SEI Stockholm Environment Institute

Adopting a user-oriented approach to make climate information more accessible across Europe

SEI discussion brief
March 2022

Andreas Hoy
Åsa Gerger Swartling
Elin Leander

Note: This discussion brief highlights findings, detailed in Hoy et al. (2022; forthcoming), from the ClimVis Europe pilot project, which created a tailored implementation concept of a transnational, multilinguistic visualization tool of observed and projected climate information in Europe for use by decision makers, educators and the general public.

IMAGE (ABOVE): In 2013, flooding from the Elbe River devastated many communities, including the German town of Meissen, which also experienced record-breaking floods in 2002. © ANDREAS HOY / SEI

Key messages

- **Research from the ClimVis Europe project shows that climate information must be presented in more effective ways to reduce climate risks and support adaptation. Users need information that is easy to access, in their own language, and designed to help them make connections between real-time weather events and long-term climate developments.**
- **Users of weather and climate data in Europe are aware of only a few (if any) relevant, available tools that provide them with the insights into current, future and long-term meteorological trends that they seek.**
- **However, efforts to boost awareness of available tools, while important, will not be enough to meet user demands. Providers of climate information need to consult with stakeholders to co-develop new tools to meet needs and support the uptake of information.**
- **Existing European tools have two key shortcomings: limited language and insufficient context. The provision of climate information exclusively in English excludes many users (especially at local and regional levels and in Eastern Europe and Russia). Tools do not link real-time extreme weather with long-term past or future climate trends; such connections are essential to assess climate change-related impacts and adaptation needs.**
- **We interpret the results as a call to action, to enhance related communication that is fundamental to the need to reduce climate risks and support adaptation.**

Background

Climatic changes in average and extreme weather conditions are increasingly manifest worldwide. In coming decades, climate change is projected to exacerbate such changing conditions, affecting patterns of temperature and precipitation, and increasing occurrences of extreme events, such as heat and cold waves, floods and droughts (IPCC 2021). The summer of 2021, for example, brought what was potentially a new European heat record in Sicily (World Meteorological Organization, 2021) and an extreme precipitation event that led to more than 200 casualties in Germany and Belgium (World Weather Attribution initiative, 2021). Those developments and other extreme events strongly influence almost all socio-economic sectors and environmental aspects (IPCC, 2022). Hence, the ramifications concern a wide range of stakeholders, including scientists, public authorities, businesses, educational institutions, media and the general public. Timely climate information at various spatial scales, including the local level, is therefore crucial to manage and optimize adaptation (and mitigation) measures, and to reduce socio-economic and ecological vulnerability to present and future climate change risks.

Data derived from meteorological observations (station and gridded data) and weather and climate models (re-analysis, predictions and projections) involve inherent complexities and uncertainties. While they are accessible to scientists and experts who are familiar with climatology, they can be difficult for non-expert users to manage and interpret (Lemos et al., 2012; Hewitt et al., 2017). Hence, there is a gap between knowledge production and use (National Research Council, 2010). Non-experts are typically interested in climate information or climate services for practical reasons, such as teaching, planning and decision-making processes (Hewitt et al., 2017). In this context, climate information is a first communicative step that provides knowledge on averages, extremes and indices of meteorological parameters such as temperature and precipitation. Climate services aim to enhance communication on these topics by providing access to such information in more user-specific, often sector-related ways and language. Such services support decision-making, covering a large variety of purposes – even within one specific sector (Vaughan & Dessai, 2014); (Swart et al., 2017); (Visscher et al., 2020). In light of climate change, a large diversity of stakeholders from public and private entities is increasingly seeking easily accessible and applicable climate information.

ClimVis Europe: In response to the growing need for useful and usable climate information, the ClimVis Europe project aimed to create a tailored implementation concept that can be the basis of a transnational, multilinguistic visualization tool of observed and projected climate information in Europe. The underlying vision is for a tool that is intuitively accessible and interactive. Such a tool would use available data to create comprehensible, meaningful and eye-catching visualizations for more efficient decision support, and to raise greater awareness on climate change. Such a tool should show a general picture of European climate variability, and be able to go into regional and local detail to all extent possible.

This discussion brief highlights the approach used and results obtained from a pilot of the ClimVis Europe project (as detailed in Hoy at al. (2022; forthcoming) and available on the project webpage).

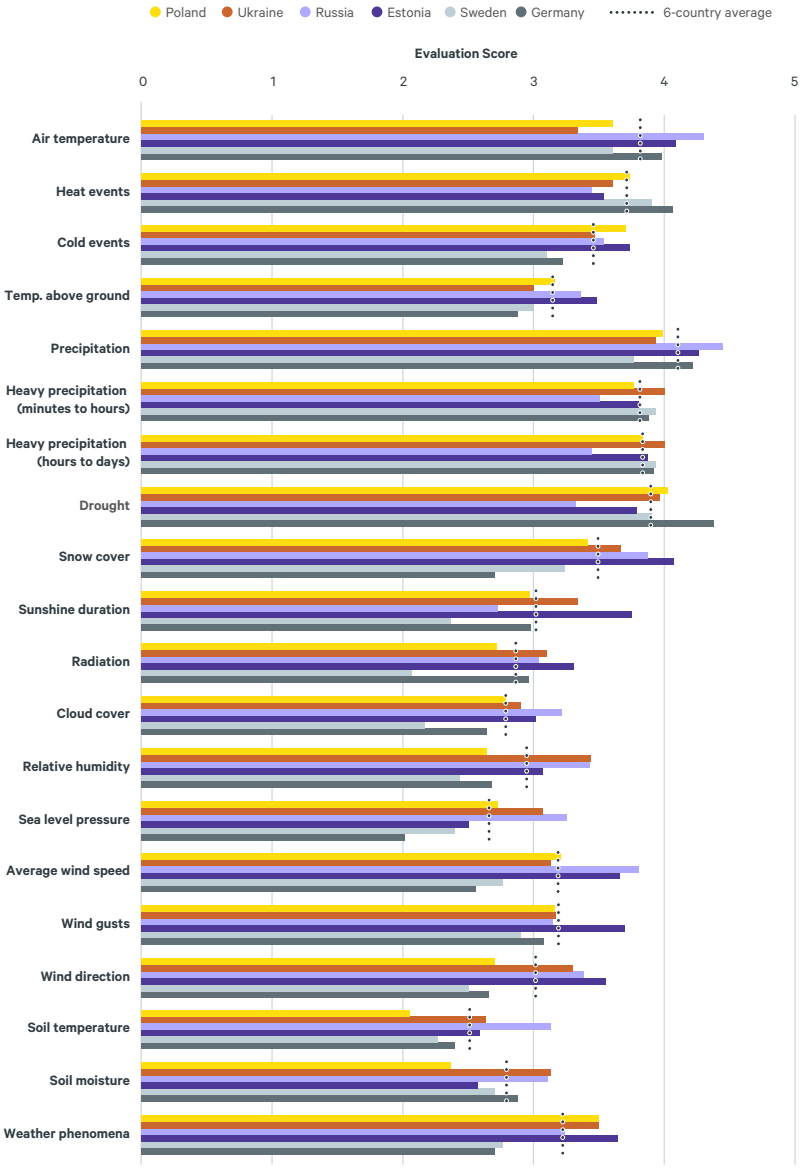
The pilot involved a survey of 390 users of climate information in six countries (Estonia, Russia, Poland, Germany, Ukraine and Sweden), and focus group discussions with 48 key stakeholders of web-based climate information tools in five of these countries (all but Sweden). Those stakeholder engagement activities were conducted between December 2020 and August 2021. The project involved stakeholders in countries that have well-established climate tools (Sweden, Germany), and in other regions that lack such tools (Eastern European countries and Russia). We thus reached out to user groups that have been underrepresented in existing studies. These interactions provided insights about their needs and preferences related to design and content of a future tool, and the stakeholders themselves established the beginnings of a key user network for a future tool co-development.

International survey with users of climate information

To gain a deeper understanding of the priorities and preferences of key users, we conducted a survey containing 24 multiple-choice and free-text questions about *existing* user experiences with web-tools providing climate information, and user *requirements* of a useful application. The survey took about 20 minutes to complete.

To increase accessibility, we translated the questionnaire into national languages in all participating countries except Sweden. We specifically reached out to users working within local or regional contexts, where foreign language skills are less likely to be required than on national or international levels.

Figure 1: Answers to the question, "How relevant are the following climate parameters for you?" The figure shows users' responses, indicating averages among users from the six participating countries and country-specific distributions. Evaluation scores range from zero (irrelevant) to five (very relevant).



We mainly consulted with two types of users: decision-makers in various sectors, and individuals engaged in education. Decision-makers apply climate information for making decisions in their sector and respective field of expertise. Educators use climate information to disseminate knowledge about climate change for educational or training/ capacity-building purposes. Both groups partly overlap. For example, a university professor is both a decision-maker and educator.

To reach existing and potential users of climate information, country-specific acquirement strategies were used. Main approaches were 1) distributing emails via institutional contact lists, and 2) asking umbrella organizations of potential climate-data users to inform their clients about the survey (e.g., via newsletters and social media posts). In all, we received 390 responses from the six countries (see Table 1).

Though the underlying user structure cannot be considered truly representative, we obtained a valuable cross section across the landscape of climate-information users in terms of age, cultural backgrounds, and the type of institutions and sectors represented.

Results

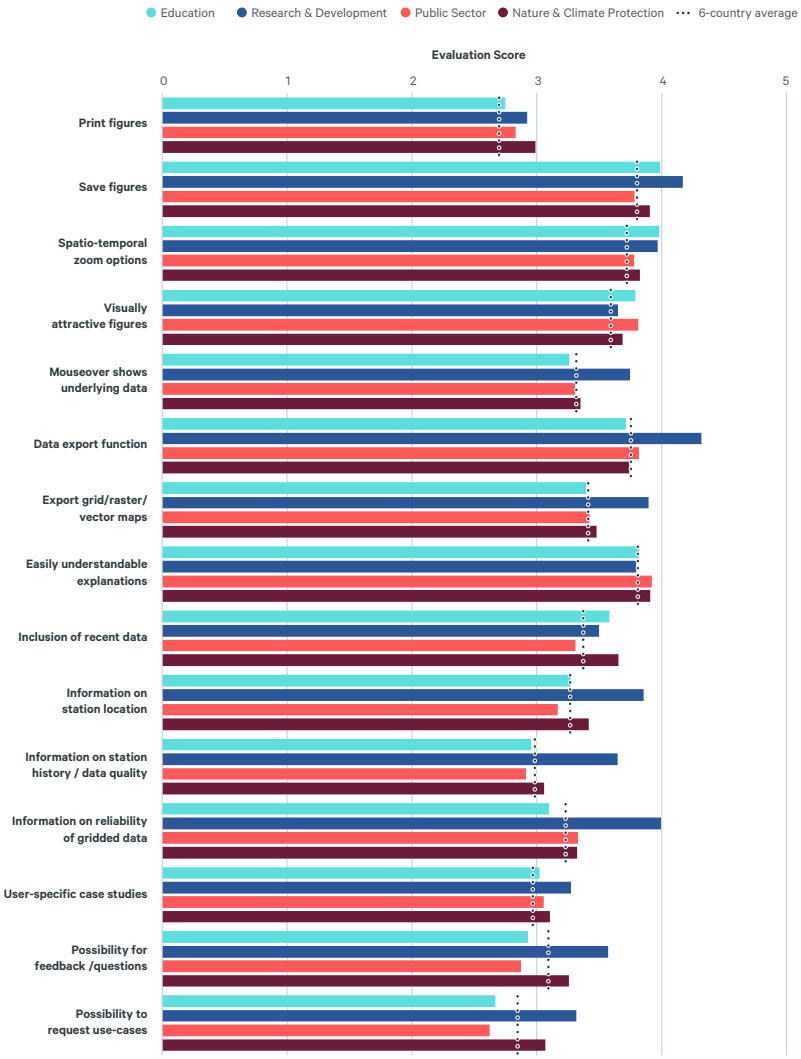
Most participants (88%) use **their own language** when accessing climate information, and almost all (95%) prefer this. Only about half of the users (56%) access and also prefer accessing (52%) climate information in English. Polish participants stand out with an extremely low current use of (13%) and willingness (18%) to apply English. This is most likely because Polish participants were predominantly local-level public service employees who usually work in their own national language and lack international contacts. In general, providing climate information exclusively in English excludes many users, especially at local and regional levels and in Eastern Europe and Russia.

Participants' interest in past, present and future climate information is high, with 87% of all users interested in present, 82% in future, and 64% in past climate information. This sequence is true for most countries and sectors. Present climate information is most desired in the education (95%) and research and development sectors (93%), and least in the public sector (80%). Our participants use climate information especially in the context of developing, coordinating and justifying climate change adaptation

Table 1: Total number of survey participants per country

Country	Germany	Sweden	Estonia	Russia	Ukraine	Poland
Responses	50	30	56	47	30	177

Figure 2: Answers to the question, "How important are the following services for you?" Evaluation scores range from zero (not important) to five (very important).



(and mitigation) measures, including discussing and communicating related activities and strategies to their stakeholders. Climate information is also utilized to assess climate effects and risks in various contexts (e.g., related to urban planning, food security, agriculture, forestry, ecosystem services and biodiversity). Such information is used for research and teaching, and in communication for outreach activities and for research purposes in the context of scientific papers and other articles.

Users' reflections on their experiences with existing webtools indicate that **useful aspects** of the tools they use are: 1) appropriate content, 2) a user-friendly interface, 3) intuitive handling and 4) comprehensive visualization styles (maps/ diagrams/ interactivity/ figures). Some tools were **criticized** for: 1) using poor design, 2) being too complicated, 3) lacking contexts, and 4) presenting overly long or confusing explanations and reports. Respondents said that they wanted better, more easily accessible data, including regional and microclimate information, and understandable approaches for presenting weather and climate forecasts, and climate projections for extreme weather events and climate risks.

We investigated the perceived **relevance of 20 climate parameters** (Figure 1). Participants rated information on precipitation (average, droughts, and heavy precipitation) and temperatures (average and heat waves) as most relevant – and almost universally, with few differences from one sector to another. Specific interests seem to relate to exposure and perceived vulnerability within the countries (such as heat events in Germany and Sweden, and snow-related information in Estonia, Russia and the Ukraine). We asked participants about the **importance of 15 website services** (Figure 2) relevant for developing a climate visualization tool. Respondents indicated that they place the greatest value on "saving figures", "data export options","easy explanations", "zoom options", "visually attractive figures", and the "inclusion of recent data". Differences between countries and sectors exist, but they are rather minor. One exception is the strong emphasis the research and development sector puts on data-quality and metadata-specific aspects.

A summary of all survey results is available here .

Country-level focus-group discussions

We held focus-group discussions online to explore in more detail which climate information key users need. We conducted two discussion group sessions, one to two hours in duration, for each country in their national languages (except for Estonia). Each group had between three and nine participants, with 48 participating in total (Table 2). We targeted decision-makers in various sectors and educators/trainers (mainly from universities, scientific institutions and public authorities, plus schoolteachers and

Table 2: Total number of participants in focus group discussions

Country	Germany	Estonia	Russia	Ukraine	Poland
Participants	8	13	10	7	10

principals). There was a high level of diversity within each group regarding expectations, professional background, and previous knowledge.

During the first online session, we briefly presented our project and the session concept, followed by a short introduction (three to five minutes) of participating stakeholders. We sought to learn how they apply climate information, how better visualizations could help them in their work, and what their motivations and expectations about our project were. Afterwards, we briefly introduced three climate data visualization websites that are relevant in a pan-European context. These sites use different approaches in terms of included content, complexity and visualization styles. They are:

- Global Climate Monitor (global)
- World Bank Climate Change Knowledge Portal (global)
- Copernicus Climate Information Portal (Europe)

Immediately after the first session, our participants received an email with links to those websites, where we asked them to freely test and explore the applications at their own convenience. Such testing could include, for instance, how easy they found the site to use, whether the site covered information they sought, whether the information and visualizations were perceived as meaningful and attractive, and whether content and figures were considered to be well explained. Users were asked which aspects they would like to see improved.

In the same email, we then asked our participants to rate their user experience via a short user-experience questionnaire that posed 10 key questions about their experiences with and demands for tools that provide climate information. Answers sent in by email varied in terms of response depth, but offered all participants a written format to allow for the time and privacy to prepare their thoughts.

The second session, which opened with a summary of the results of the user experience feedback, offered participants an opportunity to openly discuss these issues, and to bring their own perspectives about what a useful climate data visualization tool should offer. The 10 key discussion questions were used as an input, but we deliberately allowed participants to talk about issues they raised themselves. Our main goal was collecting perceptions and useful comments and recommendations from potential users of our future tool.

Results

A detailed list of user recommendations, based on the 10 sessions in five countries was created to guide the future development of the ClimVis tool. Recommendations were grouped into the following topics:

- Language demands
- Target group aspects
- Technical access demands
- Tutorial preferences
- Start page and navigation
- Display and comparison options
- Customization opportunities
- Spatiotemporal resolution demands

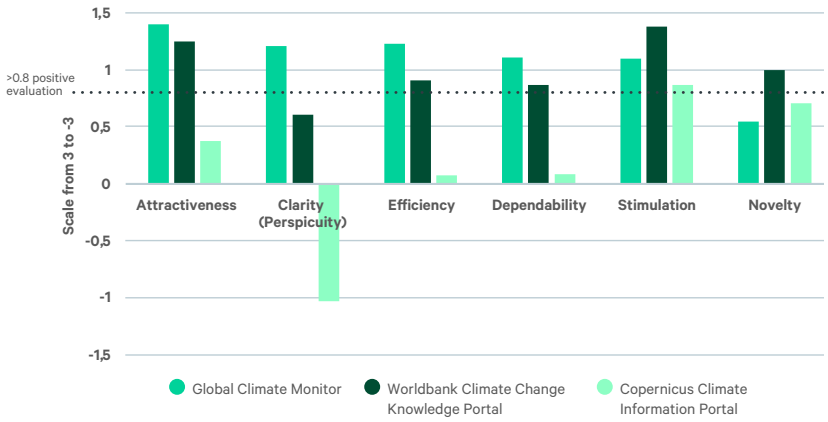
- Need for current data (and climate forecasts)
- Communication of uncertainty
- Data presentation issues
- Metadata access

We also summarized the perceptions of our participants related to aspects of the sample tools seen as positive or critical. Figure 3 provides a basic visual overview of how the three tools were perceived. The visualization shows the average rating on a 7-level-scale from -3 (negative) to +3 (positive). Evaluations with a score of above +0.8 are considered positive.

Alll three sites had advantages and shortcomings: The Global Climate Monitor was generally recognized to be the most accessible application and most positively rated in terms of attractiveness, clarity (perspicuity), efficiency and dependability, but it was also considered to lack depth in terms of substance and analytics. The World Bank Climate Change Knowledge Portal was ranked as the most stimulating site and the one that offered the most novelty; the site provides past and future climate information and contains additional information on sectors, impacts and adaptation. The Copernicus Climate Information Portal was generally considered to be the most complex application; its diverse (and meaningful) content needs to be explored over time. As an application focused on intermediaries rather than end users (which most of our participants can be considered to be) it ranked lowest, with especially low values for clarity. Tailored training sessions for a faster and more in-depth exploration of its functionality are apparently needed for better accessibility among potential users.

Figure 3: Users' perception of tools

33-35 responses per tool, users of Germany, Estonia, Poland, Russia and Ukraine



Source: Results from the user-experience questionnaire

Discussion and outlook

Reliable, trusted and accurate sources of information are needed to raise awareness of climate-change-linked, extreme weather events, and to help people understand how to interpret observed and projected long-term climatic changes. Decision-makers, educators and the general public are seeking up-to-date climate information that meets their needs. These current and would-be users of climate data visualization tools have very different skills, qualifications, interests and disciplinary backgrounds. Hence, varied communication approaches are needed to increase the uptake and use of climate information. Tools must be versatile to address diverse needs.

Greater awareness

In general, users of weather and climate data are aware of just a few tools on the market. Though these tools may not be relevant for some users, for others, the exiting tools are relevant at least to some degree. Thus information demands could *partly* be met by helping potential users become more familiar with the tools available for Europe or relevant countries. As a result, ClimVis Europe is seeking to make the inventory of climate information tools developed in the project more widely known, to link potential users to available tools that address (at least some of) their needs.

ACKNOWLEDGEMENTS

This SEI discussion brief provides highlights of the pilot project ClimVis Europe, funded by the Swedish Institute. The consortium included SEI and partners at the University of Krakow, the Institute of Monitoring of Climatic and Ecological Systems Tomsk, and the National Ecological Centre of the Ukraine.

The brief draws on Hoy et al. (2022; forthcoming), which provides detail about the project, its approach and its findings. The authors thank Blaine Lowry and Heidi Tuhkanen for their valuable comments on the initial version of this brief and the anonymous SEI staff providing a review of it.

Increasing accessibility for non-experts

A majority of the users we consulted are not scientists. They are professionals who have little or no climatological expertise. They work for public administration at various levels (from national to local), for NGOs, schools and companies. Their work involves topics related to climate (change) risk management and/or adaptation. They use climate information for teaching and education, and to make decisions. They require guidance based on observed (measured) and projected (modeled) climate data. That is they need help in understanding how to interpret long-term climatic developments and recent extreme events (e.g., heat waves, droughts and flooding) in the context of climate change. Many of the users we consulted are only partly familiar with central scientific terms, explanations and visualization approaches used by available information tools. Research notes that users may simply give up if a tool is difficult to learn, or if it is overloaded with content and/or interactive functions (Johansson et al., 2017); (VanderMolen et al., 2019). These same trends emerged in the evaluation of the three tools tested in the focus group discussions. To support information uptake by non-expert users (of climatology), ClimVis is focusing attention to consulting and co-developing tools with relevant stakeholders to better meet their accessibility needs.

Providing climate information in languages other than English

Currently, well-developed systems of national climate information tools or climate services in Europe show a pronounced West-East divide. Germany and Sweden, for example, have well-established national tools. By contrast, in Eastern Europe and Russia, few national climate information tools in users' native languages exist. Thus, to improve information access for potential users in countries that lack well-developed climate services, (Swart et al., 2017) portals with a European focus should address the needs of countries located in the east of the continent. Thus, our project's intensive outreach to and communication with users of the former Eastern Bloc is a strength of our activities, providing insights from a region where previous projects had struggled to generate user responses (Swart et al., 2017)

Connecting real-time events with long-term developments

The current tool landscape does not link current weather with long-term climate. Extreme weather events of recent years raised the level of interest in access to a tool that combines real-time weather with climatic information. Participants in our project said they want context to understand how current short-term meteorological or perceived climatological events compare with long-term (decadal to centennial) climatological developments. Users perceive that having access to such a connection is extremely relevant and needed for assessing climate change-related impacts and adaptation needs. ClimVis therefore plans to provide new data insights by merging short-term weather (current observations and weather forecasts) with long-term climate (past observations and model projections) information, with a special focus on assessments of extreme weather.

Outlook

Engaging with climate-information users from multiple countries allowed the ClimVis Europe project to establish new networks with relevant actors, and to develop an implementation concept for a more extensive project. The results will guide the technical implementation of a future ClimVis tool, and set the stage for establishing closer links between participating country partners, engaging with users, and co-developing a tool that addresses their needs. The project envisions creating a learning network of PhD students at participating institutions to foster the generation and transfer of knowledge between involved countries. Indeed, the ClimVis tool should be only the first step towards a larger integrative platform that extends its content to address different topics at international, national, regional and local levels.

References

IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, & B. Zhou (eds.)]. Cambridge University Press. https://www.ipcc.ch/report/ar6/wg1/

IPCC, 2022: Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, & B. Rama (eds.)]. Cambridge University Press. In Press. https://www.ipcc.ch/report/ar6/wg2/

Hoy, A., Ustrnul Z., Wypych A., Gordov E., Nevmerzhytska A.V., Gerger Swartling, Å., Leander, E., & Karolin, K. (2022). A user-oriented approach towards a pan-European visualization tool (working title). Forthcoming.

Hewitt, C. D., Stone, R. C., & Tait, A. B. (2017). Improving the use of climate information in decision-making. *Nature Climate Change*, *7*(9), 614–616. https://doi.org/10.1038/nclimate3378

Johansson, J., Opach, T., Glaas, E., Neset, T.-S., Navarra, C., Linner, B.-O., & Rod, J. K. (2017). VisAdapt: A Visualization Tool to Support Climate Change Adaptation. *IEEE Computer Graphics and Applications*, *37*(2), 54–65. https://doi.org/10.1109/MCG.2016.49

National Research Council. (2010). *Advancing the Science of Climate Change*. The National Academies Press. https://doi.org/10.17226/12782

Swart, R. J., de Bruin, K., Dhenain, S., Dubois, G., Groot, A., & von der Forst, E. (2017). Developing climate information portals with users: Promises and pitfalls. *Climate Services*, *6*, 12–22. https://doi.org/10.1016/j.cliser.2017.06.008

VanderMolen, K., Wall, T. U., & Daudert, B. (2019). A Call for the Evaluation of Web-Based Climate Data and Analysis Tools. *Bulletin of the American Meteorological Society*, *100*(2), 257–268. https://doi.org/10.1175/BAMS-D-18-0006.1

Vaughan, C., & Dessai, S. (2014). Climate services for society: Origins, institutional arrangements, and design elements for an evaluation framework. *WIREs Climate Change*, *5*(5), 587–603. https://doi.org/10.1002/wcc.290

Visscher, K., Stegmaier, P., Damm, A., Hamaker-Taylor, R., Harjanne, A., & Giordano, R. (2020). Matching supply and demand: A typology of climate services. *Climate Services*, *17*, 100136. https://doi.org/10.1016/j.cliser.2019.100136

World Meteorological Organization (2021, August 13). *Mediterranean gripped by extreme heat, with new reported temperature record*. https://public.wmo.int/en/media/news/mediterranean-gripped-extreme-heat-new-reported-temperature-record

World Weather Attribution initiative (2021, August 23). *Heavy rainfall which led to severe flooding in Western Europe made more likely by climate change*. https://www.worldweatherattribution.org/heavy-rainfall-which-led-to-severe-flooding-in-western-europe-made-more-likely-by-climate-change/

SEI Stockholm Environment Institute

Published by
Stockholm Environment Institute
Linnégatan 87D, Box 24218
104 51 Stockholm, Sweden
Tel: +46 8 30 80 44

https://doi.org/10.51414/sei2022.009

Author contact
andreas.hoy@sei.org

Media contact
karen.brandon@sei.org

Visit us: sei.org
Twitter: @SEIresearch
@SEIclimate