG, discussed the effectiveness of seasonal forecast information and recommended farm management practices in small scale farming systems of South Africa. He explained that most strategies consisted of organic cover, irrigation, and improved fertilizer, and that the recommendations were more effective in the Limpopo region than in the Eastern Cape.

Mariama Camara, START International, presented Promoting Gains in Renewable Energy (ProGREEN), a project on



Bianca Van Bavel, University of Leeds, UK



Delegates raise their hands during an interactive session to share their opinions of ACRC 2019

strengthening knowledge on key factors and major impacts of renewable energy access in West Africa. She explained that preliminary results demonstrate insufficient data on current and past renewable energy efforts, and, at the local level, issues include high costs of accessing renewable energy, lack of skilled workers to maintain systems, and lack of consultation with local populations.

On Wednesday, a workshop addressed the Sustainable Urban Global Initiative (SUGI), tackling urban challenges by co-creating knowledge on the food-water-energy nexus. Johannes Riegler, JPI Europe, moderated the session.

Jonas Bylund, JPI Europe, introduced the SUGI food-water-energy nexus call launched in 2016, aimed at inviting international partners to develop solutions that target the food-water-energy nexus challenge, focusing on: robust knowledge, indicators and assessments; multi-level governance and management; and managing strategies and solutions.

Outlining the Gdansk smart city strategy and urban innovative agenda, Joanna Tobolewicz, Poland, emphasized participation as the key to city management. She provided an overview of various city initiatives including the Tristar road management programme, which led to a shift from public to car transportation, noting that not every smart solution is sustainable.

Joanna Bach Glowinska elaborated on the Climate Resilient Urban Nexus CHOICES (CRUNCH) project aimed at combining an integrated decision support system and visualization models around waste, food, water and energy management. She explained how under CRUNCH, an urban living lab project in Gdansk was being developed with the aim of bringing people together and helping them to understand innovation around the food-water-energy nexus.

Jose A. Puppim de Oliveira, Brazil, highlighted the Innovative Initiatives for Governing Food, Water and Energy Nexus in Cities (IFWEN) project aimed at improving understanding of the innovative governance structure of the food-water-energy nexus in cities. He highlighted that it aims to provide significant benefits

in addressing some of the most complex global problems, including climate change and biodiversity loss, as well as helping to achieve other developmental goals such as food security and health.

High-Level Closing Session

Ernest Afiesimama, WMO, moderated the closing plenary session. He underscored that “the first” ACRC implies an expectation of subsequent conferences; applauded the success of the conference, which he said encourages future work; and highlighted initiatives to break barriers and have an integrated climate risk analysis in Africa.

Chris Jack, CSAG, South Africa, invited delegates to assess whether the conference had achieved its objectives, and highlighted key progress on: high-resolution modeling; conceptual understanding of model performance to inform model development; linking risk management resilience and climate information; and capacity development using climate information. He outlined key challenges, including capacity development and African leadership, the “last mile” problem and



Ernest Afiesimama, WMO



Chris Jack, CSAG, South Africa

scaling, finance, and uncertainty in climate predictions in Africa. Jack further identified interrelated challenges and opportunities, and invited delegates to express their opinions on options for the way forward.

Rosalind West, DFID, UK, highlighted successes in advancing the fundamental science, and bringing that science into use, while underscoring the need to do more on capacity building and on making the economic case for weather and climate information services. She said, “climate science isn’t just for climate scientists, it is for everyone.”

Joseph Mukabana, WMO, emphasized the need to develop national frameworks for climate services in order to scale up the use of climate services in monitoring, production, delivery, and user application, as well as research to support socio-economic development and to understand impacts.

Frank Rutabingwa, UNECA, stressed that the depth of discussions demonstrates that climate change is the biggest challenge on the continent. Reminding delegates that Africa will be the second hardest hit region by climate impacts following the polar zones, he emphasized that adaptation is key, praising the conference for its steps forward in that respect.

Robbie Redda, SSN, offered a vote of thanks and closed the session at 5.04 pm.

Upcoming Meetings

17th Regular Session of the African Ministerial Conference on the Environment (AMCEN): The 17th meeting of the African Ministerial Conference on the Environment will be held under the theme, “Taking action for Environmental Sustainability and Prosperity in Africa.” **dates:** 11-15 November 2019 **location:** Durban, Kwazulu-Natal, South Africa **www:** <https://www.unenvironment.org/regions/africa/african-ministerial-conference-environment>

3rd Conference on Land Policy in Africa (CLPA-2019): The 3rd edition of the Conference on Land Policy in Africa will convene under the theme, “Winning the Fight against Corruption in the Land Sector: Sustainable Pathway for Africa’s Transformation.” **dates:** 25-29 November 2019 **location:** Abidjan, Côte d’Ivoire **www:** <https://www.uneca.org/clpa2019>

Santiago Climate Change Conference (UNFCCC COP 25): The Santiago Climate Change Conference, which will feature



Rosalind West, DFID, UK

the 25th session of the Conference of the Parties (COP 25) to the UNFCCC, the 15th session of the Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol (CMP 15), and the 2nd session of the Conference of the Parties serving as the Meeting of the Parties to the Paris Agreement (CMA 2), will convene along with meetings of the UNFCCC subsidiary bodies. The pre-session period will be from 26 November - 1 December 2019. **dates:** 2-13 December 2019 **location:** Santiago, Chile **www:** <https://unfccc.int/santiago>

Glossary

AMMA	The African Monsoon Multidisciplinary Analysis
ASPIRE	Adaptive Social Protection – Information for Enhanced Resilience Project
CMIP5	Fifth phase of the Coupled Model Intercomparison Project
CSAG	Climate Systems Analysis Group
CSIR	Council for Scientific and Industrial Research
DFID	Department for International Development, UK
FRACTAL	Future Resilience for African Cities and Lands
GCM	Global Climate Model
GFCS	Global Framework for Climate Services
GHG	Greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
NMA	National Meteorology Agency
RCM	Regional Climate Model
SHEAR	Sciences for Humanitarian Emergencies and Resilience
SSN	SouthSouthNorth
UCT	University of Cape Town
UNECA	UN Economic Commission for Africa
WISER	Weather and Climate Information Services for Africa
WMO	World Meteorological Organization