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4 MARCH, 2025 | ISSUE 4

CLIMATE INSIGHTS

Your fortnightly update on the latest publications

CGIAR

Hello! Welcome to Issue #4 of Climate Insights 2025, the Climate Impact Platform's fortnightly roundup of the latest publications on climate change impacts and adaptation, mitigation measures, and the physical science from the literature. We're tracking trending topics in the climate space and linking them to our work for a food secure future with a brief comment on the implications of this new research on our own portfolio of climate research for development.

Here's your roundup from the last week:

CLIMATE CHANGE IMPACTS AND ADAPTATION

Human-induced climate change increased 2021-2022 drought severity in horn of Africa

Kimutai, Joyce, et al. (2025), Human-induced climate change increased 2021-2022 drought severity in horn of Africa, *Weather and Climate Extremes.*

From October 2020 to early 2023, Eastern Africa experienced five consecutive failed (SPEI -2.6) rainy seasons, resulting in the worst drought in 40 years. This led to harvest failures, livestock losses, water scarcity, and conflicts, leaving approximately 4.35 million people in need of humanitarian aid. To understand the role of human-induced climate change in the drought, the authors analysed rainfall trends and the combined effect of rainfall deficit with high temperatures in the Southern Horn of Africa covering parts of southern Ethiopia, southern Somalia, and eastern Kenya. The study employed various climate models and observations to assess changes in 24-month rainfall (2021–2022), and seasonal rainfall; both the (March-April-May, MAM) 'long rains' and (October-November-December, OND) 'short rains' in 2022. The study also contextualised the event in terms of vulnerability and exposure to understand how these elements influenced the magnitude of the impacts. The analysis shows that anthropogenic influence on the combined effects of low rainfall and high evapotranspiration caused by higher temperatures made the drought exceptional, leading to major crop and pasture losses and water shortages. The results also show a decline in rainfall during MAM and an upward trend during OND, which is attributable to climate change. Despite the wetting trend in OND season, the drought years concluded with successive La Niña conditions, typically linked with below-average rainfall in the region during that season. The authors do not find a trend in the 24-month precipitation. The assessment on vulnerability and exposure highlights the need for enhanced preparedness of government drought management systems and international aid infrastructure for future severe and prolonged droughts. The study's findings, combined with climate projections that indicate increased heavy precipitation in the region, underscore the pressing necessity for robust adaptation strategies that can address both wet and dry extremes. The impacts of climate change in Eastern Africa necessitate investments in adaptive measures and resilience building that can evolve with emerging climate signals.

Learn more

In CGIAR's Climate Impact Area Webinar Series #1 in 2024, Dr. Joyce Kimutai explored the question of how attribution science can inform loss and damage. She discussed the human-induced impacts of climate change in Africa and emphasized the need for additional ways of assessing loss and damage to address farmer's vulnerabilities in the face of extreme weather events.

Watch here

Loss and damage in tropical fisheries: a systematic review of people, climate, and fisheries

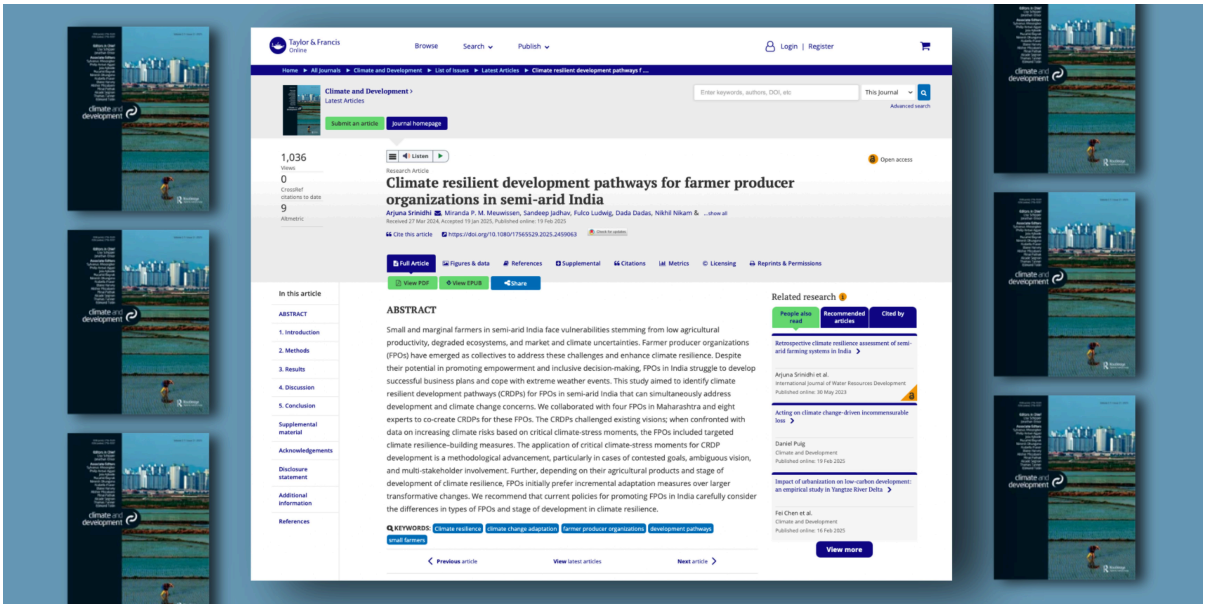
N’Guetta, Alicia, et al. (2025), Loss and damage in tropical fisheries: a systematic review of people, climate, and fisheries, *Regional Environmental Change.*

Climate change loss and damage research and policy includes biodiversity loss as a non-economic loss and damage. Yet there is scant understanding of what is loss and damage in tropical fisheries and how it is measured. The authors conducted the first systematic review of loss and damage in fisheries. The study uses a qualitative interpretivist values–based lens to examine fishers’ intrinsic, instrumental, and relational values in the literature. A systematic review was carried out on the interdisciplinary literature on fisheries in 2022–2023. Guided by criteria and questions, 11 case studies that fit the criteria for loss and damage in fisheries (17% of total literature identified) were identified. All 11 cases reported economic loss and damage (e.g. income and fisheries catch). Many studies have reported non-economic loss and damage (e.g. loss of ecosystem services and species (82%), food security and health (82%), mobility (19%)). The results also show that loss and damage in fisheries are valued in a relational way to fishers’ livelihood, way of life, and well-being through for example loss of social and emotional well-being (73%), sense of belonging (36%), and identity (27%). Several studies underscore socioeconomic, political, and environmental drivers that intersect locally with climate change, such as overfishing and pollution (55%), or failure of international policies and development aid (37%). The authors suggest that the current international policy framing of loss and damage risks undermine the understanding of local fishers’ everyday experience and argue for plural and inclusive ways of knowing and valuing loss and damage in fisheries.

Learn more

CGIAR scientists at WorldFish published a paper that explores how climate change impacts on tropical fisheries will affect sustainable development, and identifies practical adaptations measures to tackle these challenges.

Read more



Climate resilient development pathways for farmer producer organizations in semi-arid India

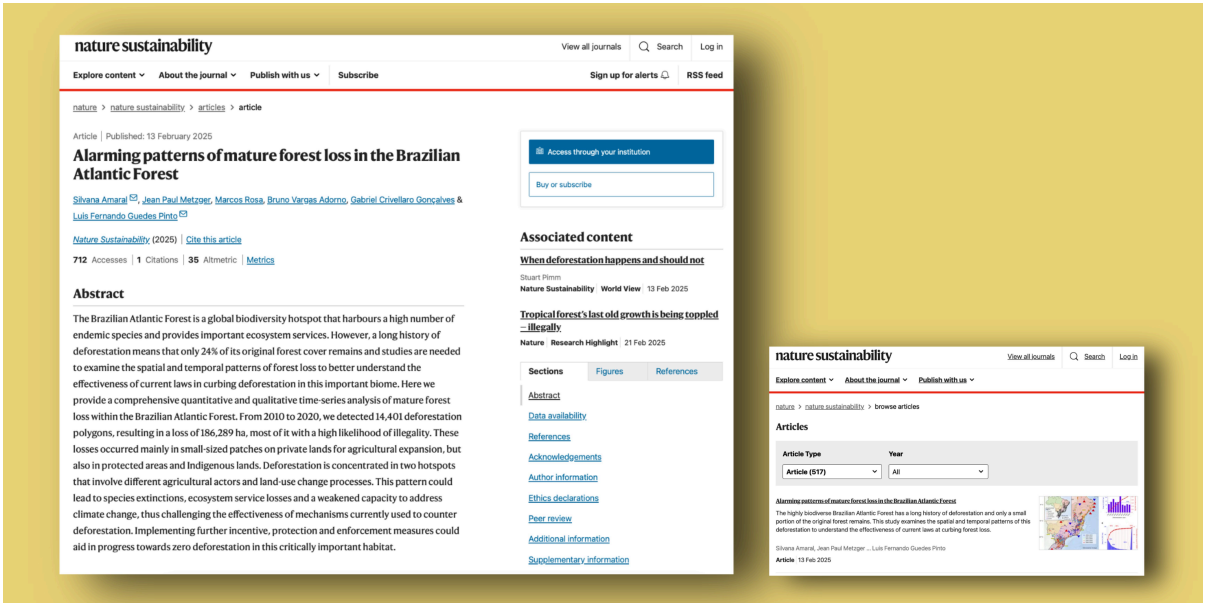
Srinidhi, Arjuna, et al. (2025), Climate resilient development pathways for farmer producer organizations in semi-arid India, *Climate and Development.*

Small and marginal farmers in semi-arid India face vulnerabilities stemming from low agricultural productivity, degraded ecosystems, and market and climate uncertainties. Farmer producer organizations (FPOs) have emerged as collectives to address these challenges and enhance climate resilience. Despite their potential in promoting empowerment and inclusive decision-making, FPOs in India struggle to develop successful business plans and cope with extreme weather events. This study aimed to identify climate resilient development pathways (CRDPs) for FPOs in semi-arid India that can simultaneously address development and climate change concerns. The authors collaborated with four FPOs in Maharashtra and eight experts to co-create CRDPs for these FPOs. The CRDPs challenged existing visions; when confronted with data on increasing climate risks based on critical climate-stress moments, the FPOs included targeted climate resilience–building measures. The application of critical climate-stress moments for CRDP development is a methodological advancement, particularly in cases of contested goals, ambiguous vision, and multi-stakeholder involvement. Further, depending on their agricultural products and stage of development of climate resilience, FPOs initially prefer incremental adaptation measures over larger transformative changes. The authors recommend that current policies for promoting FPOs in India carefully consider the differences in types of FPOs and stage of development in climate resilience.

Learn more

CGIAR scientists support research on climate resilience as part of the ClimBeR - CGIAR's initiatives on climate resilience, which aims to transform the climate adaptation capacity of food and agricultural systems in low- and middle-income countries.

Read more



Alarming patterns of mature forest loss in the Brazilian Atlantic Forest

Amaral, Silvana, et al. (2025), Alarming patterns of mature forest loss in the Brazilian Atlantic Forest, *Nature Sustainability.*

The Brazilian Atlantic Forest is a global biodiversity hotspot that harbours a high number of endemic species and provides important ecosystem services. However, a long history of deforestation means that only 24% of its original forest cover remains and studies are needed to examine the spatial and temporal patterns of forest loss to better understand the effectiveness of current laws in curbing deforestation in this important biome. The study provides a comprehensive quantitative and qualitative time-series analysis of mature forest loss within the Brazilian Atlantic Forest. From 2010 to 2020, 14,401 deforestation polygons were detected, resulting in a loss of 186,289 ha, most of it with a high likelihood of illegality. These losses occurred mainly in small-sized patches on private lands for agricultural expansion, but also in protected areas and Indigenous lands. Deforestation is concentrated in two hotspots that involve different agricultural actors and land-use change processes. This pattern could lead to species extinctions, ecosystem service losses and a weakened capacity to address climate change, thus challenging the effectiveness of mechanisms currently used to counter deforestation. Implementing further incentive, protection and enforcement measures could aid in progress towards zero deforestation in this critically important habitat.

Learn more

CGIAR scientists at the CIFOR-ICRAF have been working in Brazil since 2004, conducting research on forest landscape restoration, systems, and climate change mitigation and adaptation, mainly in the Amazon, Cerrado and Atlantic Rainforest biomes.

Read more


frontiers | Frontiers in Agronomy

Agroecology and the limits to resilience: extending the adaptation capacity of agroecosystems to drought

Agroecology and the limits to resilience: extending the adaptation capacity of

agroecosystems to drought

Altieri, Miguel A., et al. (2025), Agroecology and the limits to resilience: extending the adaptation capacity of agroecosystems to drought, *Frontiers.*

Given the unpredictability, increasing frequency and severity of climatic events, it is crucial to determine the adaptation limits of agroecological strategies adopted by farmers in a range of environments. In times of drought many smallholders' farmers cope with stress using a series of crop diversification and soil management strategies. Intercropping and agroforestry systems complemented with mulching and copious organic matter applications can increase water storage, enhancing crops' water use efficiency. Although an overwhelming number of studies demonstrate that these agroecological designs and practices are associated with greater farm-level resilience, it is important to recognize the limits of resilience. The aim of this paper is to assess the limitations of agroecological practices in enhancing the ability of agroecosystems to adapt to climate change under extended drought stress which may overwhelm crops' adaptation response. A set of agroecological practices that can extend such limits under prolonged water stress scenarios are described. Two methodologies to assess farms' resilience to drought provide useful tools, as they can assist farmers and researchers in identifying the practices and underlying mechanisms that reduce vulnerability and enhance response capacity allowing certain farm systems to better resist and/or recover from droughts. Clearly, reducing farmers exposure to drought requires collective actions beyond the farm scale (i.e. restoring local watersheds to optimize local hydrological cycles) aspects not explored herein. When climatic events are compounded by uncertainties imposed by external economic and political conditions, farmers' abilities to overcome adversity may be reduced, emphasizing the importance of policy support, a dimension beyond the scope of this review.

Learn more

This paper is led by Dr. Miguel Altieri, former chairman of the CGIAR-NGO Committee. Learn more on the CGIAR-NGO committee.

Read more

Shorter growing seasons may moderate climate change effects on crop water demands

Abatzoglou, John T., et al. (2025), Shorter growing seasons may moderate climate change effects on crop water demands, *Environmental Research Letters.*

Rising evaporative demand (ETo) with a warming climate contributes to diminished water availability in water-stressed agricultural regions globally. While increased ETo typically necessitates increased irrigation, the study explore how crop phenological response can moderate this challenge. Focusing on five key agricultural crops in California's San Joaquin Valley (SJV), the authors employ coupled water balance and phenology models to project crop water demands as a function of increased ETo and changing phenology. All crops exhibited accelerated growth from a shortened growing season with warming. The shortened crop maturation period partially to fully offset increased crop water demands due to rising ETo, with the largest phenological influence for annual crops such as tomato and corn. By contrast, models that do not account for phenological changes showed increased irrigation demands of approximately 3.5%–4.5% per °C of global warming primarily due to increased ETo. Integration with dynamic phenological models for the five key crops across the extent of agricultural land in the SJV showed a 1.6% decrease in irrigation needs under a 2 °C warming scenario. While phenological change alongside plant physiological responses to increased atmospheric CO2 may help buffer the impact of climate change on crop irrigation demand, decreased crop yields with a shorter growing season and continued reliance of groundwater reserves for agricultural water use and reduced spring snowpack will threaten coupled agricultural and water security in the region.

Learn more

CGIAR's IWMI key area of research is on water, food, and ecosystems. IWMI explores 'beyond growth' framing in a recent study as a response to the world's water crises.

Read more

CLIMATE CHANGE MITIGATION

Coping with decarbonisation: An inventory of strategies from resistance to transformation

Brisbois, Marie Claire, et al. (2025), Coping with decarbonisation: An inventory of strategies from resistance to transformation, *Global Environmental Change.*

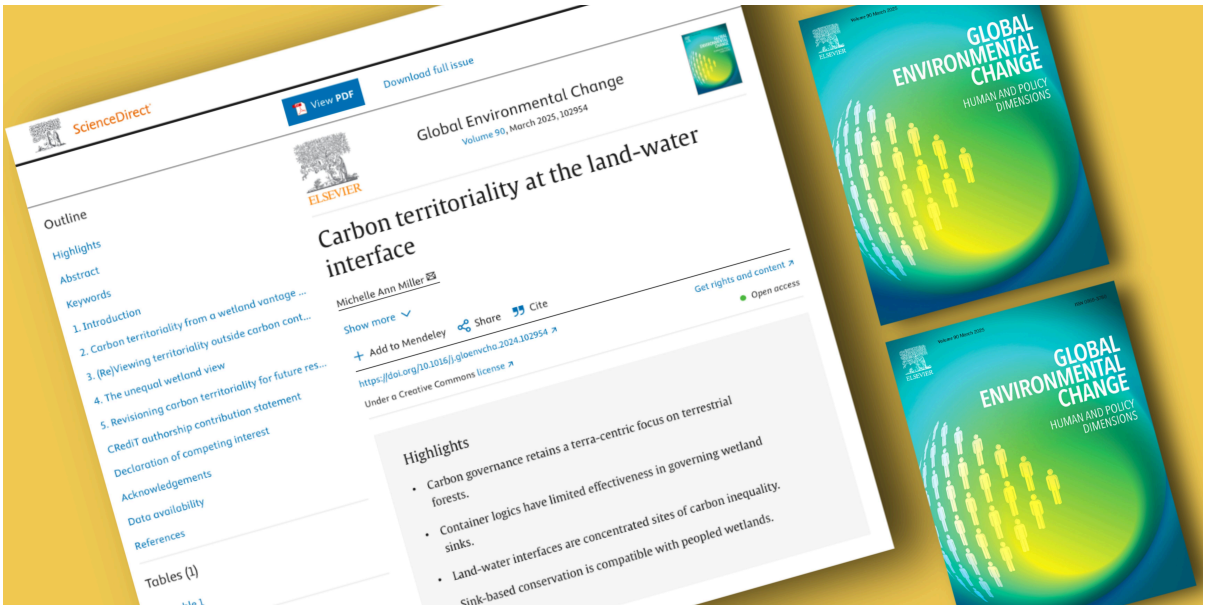
Decarbonisation is progressing rapidly and different actors respond to its impacts in different ways. Whether these responses seek to resist decarbonisation, adapt to new realities, or fundamentally transform the social and economic conditions that define decarbonisation contexts depends on the actor groups in question and the resources they are able to draw upon. This paper provides an overview of the kinds of "coping strategies" used by different actor groups in response to decarbonisation policy by inventorying these responses across eleven European carbon intensive regions in transitions. Using newspaper data, local level focus groups and elite interviews, a data set of 651 responses was created. Actions were grouped into 8 themes and 34 discrete strategies. These strategies reveal a wide range of responses. They demonstrate that resistance responses often reflect unaddressed injustices, that many governments are focused on decarbonisation strategies that substitute renewables for fossil fuels without changing wider socioeconomic conditions, and that there is broad appetite on the part of publics for more transformative strategies that allow deeper participation

and representation, and reshape who benefits, and how, from the reorganisation of energy systems.

Learn more

CGIAR's CCAFS program explored decarbonizing Costa Rica's agriculture sector with a focus on diverse stakeholder inclusion to create recommendations for the effective transformation of the sector.

Read more



Carbon territoriality at the land-water interface

Miller, Michelle Ann (2025), Carbon territoriality at the land-water interface, *Global Environmental Change*.

Large volumes of organic carbon are stored in wetland ecosystems such as mangrove forests, peatlands, salt marshes and seagrass meadows. Efforts to mitigate anthropogenic climate change are transforming the governance of these naturally saturated carbon sinks. Scientific and market valuations of wetlands as carbon have prompted diverse experimentation with carbon sequestration projects and offset programs. These activities may displace wetland-reliant communities and add to societal equalities. This perspective paper develops the concept of carbon territoriality to explore emerging spaces of climate governance in wetlands. It moves beyond terra-centric policy debates tied to fixed and flat landscapes by integrating literature on the dynamic (sub)surface and atmospheric territorial dimensions of carbon. It posits that combining scientific knowledge of fixed carbon stocks with the inherited knowledge of coastal and riparian communities about fluid land–water connections could foster more inclusive and equitable forms of climate stewardship within biogeophysically relevant boundaries.

Learn more

CGIAR's IWMI researches wetland ecosystems to provide strong governance inputs and develop frameworks for its equitable use. Read a framework for Colombo's wetlands here.

Read more

Climate change inequalities: A systematic review of disparities in access to mitigation and adaptation measures

Zahnow, Renee, et al. (2025), Climate change inequalities: A systematic review of disparities in access to mitigation and adaptation measures, *Environmental Science & Policy.*

Climate change is tightly coupled with patterns of inequality at both the global and local spatial scales. Inequitable access to climate change mitigation and adaptation strategies can exacerbate existing social vulnerabilities and enhance disparities in the impacts of climate change. Despite advances in the development of sustainable adaptation and mitigation strategies, the extent to which access to practical initiatives is equitable across the population remains poorly understood. This study provides a systematic review of empirical studies that consider social equality in access to climate change adaptation and mitigation initiatives. Its findings show that in the last decade, research has tended to focus on international income inequalities and climate injustice while few studies have considered inequalities in access to mitigation and adaptation initiatives at the neighbourhood or city level. Also largely absent from the reviewed research, were studies focused on vulnerabilities other than economic disadvantage, such as immigrant status, language barriers or physical disabilities. The authors suggest that more studies using mixed-methods are required to co-develop sustainable climate

change adaptation practices that are accessible for all individuals and appropriate within local contexts.

Learn more

CGIAR scientists with the ClimBeR - CGIAR's initiative on climate resilience explored applying a social equity approach to transformative climate change adaptation to minimize maladaptation and ensure the protection of marginalized groups.

Watch here

Recommendations for strengthening blue carbon science

Dahl, Martin, et al. (2025), Recommendations for strengthening blue carbon science, *One Earth.*

Blue carbon (BC) habitats (e.g., mangroves, tidal marshes, and seagrasses) are important CO2 sinks but are among the most threatened ecosystems on Earth. Substantial research over the last decade has quantified BC to evaluate the climate benefits associated with habitat conservation and restoration. However, the exponential growth in BC science has resulted in differing approaches that hinder comparison across studies and increase uncertainty. Here, the authors synthesized existing data to depict the range of uncertainty associated to different BC methodologies and argue that cumulative biases linked to multiple methodologies can result in BC estimates differing by up to 10-fold. The authors identified 14 common research procedures that can be improved to strengthen BC biophysical assessments and support implementation of BC projects, and outlined good practices to align research with policy, management, and ethical values. Standardization of practices will help generate high-quality BC projects that can deliver multiple co-benefits for humans and the environment.

Learn more

CGIAR scientists are supporting the development of research on blue carbon through assessments on seagrass and mangrove ecosystems and the future of blue carbon science (read here).

Read more

Optimizing sustainability in rice-based cropping systems: a holistic approach for integrating soil carbon farming, energy efficiency, and greenhouse gas reduction strategies via resource conservation practices

Dash, P.K., et al. (2025), Optimizing sustainability in rice-based cropping systems: a holistic approach for integrating soil carbon farming, energy efficiency, and greenhouse gas reduction strategies via resource conservation practices, *Agronomy for Sustainable Development.*

In lowland rice agroecosystems, inefficient resource utilization has led to reduced agricultural productivity and increased greenhouse gas emissions, particularly methane from flooded paddy fields. Alternative systems, such as rice-green gram under resource conservation practices, are underexplored in eastern India, where energy-intensive, high-emission, low-productivity rice-rice and rice monocropping systems prevail. This study is the first to demonstrate that a rice-green gram system with resource conservation technologies can improve soil health, reduce emissions, and increase productivity. A field study conducted during the 2014–2015 and 2015–2016 cropping seasons, part of a long-term experiment beginning in 2011-2012, compared six resource conservation technologies, including brown manure, green manure, wet drum seeding, zero tillage, green manure with real-time nitrogen, and biochar, to conventional

practices. Key metrics assessed included system yield, greenhouse gas emissions, soil organic carbon stocks, and energy savings across different seasons. Zero tillage showed the highest carbon sequestration rate (0.97 Mg ha−1 yr−1), significantly increased soil organic carbon levels, and provided substantial energy savings (52.0 to 67.8%) while exhibiting the lowest global warming potential. Green manure also increased soil organic carbon and crop yields but was associated with higher greenhouse gas emissions compared to other practices. Overall, all resource conservation technologies improved system productivity and soil organic carbon stocks compared to conventional practices. The findings suggest that zero tillage and green manure are particularly effective in enhancing soil organic carbon levels and reducing greenhouse gas emissions in lowland rice-based cropping systems. Zero tillage, especially, stands out as a sustainable agricultural practice, offering a promising approach to mitigating methane emissions and achieving long-term soil carbon storage. The adoption of these practices can therefore contribute significantly to the sustainability and resilience of agricultural systems, paving the way for climate-smart agriculture that balances productivity with environmental sustainability.

Learn more

The authors are from ICAR, which partnered with CGIAR's IRRI in 2023 to promote cooperation in research and development work related to rice genetic resources. Read about IRRI here.

Read more

Natural sequestration of carbon dioxide is in decline: climate change will accelerate

Curran, James C. and Curran, (2025), Natural sequestration of carbon dioxide is in decline: climate change will accelerate, *Weather.*

The rate of natural sequestration of CO2 from the atmosphere by the terrestrial biosphere peaked in 2008. Atmospheric concentrations will rise more rapidly than previously, in proportion to annual CO2 emissions, as natural sequestration is now declining by 0.25% per year. The current atmospheric increment of +2.5ppm CO2 per year would have been +1.9ppm CO2, if the biosphere had maintained its 1960s growth rate. This effect will accelerate climate change and emphasises the close connection between the climate and nature emergencies. Effort is urgently required to rebuild global biodiversity and to recover its ecosystem services, including natural sequestration.

Learn more

CGIAR's CCAFS program provides evidence and tools for monitoring emissions and sequestration in LED smallholder farming.

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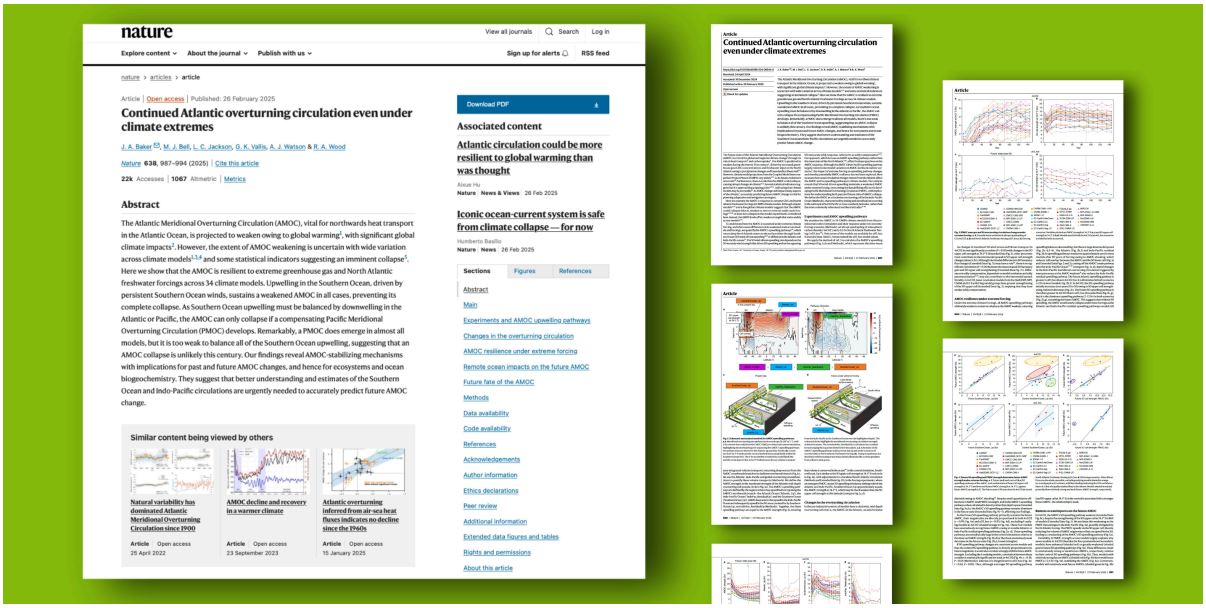
PHYSICAL BASIS OF CLIMATE CHANGE



Continued Atlantic overturning circulation even under climate extremes

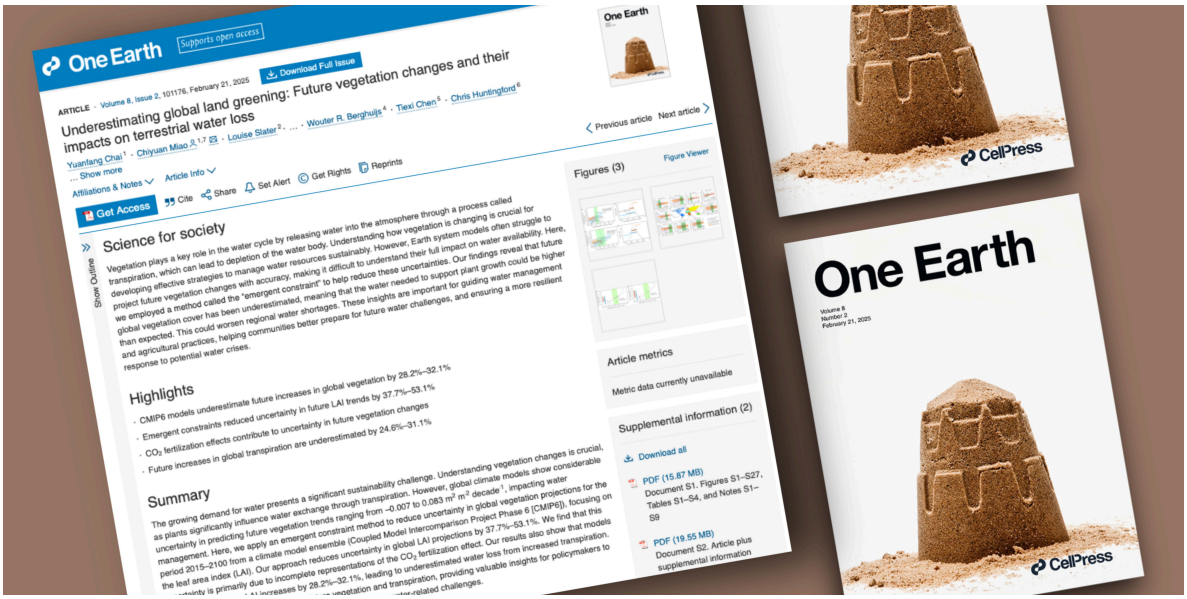
Baker, J.A., et al. (2025), Continued Atlantic overturning circulation even under climate extremes, *Nature.*

The Atlantic Meridional Overturning Circulation (AMOC), vital for northwards heat transport in the Atlantic Ocean, is projected to weaken owing to global warming, with significant global climate impacts. However, the extent of AMOC weakening is uncertain with wide variation across climate models and some statistical indicators suggesting an imminent collapse. In this study the authors show that the AMOC is resilient to extreme greenhouse gas and North Atlantic freshwater forcings across 34 climate models. Upwelling in the Southern Ocean, driven by persistent Southern Ocean winds, sustains a weakened AMOC in all cases, preventing its complete collapse. As Southern Ocean upwelling must be balanced by downwelling in the Atlantic or Pacific, the AMOC can only collapse if a compensating Pacific Meridional Overturning Circulation (PMOC) develops. Remarkably, a PMOC does emerge in almost all models, but it is too weak to balance all of the Southern Ocean upwelling, suggesting that an AMOC collapse is unlikely this century. These findings reveal AMOC-stabilizing mechanisms with implications for past and future AMOC changes, and hence for ecosystems and ocean biogeochemistry. They suggest that better understanding and estimates of the Southern Ocean and Indo-Pacific circulations are urgently needed to accurately predict future AMOC change.

Learn more

CGIAR scientists at WorldFish research the sustainability and resilience of aquatic food systems, addressing the impacts of global climate change on oceans and the communities that directly depend on healthy marine ecosystems. Read more about WorldFish projects on climate and aquatic food systems.

Read more



Underestimating global land greening: Future vegetation changes and their impacts on terrestrial water loss

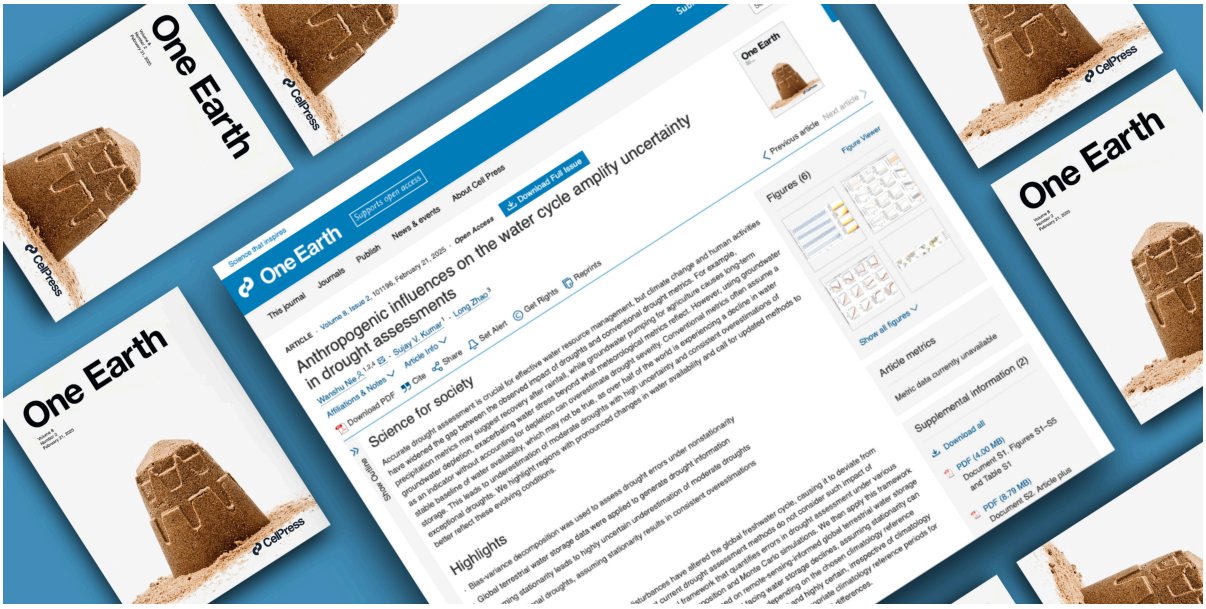
Chai, Yuanfang, et al. (2025), Underestimating global land greening: Future vegetation changes and their impacts on terrestrial water loss, *One Earth.*

The growing demand for water presents a significant sustainability challenge. Understanding vegetation changes is crucial, as plants significantly influence water exchange through transpiration. However, global climate models show considerable uncertainty in predicting future vegetation trends ranging from −0.007 to 0.083 m2 m⁻2 decade⁻1, impacting water management. In this study, the authors apply an emergent constraint method to reduce uncertainty in global vegetation projections for the period 2015–2100 from a climate model ensemble (Coupled Model Intercomparison Project Phase 6 [CMIP6]), focusing on the leaf area index (LAI). approach reduces uncertainty in global LAI projections by 37.7%–53.1%. The authors find that this uncertainty is primarily due to incomplete representations of the CO2 fertilization effect. Our results also show that models underestimate future LAI increases by 28.2%–32.1%, leading to underestimated water loss from increased transpiration. These findings improve predictions of future vegetation and transpiration, providing valuable insights for policymakers to adjust water management strategies and better prepare for water-related challenges.

Learn more

CGIAR scientists from the IWMI developed a satellite-based method to monitorimate, and unlock agricultural water use insights in the Ganges and Mekong deltas.

Read more



Anthropogenic influences on the water cycle amplify uncertainty in drought assessments

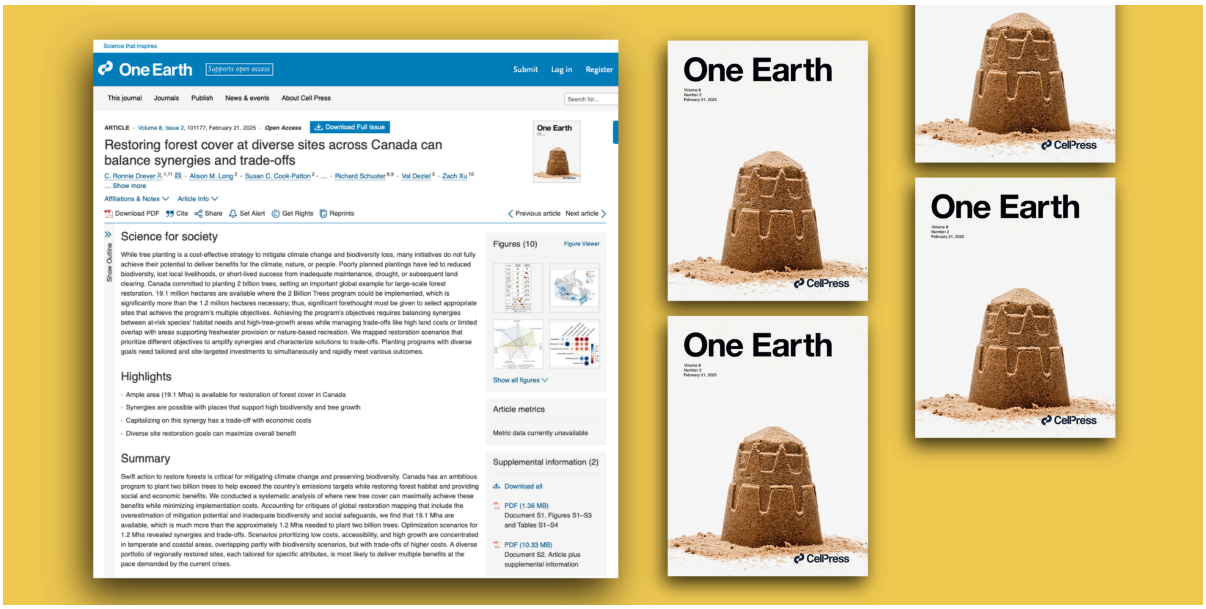
Nie, Wanshu, et al., (2025), Anthropogenic influences on the water cycle amplify uncertainty in drought assessments, *One Earth.*

Climate change and anthropogenic disturbances have altered the global freshwater cycle, causing it to deviate from assumptions of stationarity. However, most current drought assessment methods do not consider such impact of nonstationarity. In this study the authors introduce a theoretical framework that quantifies errors in drought assessment under various nonstationary conditions, using bias-variance decomposition and Monte Carlo simulations. The authors then apply this framework to evaluate bias and uncertainty in drought estimation based on remote-sensing-informed global terrestrial water storage changes. This analysis confirms that with over half of the world facing water storage declines, assuming stationarity can lead to underestimation of moderate droughts with high uncertainty depending on the chosen climatology reference periods, while overestimations of exceptional droughts remain consistent and highly certain, irrespective of climatology reference periods on average. This framework offers insights into building appropriate climatology reference periods for drought estimation while emphasizing the need to recognize seasonal and regional differences.

Learn more

CGIAR scientists at IWMI, with the support of the CGIAR Initiative on NEXUS Gains, developed a new platform to share comprehensive information from the Institute's work implementing drought-management initiatives in Africa and South Asia.

Read more



Restoring forest cover at diverse sites across Canada can balance synergies and trade-offs

Ronnie Drever, C., et al., (2025), Restoring forest cover at diverse sites across Canada can balance synergies and trade-offs, *One Earth.*

Swift action to restore forests is critical for mitigating climate change and preserving biodiversity. Canada has an ambitious program to plant two billion trees to help exceed the country's emissions targets while restoring forest habitat and providing social and economic benefits. The authors conducted a systematic analysis of where new tree cover can maximally achieve these benefits while minimizing implementation costs. Accounting for critiques of global restoration mapping that include the overestimation of mitigation potential and inadequate biodiversity and social safeguards, they find that 19.1 Mha are available, which is much more than the approximately 1.2 Mha needed to plant two billion trees. Optimization scenarios for 1.2 Mha revealed synergies and trade-offs. Scenarios prioritizing low costs, accessibility, and high growth are concentrated in temperate and coastal areas, overlapping partly with biodiversity scenarios, but with trade-offs of higher costs. A diverse portfolio of regionally restored sites, each tailored for specific attributes, is most likely to deliver multiple benefits at the pace demanded by the current crises.

Learn more

This paper is co-authored by CGIAR scientist, Nathaniel Robinson, of CIFOR-ICRAF. Learn more about CIFOR-ICRAF.

Read more

Advances in Permafrost Representation: Biophysical Processes in Earth System Models and the Role of Offline Models

Matthes, Heidrun, et al. (2025), Advances in Permafrost Representation: Biophysical Processes in Earth System Models and the Role of Offline Models, *Permafrost and Periglacial Processes.*

Permafrost is undergoing rapid changes due to climate warming, potentially exposing a vast reservoir of carbon to be released to the atmosphere, causing a positive feedback cycle. Despite the importance of this feedback, its specifics remain poorly constrained, because representing permafrost dynamics still poses a significant challenge for Earth System Models (ESMs). This review assesses the current state of permafrost representation in land surface models (LSMs) used in ESMs and offline permafrost models, highlighting both the progress made and the remaining gaps. This study identify several key physical processes crucial for permafrost dynamics, including soil thermal regimes, freeze–thaw cycles, and soil hydrology, which are underrepresented in many models. While some LSMs have advanced significantly in incorporating these processes, others lack fundamental elements such as latent heat of freeze–thaw, deep soil columns, and Arctic vegetation dynamics. Offline permafrost models provide valuable insights, offering detailed process testing and aiding the prioritization of improvements in coupled LSMs. This analysis reveals that while significant progress has been made in incorporating permafrost-related processes into coupled LSMs, many small-scale processes crucial for permafrost dynamics remain underrepresented. This is particularly important for capturing the complex interactions between physical and biogeochemical processes required to model permafrost carbon dynamics. The authors recommend leveraging advancements from offline permafrost models and progressively integrating them into LSMs, while recognizing the computational and technical challenges that may arise in coupled simulations. They highlight the importance of enhancing the representation of physical processes, including through improvements in model resolution and complexity, as this is a fundamental precursor to accurately incorporate biogeochemical processes and capture the permafrost carbon feedback.

Learn more

CGIAR scientists from ILRI authored a book chapter that synthetizes greenhouse gases and energy fluxes at the Permafrost Zone, alongside discussing pathways for improving the knowledge and monitoring of these changing high-latitude ecosystems in Alaska and Siberia.

Read more

Community estimate of global glacier mass changes from 2000 to 2023

Zemp, Michael, et al. (2025), Community estimate of global glacier mass changes from 2000 to 2023, *Nature*.

Glaciers are indicators of ongoing anthropogenic climate change. Their melting leads to increased local geohazards, and impacts marine and terrestrial ecosystems, regional freshwater resources, and both global water and energy cycles. Together with the Greenland and Antarctic ice sheets, glaciers are essential drivers of present and future sea-level rise. Previous assessments of global glacier mass changes have been hampered by spatial and temporal limitations and the heterogeneity of existing data series. Here the authors show in an intercomparison exercise that glaciers worldwide lost 273 ± 16 gigatons in mass annually from 2000 to 2023, with an increase of 36 ± 10% from the first (2000–2011) to the second (2012–2023) half of the period. Since 2000, glaciers have lost between 2% and 39% of their ice regionally and about 5% globally. Glacier mass loss is about 18% larger than the loss from the Greenland Ice Sheet and more than twice that from the Antarctic Ice Sheet. These results arise from a scientific community effort to collect, homogenize, combine and analyse glacier mass changes from in situ and remote-sensing observations. Although these estimates are in agreement with findings from previous assessments at a global scale, the authors found some large regional deviations owing to systematic differences among observation methods. Their results provide a refined baseline for better understanding observational differences and for calibrating model ensembles, which will help to narrow projection uncertainty for the twenty-first century.

Learn more

CGIAR scientist at CIP co-authored an article estimating the glacier outline and volume changes of Peru snow-capped mountains using 1990 to 2013 temporal series of a combination of optical, radar and LIDAR data sources.

Read more

OTHER CLIMATE CHANGE PAPERS OF INTEREST

Spielman, David J., et al. (2025), **Fertilizer policy reforms in the midst of crisis: Evidence from Rwanda**, *Food Policy.*

Click here for DOI

Nagendra, Harini (2025), **How scientists can drive climate action: celebrate nature and promote hope**, *Nature.*

Click here for DOI

Isah Abdulrasheed, et al. (2025), **Quantifying climate finance needs in the nationally determined contributions of developing countries**, *Climate Policy.*

Click here for DOI

Kehinde, et al. (2025), **Principles, barriers, and challenges of Indigenous water governance around the world**, *Environmental Science & Policy.*

Click here for DOI

Quoß, Franziska (2025), **The link between objective measures and subjective perceptions of extreme weather**, *Climatic Change*.

Click here for DOI

Mingolla, Stefano, et al., (2025), **Low-carbon ammonia production is essential for resilient and sustainable agriculture**, *Nature Food.*

Click here for DOI

Barnes, Jonathon, (2025), **The Expert Epistemology of Climate Finance: Re-Visiting the Depoliticisation Critique**, *A Radical Journal of Geography.*

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We would like to thank all funders who support this research through their contributions to the CGIAR Trust Fund: www.cgiar.org/funders.

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