ClimVis Europe
Focus Group Discussions: user feedback and recommendations

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Background

Climate Change strongly influences almost all socio-economic and environmental sectors, and hence concerns a wide range of interest groups (e.g., scientists, public authorities, businesses, schools, universities, media and the general public). Timely climate information at various spatial scales, but primarily regional and local levels are crucial to understand climatic trends and extreme events, manage and optimise adaptation (and mitigation) measures and to decrease socio-economic and ecological vulnerability to future climate change.

ClimVis Europe serves as a pilot study in preparation for a pan-European visualisation tool, where we plan to combine historical data, daily updated near-real-time data (until yesterday), weather forecasts (until one week ahead) and state-of-the-art climate projections. Once existing, our tool should enable a better accessibility and understanding of often complex climatic changes, supported by regionally and locally relevant climate information.

One main outcome of ClimVis Europe is the feedback of climate information users, mainly collected via virtual focus group discussions (FGD) in Estonia, Germany, Poland and Russia in April/May 2021 and Ukraine in August 2021. Therewith, we explored which climate information key users need, in which complexity, spatio-temporal detail, actuality, explanation level and visualisation style. This activity helped us strengthening our scientific focus while striving towards identifying our "niche" in comparison to other existing tools.

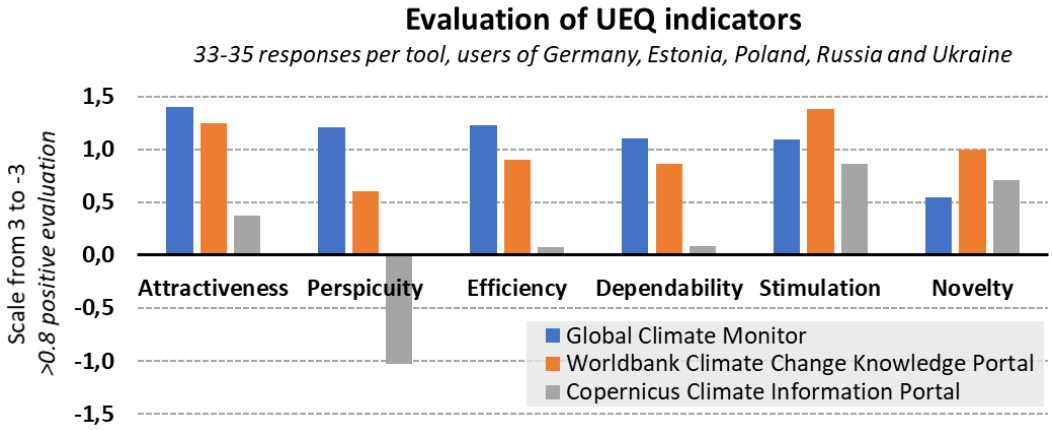
National FGD were conducted by:
- *SEI Tallinn* (country coordinator for Estonia and Germany)
- *University of Krakow / Polish National Weather Service* (country coordinator for Poland)
- *Institute of Monitoring of Climatic and Ecological Systems Tomsk* (country coordinator for Russia)
- *National Ecological Centre of Ukraine* (country coordinator for Ukraine)

FGD were conducted in two groups per country – via two virtual online sessions and an in-between email query – focussing on decision makers and educators/trainers (mainly from universities, scientific institutions and local/regional/national authorities, plus school teachers/principals). All countries followed a common approach agreed within the project group, applying a tailored FGD guide, containing detailed step-by-step information on how to prepare and conduct sessions and stakeholder communication. Hereafter, user feedback on three tested climate visualisation tools, as well as general user recommendations grouped by topics are summarised across all sessions and countries.

Summary of user feedback on tested climate applications

Three climate data visualisation websites – relevant in a pan-European context – were tested by FGD participants. Those tools are characterised by quite different approaches in terms of included content, complexity and visualisation style:

- Global Climate Monitor
- World Bank Climate Change Knowledge Portal
- Copernicus Climate Information Portal



Results of the user experience questionnaire (UEQ), summarized for participating countries

The illustration provides a basic (and not statistically significant) visual overview of how the three tools were perceived by the users, using the short user experience questionnaire (UEQ) distributed among the participants. Visualised is the average rating on a 7-level-scale from -3 (negative) to +3 (positive). Evaluations with a score of >+0.8 are considered positive. The Global Climate Monitor was most positively rated in terms of attractiveness, perspicuity, efficiency and dependability, while the World Bank Climate Change Knowledge Portal ranks first in terms of stimulation and novelty. The more specialist-orientated Copernicus Climate Information Portal generally ranked at the last position, with especially low values for perspicuity, but a rather positive rating for stimulation and novelty. A summary of the tool perceptions is provided below.

The **Global Climate Monitor** (GCM) was generally considered to be the most accessible application, but also without too much depth.

Appreciated aspects:

- Very good structure = easy to use with clear navigation options
- Practical download option
- Receiving exact point values via cursor selection
- Creating point profiles easy to use and innovative
- Simple but effective guided tour via text boxes

Critical aspects:

- Tool was not updated after 2014 (dead links, e.g., to metadata section; some data end in 2013)
- Information limited to (only) averages of temperature, precipitation and evaporation
- Used grid cells are too wide-meshed (results in low spatial resolution, hence spatial differences are not well graduated)
- Buttons for simple forward and backward movement in time missing at start page
- Animation windows difficult to interpret and use (no customization possible)

The **Climate Change Knowledge Portal** (CCKP) of the World Bank provides general information on past and future climate (but without current data included) and contains additional information on sectors, impacts, adaptation, etc., beyond climatology.

Appreciated aspects:

- Simple overview of mean climate characteristics and changes for all countries and grid points globally
- For climate projections, large selection of different indices / scenarios with clear visualizations
- Comparison of climatic and socio-economic aspects possible via slide controls
- Useful sectoral summaries per country incl. expected climatic changes and implications on sectors
- Tutorial videos provide good overviews of tool functionalities

Critical aspects:

- Cartographic representation evaluated as not particularly original
- Only long-term average data used, no data from individual years or periods
- For past climate, only information on mean temperature and precipitation (and no other elements) available
- Separation of water catchment areas spatially not differentiated and logical (at least in Europe)
- Comparisons of time series between different locations not possible

The **Climate Information Portal** (CLIPC) by Copernicus was generally considered to be the most complex application – its diverse (and meaningful) content needs to be explored over time. (Tailored) training sessions for a faster and more in-depth exploration of its functionality would be needed.

Appreciated aspects:

- Logical choice of content based on themes and parameters
- Contains a lot of interesting and important data (long list of variables and indices)
- Contains some unique functions (comparing and combining functions) for advanced users

Critical aspects:

- The too large complexity right from the beginning is seen as main problem = not intuitive enough and difficult to understand even when using tutorial videos
- Level selection and activation not considered intuitive
- Need of selecting appropriate climate models from a list of complex model denominations as precondition of most evaluations overwhelms most non-climatologist users (expert knowledge required for meaningful decisions)
- Compare and combine functions also difficult to use without expert knowledge

Summary of user recommendations and preferences

The following qualitative summary and interpretation of user feedback is mainly based on results of the FGD across the five countries (*with a few clarifications and additions based on the previous ClimVis survey included, in italics*). The feedback is grouped by themes and will guide us during the future development of the ClimVis tool.

Target groups:

- Data users focus on data details and their availability *(specialist tools)*, while information users focus on visualised (and interpreted) climate information *(ClimVis focus)*
- User needs and feedback – even by those belonging to a common group (like teachers) – differs widely, e.g., regarding portal content, functionality and complexity: impossible to fulfil all demands in one tool
- ClimVis needs to develop a clearer focus (and delimitation) of the intended target groups to account for the very large diversity of stakeholder demands
- The ClimVis tool cannot fulfil every demand, therefore provide good international and national links to complementing tools/information → *ClimVis provides a collection of international and national tools as added value to users: as links on the future tool page (to be extended with time) and additionally as Excel file with summary of tool characteristics (already online, status summer 2021).*

Language:

- Almost all users prefer their national language (simpler and more convenient), while English is accepted primarily in an academic environment
- Some use automatic translations in their browser to enable access in their own language, but this is only partly leading to accurate and/or clear results and only seen as expedient as long as no sufficient information tool in own national language is available
- As alternative to a multilingual tool, users suggest that access to top levels should be provided in national languages (*degree of possible realisation within ClimVis needs to be discussed*), while more in-depth (meta) information can be provided in English ("is a scientific international project")
- School context: different demands exist by different age groups or school types (e.g, primary school students need native language access, while English may be acceptable in final years in gymnasium)

Access:

- Usage and navigation must work well on very different devices
    - screen size and device purpose: PC vs. tablet vs. smartphone
    - browsers: Chrome, Edge, Firefox ...
    - operation system: Microsoft, Apple, Google …
    - manufacturers: Samsung, Apple, Huawei …
- Gradual increase in tool complexity via layer structure is not only intuitive, but also useful from the perspective of technological diversity
- Access for people with limited internet connection speed needs to be ensured (time consuming loading discourages users), e.g., by diversifying degree of presented information per layer
- Use in class: lessons may (still) be conducted in a computer room (PC, laptop), but tablets are more and more introduced, or smartphones used

Tutorials:

- Best practice: GCM's text tutorial and CCKP introductory videos
- Short tutorial videos (2-3 minutes) recommended, providing an efficient overview of the functionality and content of the site (better several short videos than one long one)
- Other, slightly longer (3-5 minutes) videos recommended for special functions and topics
- 1-2 hour training courses or webinars are considered adequate to convey in-debth-knowledge about usability, content, special context and application examples, but live sessions may be difficult to schedule → *ClimVis will later record and provide such sessions on the webpage*
- Long texts (e.g., with explanations of results or methods) are seen as discouraging on top layers, but they can still be provided (in case needed) to convey background information
- *ClimVis strategy: text tutorial in GCM style as well as a short introductory tutorial (<3min) on the start page; provide further tutorials on special topics and / or case studies on special tutorial page; here, also meaningful webinars should be hosted*

Start page and navigation

- Start page access needs to be as simple as possible: create intuitive entry, then increase complexity by layer level (and provide meta level information etc.)
- All available data, themes and categories should be easily accessible from the start page
- Menu: easily understandable pictograms are important
- Reduce number of necessary clicks (avoid redundancies)
- If possible and applicable include easy to use search engine
- Access own location: a) Geolocation as a button, which can be used to get quickly to your city / area and alternatively b) enter a location
- Best practice: intuitive entry with little complexity ideal (like GCM); Access to CCKP via buttons is viewed as rather unfavourable
- *ClimVis strategy: display "the big picture" via a Pan-European map (start page), then allow for zooming options to access regional and local information*

Display and comparison options, and customisation

- Division into geographical units (countries, regions, catchments) seen as intuitive and inviting
- Include meaningful animation functions (e.g. map animations of monthly, annual or decadal climatic developments, annual cycle etc.; allow for customisation of animation speed and content)
- Provide short and clear descriptive texts that update automatically with new data
- Include simple comparison options for parameters (like minimum and maximum temperature), time frames (like reference periods or 2-3 years) and stations/regions – such options are seen as important, but hardly available in the current tool landscape
- Allow comparison of 2 or more climate diagrams (temperature and precipitation) for regions, larger cities or capital cities (e.g., useful in education and communication) – connected to a general climatic overview and climatic changes over time (e.g., compare reference periods 1961-1990 and 1991-2020)
- Intuitive, creative ideas are welcomed and will increase usability and user satisfaction (e.g. comparison via two images next to each other, but also sliders, overlay, etc.)
- Important remark regarding comparison functions: zoom option should affect both images at the same time (and not just one, so that identical changes need to be applied to two or more images like in CLIPC)

- Options to customise content are welcomed: the most common settings must be displayed by default, but as many (intuitive) adjustment options as possible should be available for expert users (hardly available in current applications): e.g. via an expert button
    - Graphical adjustments: legend, colouring, heading, axis scaling, labelling etc. to create customised illustrations for communication and decision-making purposes
    - Content adjustments: adjustment of reference periods (length, time frame), displayed time frame etc.
- (only) in order to save and re-use customised choices and adjustments: provide user login options
- Best practice: often mentioned innovative functions of the 3 tested tools
    - GCM: selecting a point on the map and displaying time series; profile function
    - CCKP: comparison of climatic aspects with socio-economic aspects using sliders
    - CLIPC: compare / combine functions (for advanced users)
- *ClimVis should include, advance, and develop such useful display and compare options (can be expanded and optimized over time according to user feedback)*

Data issues and clarity:

- Provide data download options for points (locations) and geographic regions
- Data download: progress on data and file download needs to be indicated
- All scientific content should be explained, e.g., via mouseover (e.g., climate scenarios and models, used methods)
- Data set names (especially valid for climate models) need to be clear/understandable for users to allow informed working with them (currently this is often unclear for "normal users" without modelling experience; e.g., in CLIPC)
- In case of inclusion of different data sets: provide the most robust data (possibly including ensemble information) as an introduction; followed by the opportunity to go into detail including meta information (presentation of various model outputs as expert mode)

Spatio-temporal resolution:

- Strongly expressed demand to select weather stations (locations) instead of grid data ("it is more intuitive to click on a specific (measuring) location than a grid point whose data origin is unclear") – *could be approached in ClimVis via choice of grids or towns (but related data would be the same at least in the first tool version: grid data as basis for both)*
- Spatial resolution of 0.1 ° (11 km) is sufficient for most users at the European level: Users are aware that higher resolution (taking in the lower resolution of the input data) no longer brings spatial knowledge gain and that for higher-resolution data they must use higher-resolution national or regional sources (if available)
- Daily data resolution is sufficient for most users (clearly expressed and justified concerns about the quality of hourly data at the European level, if available at all)

Metadata:

- Meta information are seen as extremely valuable to prove and illustrate the reliability and creditability of the application
- Must contain at least the data source and information on uncertainties
- Should be easily accessible from the displayed images / layers
- Intuitive and easy access for metadata needed, e.g. using pictograms or visualisations providing an overview for the entire area to explore in which region a dataset is uncertain or certain; followed

by detailed local information and added by sources providing scientific background information from the data publisher (website, publications, etc.)
- Demand for a short tutorial devoted to metadata and uncertainty (or additionally a recorded webinar, providing in-depth information)

Current data (and climate predictions)

- Often mentioned: enquiries (e.g., by citizens, municipalities, schoolchildren etc.) on how observed weather (especially extreme events) fits into the long-term climate context – important to provide such information, but real-time access currently difficult or impossible
- Comparing current weather information (observed presence) with past and future time frames generally seen as very useful and needed feature (level of importance varies with purpose of climate data use)
- Users of current data ideally need data from today (yesterday), or even weather forecasts (up to 7/10 days) – such data are most needed for immediate assessments of extreme weather events, and more and more important with increasing heat, heavy precipitation and other extremes – *a useful application would be a comparison of real-time weather data with climate information of past and future periods*
- Current data should be accompanied by a good explanation of the uncertainties (as spatiotemporal information is mixed from different sources
- Climate predictions could be usable in various contexts, but their large uncertainty and low reliability is preventing their use → *ClimVis will not focus on them, but continue to monitor their progress; if they would be used in the future, their data must be communicated very cautiously and clearly*

Communication of uncertainty

- Communication example: climate signal maps (e.g. robust = 66% agreement of the models in terms of direction and / or strength of the signal; example: GERICS climate signal maps)
- Clearly present uncertainty ranges and choose new and innovative ways to reach out to non-expert users
- Ways to present uncertainty, data significance and data sources: e.g., representation within the image/map itself or next to it; animation/shift key, layer principle

Additional remarks:

- Content and layout of the website must be kept up to date, otherwise it loses relevance (and current and potential users may be deterred)
- User feedback must be possible and processed promptly; good ideas should be implemented into the application
- Stakeholders often expect the “one stop shop” tool, which cannot be realised
- Good content and innovative functions increase use time
- Diagrams as a summary of entire countries often with dubious informative value (apart from very small countries)
- FAQs and a list of definitions of used climatological terms should be added