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Editorial: Generating actionable climate information in support of climate adaptation and mitigation

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Editorial on the Research Topic
Generating actionable climate information in support of climate adaptation and mitigation

Introduction

Climate change is exerting widespread impacts on nature, society, and economies across the globe necessitating careful consideration of climate monitoring, predictions and projections as decision support for effective medium- and long-term adaptation planning (Hewitt and Stone, 2021; IPCC, 2023). In this respect, the relevance of information at the local scale, tailored to users, is paramount in addressing potential multi-sectoral climate impacts. Recognizing this, numerous countries and organizations have instituted climate services addressing these topics in the form of national climate scenarios and climate assessments such as KNMI'23 in the Netherlands (Van der Wiel et al., 2024), UKCP18 in the UK (Lowe et al., 2018), CH2018 in Switzerland (NCCS, 2018; Fischer et al., 2022), and NCA-5 in the US (USGCRP, 2023). Such services aim to serve as a bedrock for decision support in climate action planning and to facilitate downstream applications.

Despite the shared urgency, the extent and configuration of the value chain in processing from raw climate data to the dissemination of actionable climate information as a service diverge from country to country. This divergence encompasses overarching goals (Skelton et al., 2017), scientific methodologies, specific workflow choices, integration of user needs, governance structures under institutional and political frameworks, modes of dissemination and communication, resources available and how feedback is re-integrated to adjust the production processes. The purpose of this Research Topic was to stimulate an international exchange centered on these nuanced aspects. The eleven articles that are appearing in this Research Topic of Frontiers in Climate Predictions and Projections have together shown the diversity in region-specific experiences, lessons learned, and best practices when distilling actionable climate information. They cluster around aspects of (1) distilling actionable information from climate data, (2) elaborating local-to-regional

climate assessments for adaptation planning, (3) evaluating user-needs in co-production and (4) supporting climate mitigation.

Distilling actionable information from climate data

O'Brien and Nolan outline the principles and methodological chain applied to generate a set of standardized climate projections for Ireland until the 21st century assuming three emission scenarios. The projections are based on regional climate model ensembles driven by CMIP5 global climate models. In their dedicated TRANSLATE project, initiated in 2021 by the Irish Meteorological Service, two distinct ensembles of detrended, bias-corrected and downscaled simulations are inter-compared showing consistent results, enhancing confidence, and robustness. Model uncertainty is hence addressed by merging the two model ensembles into a larger sample directed toward users.

Similar to Ireland, the methodological chain to produce future local-scale climate and hydrological projections is presented by Brox-Nilsen et al.. These projections are also based on downscaled and bias-corrected CMIP5 simulations. Beyond the methodological setup, the authors report on their way of disseminating the comprehensive and complex information. With the aim to increase uptake of information, one of their most promising dissemination channels has been the publication of county-wide factsheets. In terms of uncertainty, they conclude that the tradeoff between robustness and precision should guide the dissemination of climate information and that this information should ideally be co-produced with users.

This discrepancy between robustness and precision is also addressed by Hübener et al. for the use of spatial climate data, as there exists a significant gap between the spatial resolution requested by climate impact experts and policymakers for local adaptation planning and the resolution climate data providers typically offer to ensure robustness. The authors suggest to aggregate climate data at the level of natural units maintaining the physical geographic structures. This enables use of single grid cells within that unit for local studies as exemplified in the case study of the federal state Hesse in Germany. To be applied in downstream applications, the disseminated data should further be easily accessible and easy-to-understand for non-experts.

In another case study for western Germany (Wupper catchment) climate model data from the global decadal prediction system MPI-ESM-LR is post-processed by applying a statistical downscaling step to consider the specific local characteristics for the water catchment. In this way, actionable information is distilled to optimize flood protection and water distribution management of the catchment. While the downscaling step preserves the global prediction skill, Paxian et al. found that the application of a recalibration step clearly improved the prediction skill in Germany. In particular, the 3-year mean and seasonal probabilistic SPI (standardized precipitation index) predictions showed promising results, demonstrating potential skill for use in water management needs. To optimally reach users in this field, a user-oriented product sheet was disseminated on the Copernicus Climate Change Service website.

Local-to-regional climate assessments for adaptation planning

While national and international climate assessments are nowadays an established climate service in many countries, similar assessments on a sub-national level that support concrete adaptation planning are less established and hence their role, function and added value needs to be evaluated.

Keener et al. report on lessons learnt and the added value from the Pacific Islands Regional Climate Assessment (PIRCA), exemplifying the pressing need for nuanced, collaborative climate assessments tailored to local decision-making. Over a decade, PIRCA addressed gaps in detailed climate projections for the US-Affiliated Pacific Islands, emphasizing actionable, and culturally cognizant information. External evaluations also highlight PIRCA's role in enhancing regional adaptive capacity and accelerating climate adaptation. Key components of its effectiveness include framing climate information using human- and decision-centric methods, inclusive methods, flexibility to meet stakeholder objectives, leveraging regional organizations, building relationships, and sustaining collaborations. PIRCA's success suggests transferable lessons for other regions, emphasizing the role of collaborative regional assessments in supporting local climate adaptation and policymaking—thereby complementing national and international assessments.

In a community case study Barnes and Dow present the factors that led to a hazard bias in climate adaptation planning, using the example of the city of Charleston in South Carolina (US) and how this bias was overcome. The hazard bias materialized in that adaptation planning and funding solely focused on flooding and water management, thereby overlooking other hazards—in particular heat health risks and costs of reduced labor productivity—despite being identified in the National Climate Assessment. In the absence of investments, Charleston lacked key urban heat data and technical expertise, but also motivation to develop a prioritization approach in favor of heat risk. To increase compound risk awareness and adjust investments to be inclusive of heat risk management a new coalition of researchers, practitioners, and health experts launched a heat-health research program and initiated a new heat network that significantly helped to broaden the climate resilience agenda.

Geiger et al. go beyond the pure analysis of weather and climate hazards. To render climate information actionable for adaptation purposes, they advocate for a more holistic risk approach by assessing hazard impacts together with their societal and environmental settings in a comprehensive risk approach. The authors emphasize that in particular, National Meteorological and Hydrological Services (NMHSs) are in an excellent position to foster the implementation of such an integrated risk framework into their operational routines that incorporates hazard-exposure-vulnerability models, expanding existing forecast, and impact services. This unified approach aims to create synergies within and

across NMHSs, fostering collaboration with partners, stakeholders, and users for more effective risk-based services in the face of climate change.

User needs and co-production

Three studies exemplify the indispensable role of co-production between providers of climate services and their users to render climate information and climate services actionable.

Friedman et al. show that the tailoring of climate information services toward users is of utmost importance to increase the uptake of information as evidenced in the example of farmers in Papua New Guinea. Climatic changes threaten farming practices and reduce productivity. While climate information, tools, and practices exist to address climate variability, they often lack contextualization for equitable decision-making. One-size-fits-all information services don't consider regional, social, or local differences. To understand farmers' needs, a Papua New Guinea survey identified key design considerations for seasonal climate forecasts. The authors identified information content profiles, revealing gender and geographic differences. Tailoring weather and climate information services for specific farmer groups promotes equitable access, enhancing smallholders' capacity to adapt strategically to climate change while suggesting avenues for efficient scaling.

A second article takes on the tailoring of climate information to be used by farmers in the case of the horticulture sector in Kenya, East Africa. This sector is heavily affected by climate change, yet local adaptation efforts are strongly limited. Van der Horst et al. present the development of an agricultural climate atlas for two counties in the South of Kenya, aiming to bridge the gap between climate research and farmer uptake. Adopting a bottom-up approach, the atlas is tailored to local needs, focusing on specific crops but it also has the potential to be scalable to other counties and other crops. The co-created atlas demonstrates the significance of user engagement, flexibility and adaptability in climate information services for effective local adaptation. Reported challenges in this development include sustaining engagement beyond the project duration.

Figus et al. present a 24-month case study of knowledge co-production with an indigenous community and tribe in Southeast Alaska, US, focusing on climate services for adaptation and mitigation with priorities of food sovereignty and security. The study applies a theoretical framework for co-production among indigenous and non-indigenous partners. Results show that co-production can establish a collective vision, transforming applied climate science and shifting the researcher's focus to support local needs. Reported challenges include logistics, communication, and conducting research during a global pandemic. Similar to van der Horst et al. the authors recommend institutionalizing and maintaining long-term efforts for co-producing climate services aligned with community priorities.

Climate mitigation

The article by Cohen-Shields et al. addresses actionable climate information in support of climate mitigation. They argue for a modification of the regularly used CO_2-reporting method. This conventional method of reporting greenhouse gas emissions, using CO_2-equivalence (CO_2eq), underestimates the near-term impact of methane-dominated sectors. This is because the method calculates the warming impact over a 100-year period and therefore masks the potency of important short-lived climate forcers like methane. Simple climate modeling indicates that mid-century warming contributions from methane-dominated sectors (in particular from agriculture, fossil fuel, and waste) are twice as high as CO_2eq estimates. Relying solely on CO_2eq hence misrepresents the urgency of reducing emissions from these sectors and risks misaligning mitigation targets with desired temperature outcomes.

Conclusion

In conclusion, the articles in this Research Topic highlight the necessity to provide information on weather and climate in a way that is directly applicable to users and stakeholders and their needs. A user-centered approach with "actionable" information is of paramount importance and is urgently needed to support climate adaptation and mitigation measures worldwide. The exchange here also shows examples for other countries to stimulate and accelerate the use of scientific information and knowledge in user-tailored and actionable climate services in order to better manage risks and identify opportunities. This collective exchange might even contribute to the formulation of international guidelines and best practices, which are currently absent. The Research Topic also underscores the importance of establishing, maintaining and coordinating regional, national and international climate service centers worldwide as a facilitating mechanism and instrument to foster the implementation of adaptation and mitigation measures (e.g., WMO, 2011; Hewitt et al., 2020). Moreover, the Research Topic strives to delve into future challenges, the sustainability of climate services, and the exploration of long-term strategies to establish these services as indispensable sources for decision-making, akin to the commonplace reliance on weather forecasts today.

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References

Fischer, A. M., Strassmann, K. M., Croci-Maspoli, M., Hama, A. M., Knutti, R., Kotlarski, S., et al. (2022). Climate scenarios for Switzerland CH2018 - approach and implications. *Clim. Serv.* 26:100288. doi: 10.1016/j.cliser.2022.100288

Hewitt, C. D., Allis, E., Mason, S. J., Muth, M., Pulwarty, R., Shumake-Guillemot, J., et al. (2020). Making society climate resilient: international progress under the global framework for climate services. *Bull. Am. Met. Soc.* 101, E237–E252. doi: 10.1175/BAMS-D-18-0211.1

Hewitt, C. D., and Stone, R. (2021). Climate services for managing societal risks and opportunities. *Clim. Serv.* 23:100240. doi: 10.1016/j.cliser.2021.100240

IPCC (2023). "Climate Change 2023: Synthesis Report," in Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, eds. Core Writing Team, H. Lee and J. Romero (Geneva, Switzerland: IPCC), 184.

Lowe, J. A., Bernie, D., Bett, P., Bricheno, L., Brown, S., Calvert, D., et al. (2018). *UKCP18 Science Overview Report, Met Office.* Available online at: https://www.metoffice.gov.uk/pub/data/weather/uk/ukcp18/science-reports/UKCP18-Overview-report.pdf (accessed January 15, 2024).

NCCS (2018). *CH2018 - Climate Scenarios for Switzerland, National Centre for Climate Services.* Zurich, 24. ISBN: 978-3-9525031-3-3.

Skelton, M., Porter, J. J., Dessai, S., Bresch, D. N., and Knutti, R. (2017). The social and scientific values that shape national climate scenarios: a comparison of the Netherlands, Switzerland and the UK. *Reg. Envrion. Change* 17, 2325–2338. doi: 10.1007/s10113-017-1155-z

USGCRP (2023). "Fifth National Climate Assessment," in *U.S. Global Change Research Program,* eds. A.R. Crimmins, C.W. Avery, D.R. Easterling, K.E. Kunkel, B.C. Stewart, and T.K. Maycock (Washington, DC, USA).

Van der Wiel, K., Beersma, J., van den Brink, H., Krikken, F., Selten, F., Severijns, C., et al. (2024). KNMI'23 climate scenarios for the netherlands: storyline scenarios of regional climate change. *Earth's Fut.* 12:e2023EF003983. doi: 10.1029/2023EF003983

WMO (2011). *Climate Knowledge for Action: A Global Framework for Climate Services — Empowering the Most Vulnerable.* The Report of the High Level Task Force for the Global Framework for Climate Services, 240.