Climate Systems

National Environmental Science Program

From needs and challenges to practitioner led solutions

Delivering tailored climate information

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Introduction

The Climate Systems Hub is one of many groups delivering quality climate information and data related to decision making in Australia. With so much information available, users want to understand what information is most applicable to their decision-making needs and where they can find it.

Between July 2021 and December 2024, the Climate Systems Hub supported a series of projects focused on understanding the needs of decision makers in accessing information to support adaptation, and in particular, to make climate change information more accessible, useful and ultimately used.

Through co-design, stakeholder engagement and collaboration with state and Australian government knowledge brokers across the country, we summarised the users' needs to better understand how climate information is used in their decision-making (Murphy et al. 2022). Research into existing climate data portals demonstrated much of the required information already exists, but stakeholder climate literacy and specific information needs are often barriers to this information being applied in decision-making. Stakeholders expressed a desire for a 'one-stop-shop' for climate information and the project team set out to understand if a climate information gateway could provide a single trusted location where guidance was available to help navigate various sources of complex information available. Murphy et al (2022) outlined a set of recommendations to inform what such a gateway might provide, and how it could be designed.

Projects running from 2023 – 2024 set out to test what a gateway might deliver and how. This report captures what we have learnt in pursuing development of a gateway and the many barriers and challenges we encountered.

Who needs climate information?

Extensive stakeholder engagement was carried out to determine their highest priority needs for climate information, as detailed in Murphy et al. (2022). Twelve categories of user needs were identified:

- Guidance on accessing, interpreting, and using climate information
- Information applicable at a user's location
- Information applicable to a specific sector or decision-making process
- Information of appropriate complexity – often simplicity is preferred
- A trusted guide to finding the right information
- Inter-operability between climate data and other information
- Up-to-date information
- Data and information presented as visuals, maps, or summaries
- Guidance on using climate information for risk assessments
- Information on climate hazards that may impact a location or sector
- Case studies on finding and applying climate information
- Guidance on the integration of First Nations traditional knowledge (Murphy et al. 2022).

Research into existing climate data portals demonstrated that much of the required information already exists. Still, stakeholder climate literacy and specific information needs are often barriers to this information being applied in decision-making. Calls for guidance, training, and support on how best to use information also emerged as pressing concerns for stakeholders. These confirm the importance of providing climate literacy training and guidance materials in addition to a single trusted location (a “gateway”) to help navigate the many sources of complex information available.

The review of existing data portals identified that many users lacked the technical knowledge required to use the rich and data-heavy information sources available. And despite the many existing sources of information, users often reported that these did not meet their needs. To better understand why this gap existed, we identified 3 personas (Figure 1) of typical users of climate information. These personas have been important in identifying who a gateway, training and guidance should be targeted towards.

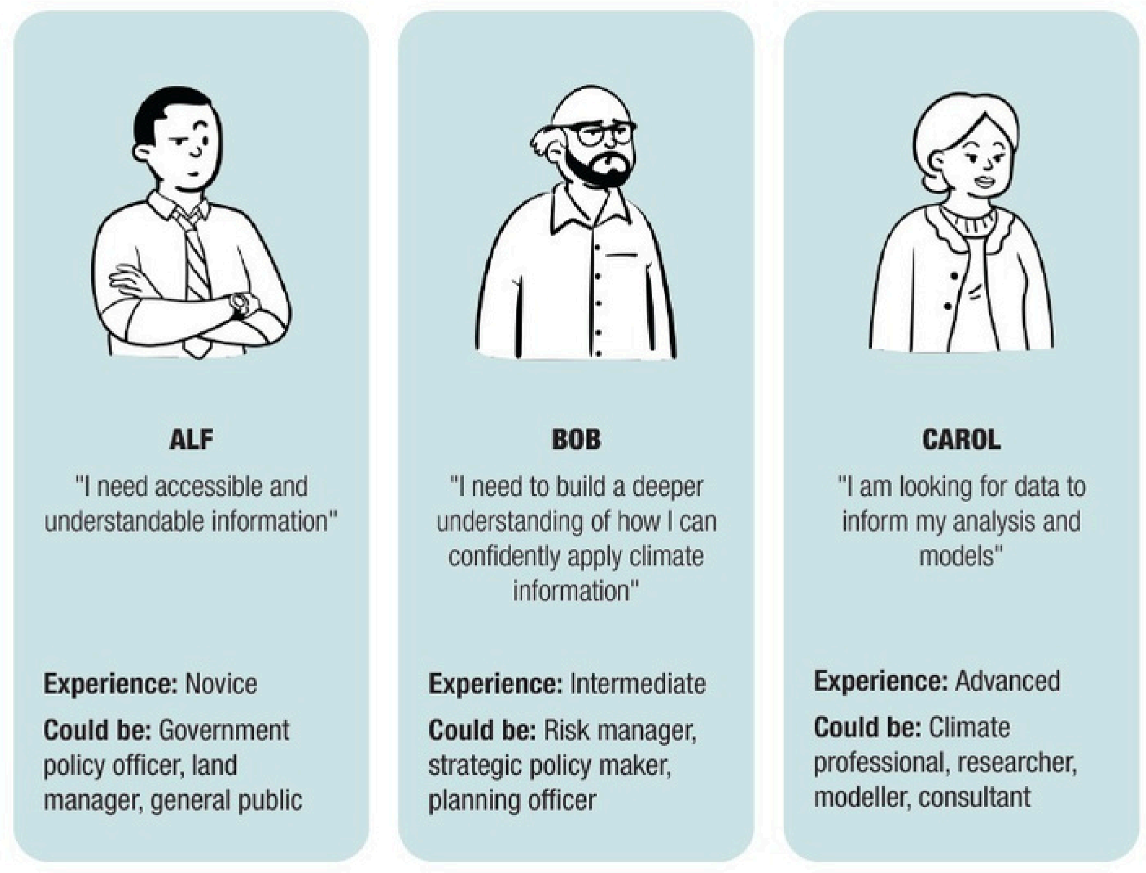


Figure 1: The project team identified three user personas to help decipher who's needs might be met by the project.

Our needs analysis considered the content needs and preferred delivery mechanism for the three personas (Table 1). Both Alf and Bob sought summarised information either for themselves or to build the knowledge and buy-in of stakeholders or organisation, as well as guidance and locally relevant information to undertake their work in responding to climate change.

<table>
<tr><td colspan="3">Persona 1: Alf - Proficiency: Novice</td></tr>
<tr>
<td>Needs:
high-level understanding of climate projections and hazards
confidence in projections information
to be a good ‘buyer’ of climate information
contribute to first pass risk scan</td>
<td>Content of interest:
simple, non-technical, easy to understand information on climate change, and sea level rise for their region
climate change impacts
credible future scenarios</td>
<td>Delivery mechanisms:
short, plain-English summaries
briefings
analogues</td>
</tr>
<tr><td colspan="3">Persona 2: Bob - Proficiency: Intermediate</td></tr>
<tr>
<td>Needs:
confidence in data products
guidance to identify most appropriate data sources
undertake a hazard and risk assessment
consider the risks, but also demonstrate the opportunities / benefits, of taking action</td>
<td>Content of interest:
regional summaries of climate projections
explainers of ranges and uncertainty
translation of projections to impacts
Likelihood of risks in local area
clear narratives around scenarios and model selection
a limited set of credible future scenarios
how to apply climate information</td>
<td>Delivery mechanisms:
short, plain-English summaries
synthesis summaries
local or topic -relevant figures and charts
resources to help up-skill others
step-by-step guidance
case studies/exemplars</td>
</tr>
<tr><td colspan="3">Persona 3: Carol - Proficiency: Advanced</td></tr>
<tr>
<td>Needs:
high-level understanding of climate projections and hazards
confidence in projections information
to be a good ‘buyer’ of climate information and consulting services
contribute to detailed risk assessment/s</td>
<td>Content of interest:
datasets from a range of models
research gaps and limitations
model methods and assumptions, assessment and quality assurance information</td>
<td>Delivery mechanisms:
application ready datasets
technical papers including technical figures and charts.
peer reviewed model assessment</td>
</tr>
</table>

Table 1: Summary of the climate information needs, content priorities and preferred delivery mechanism for each of the three personas developed by the project team.

Initial scope of gateway

It was clear that no single online resource could provide all the information required by all users. However, the concept of a "one-stop-shop" that stakeholders can go to as a starting point and gateway with guidance to other information is highly sought after and has many advantages. By integrating such a gateway with training and guidance material, users' ability to find and apply appropriate climate information to their decision making could be enhanced.

With the advantages and challenges of a gateway firmly in mind, a set of guiding principles for a gateway were proposed:

- Begin with a focus on providing users with a starting point on their climate information journey, specifically for the personas identified above.
- Present options initially to users, include asking a series of questions to determine their sector, location, level of expertise, and application for the information (for example, first-pass risk assessment), to enable relevant information to be gathered and presented to them.
- The hub gateway can add the available climate information data sources and portals by providing summary data at the desired location at the relevant spatial scales (for example, local government area).
- A focus on the synthesis of data and information, guidance, and training to make existing resources more accessible.
- Presenting a "layered" approach for users is likely to be most effective – presenting relatively high-level information and allowing options to drill down to more detail or to access explanatory resources.
- Provide users with options and guidance on choosing between them, including strengths and weaknesses of each data set, model, framework, etc.
- Ensure that the gateway design is strongly user-centred, with a co-design focus to ensure it meets user needs. Deploy user experience design expertise to help design the portal.
- Ensure the needs analysis accurately captures user needs and hone them further by sharing findings with stakeholders who were surveyed and other experts (including the hub knowledge brokering team).
- Consider the purpose of the gateway during the lifetime of the hub and its legacy beyond.
- Work closely with other existing programs (e.g. Australian Climate Service) to leverage the resources and ensure the two complement the hub gateway, presenting a unique user-focused gateway accessible to stakeholders.

We recognised that the hub gateway would need to be designed to complement other portals, including those currently being developed. It also needed to work in conjunction with training, guidance and synthesis products. Detailed user-centred design work was vital to ensure user needs are met, while recognising that every user has different needs.

From the user needs engagement we created a priority list of what a gateway 'must have', 'should have', 'could have' and 'won't have' (Table 2).

Priority	Gateway
Must-have	• User-friendly, co-created UX (skimmers, waders, divers) • First-stop-shop - Getting started • Clear start page to specify persona and needs/sector • Climate variables relevant for each sector • Climate literacy/Basic training (climate 101, scenarios, climate risk assessment, uncertainty, how to use the gateway) in a modular fashion for different levels • Explainers (understand application, find right information, case studies) • Regional and sectoral summaries • Interactivity/guided
Should-have	• Dynamic selection of region based on sector (layering) • Ongoing updates with best available science (living document) • Customer journey • Multiple points of entry/different lenses
Could-have	• Ask a scientist system • Background data available to download (Carol) • Implementation of information from other webpages/portals (not leaving the gateway)
Won't-have	• Very detailed information about climate models, downscaling, etc. Would rather refer to other places for this kind of information • Endless ongoing support -> shelf-life for duration of NESP (move to government (DCCEEW) or universities?) • 'Not like a book in a library'

Table 2: Summary of priority needs for the gateway and what to avoid based on conversations with users.

Defining and testing an 'Almanac' approach

The data collected from stakeholders and the analysis conducted suggested the way forward was to develop a climate information gateway to suit personas Alf and Bob. Such a gateway could meet many of the pressing needs of these user groups. One example of information collation that pointed to a good potential representation of a gateway was co-developed with users in the hospital and health sector of the Queensland Government.

The Climate change adaptation planning guidance: Almanac (Boulter et al. 2024) provides the underpinning information required by regional Hospital and Health Services (HHS) in Queensland developing a climate change adaptation plan. It is a set of regional climate summaries together with general guidance to understand the climate information, examples of risks, adaptation options and case studies specific to the HHS businesses. The project team identified this was a very relevant example of what users were asking for, and the project began working on the premise that the gateway could be an online 'almanac' of supporting information.

At this point, a User Experience (UX) expert and hub knowledge brokers were brought into the project team to help co-design the almanac with stakeholders. While confidence in the needs of our users was high, confidence that a gateway was the most effective solution was lower, and we looked to explore whether other approaches could lead to better outcomes.

An independent assessment of the user research that had contributed to the rationale behind the gateway concept was conducted. It characterised the user needs, pain points and issues identifiable within the research, summarised the opportunities and unmet user needs that might contribute to a gateway solution, and aimed at establishing a baseline for user needs and pain points data for future stakeholder engagements around the gateway. That assessment also reviewed 18 national and international climate portals to assess the landscape of existing climate and adaptation resources, content strategy, site feature and value offering.

It confirmed that an almanac-style gateway would predominately benefit novice ('Alf' and 'Bob') users looking for resources, advice and support on how to get started. It was concluded that a gateway would be a practical and useful application if it provided curated climate information and data sources for popular use cases, including guidance and clearly signposted entry points to the gateway – along the lines of the almanac approach (Box 1).

Two strategy workshops followed with project members and hub knowledge brokers to capture key stakeholder feedback and domain knowledge to guide user centred design of a gateway. Eight use cases were formulated around archetypes of users (3 each of Alf and Bob, 2 of Carol personas) of climate information, each covering specific user needs and requirements relevant for their climate decision making. See the Gateway User Experience report. These use cases were prioritised and shortlisted. A use case was chosen (as detailed below) that would highlight the benefits and drawbacks of a gateway approach, and the challenges faced when designing one for either a narrow or broad use case. Ensuring the use case was achievable within the modest project timelines and resources was essential. Developing a gateway or almanac that would cater to all users and their requirements within those eight use cases would not be possible in the project, and would be challenging even with significantly more time and resources.

The other considerations in selecting the use case were:

- to focus on an 'Alf' user-group that would be able to collaborate towards designing a solution for their decision-making needs
- ecological management, as this was the prevalent theme among the eight use cases and provided co-benefits to other hub projects.
- limiting the scope to a single bioregion, and
- working with users with whom a relationship existed.

The project approached a group of land managers in the Brigalow Belt South bioregion and developed a collaborative project that would use a values-based approach to risk management. The aim was to work intensively with the users to design a prototype climate almanac that presented current and future climate and hazard changes, bringing together relevant synthesised climate information for the decision makers. This required developing a joint understanding of decision-making processes, existing management frameworks and the relative strengths and limitations of available climate information.

Case study: Provision of climate information for ecological managers

Climate change presents unprecedented challenges to land and sea managers tasked with managing natural ecosystems. Managers require context-specific climate information to make informed decisions and plan for the future. To be effective, the provision of climate information must consider the unique needs of end-users, address practical challenges, and deliver bespoke solutions that are able to be integrated into existing operational frameworks. Ideally, climate data integration should occur without the need for any additional analysis or manipulation.

Understanding the needs of land and sea managers

Land and sea managers' responsibilities include biodiversity conservation, risk management (including invasive species and bushfire threat), restoration of degraded habitats and maintaining ecosystem services in environments that are highly sensitive to climatic change. Currently, many land and sea managers do not incorporate climate information into decision making. The reasons for this include:

- Uncertainty or confusion of where to source the 'best' or 'correct' information.
- Climate information does not exist in a format that can be incorporated into existing operational frameworks.
- Perceived conflict between different sources of climate information.
- Unsuitable resolution of information for the location or the nature of the work being performed.
- The fast-paced cycling of new climate models creates a sense that better data is "just around the corner." This creates an environment of constantly waiting for the latest and greatest climate information.

Another barrier is that many planning frameworks are relatively short-term. A 10-year plan is often the longest planning horizon decision-makers are expected to consider, and many work to much shorter timeframes.

Despite the need for reliable climate information, several barriers complicate the provision of appropriate, actionable information. These include:

- Data gaps. These include spatial data gaps with smaller Australian states having no regionally downscaled, easily accessible climate information. Currently no readily accessible national high-resolution climate information exists.
- Existing information may not provide all the hazard information required by end-users, such as domain-specific or bespoke variables.
- The inherent uncertainty in climate modelling can undermine confidence in projections. Managers may struggle to incorporate uncertain information into concrete action plans.
- Limited funding, technical expertise, and institutional capacity can hinder ecological managers' ability to access, interpret, assess and utilise climate information effectively.
- Climate scientists and ecosystem managers often operate in separate spheres. Misalignment in terminologies, priorities and methodologies can impede the effective exchange of information.

Climate impacts

An issue commonly raised by land and sea managers is that the future climate variables themselves are of limited interest. Instead, land and sea managers are wanting information on the impact these changed variables will have on the ecosystems they manage.

It is not possible for climate data to provide the answer to all these questions and this is an area that requires collaboration between several experts including climate scientists, ecologists and managers. Knowledge brokers offer an important service in delivering the cross-disciplinary collaboration that is required to achieve this.

Figure 2 shows the different information types needed to reach an understanding of climate impacts on natural systems as well the relative input needs from different expert groups. In addition to climate models, other collaborative, structured and robust decision-making processes such as expert elicitation (e.g. the IDEA protocol (Hemming et al. 2018)) can also be helpful.

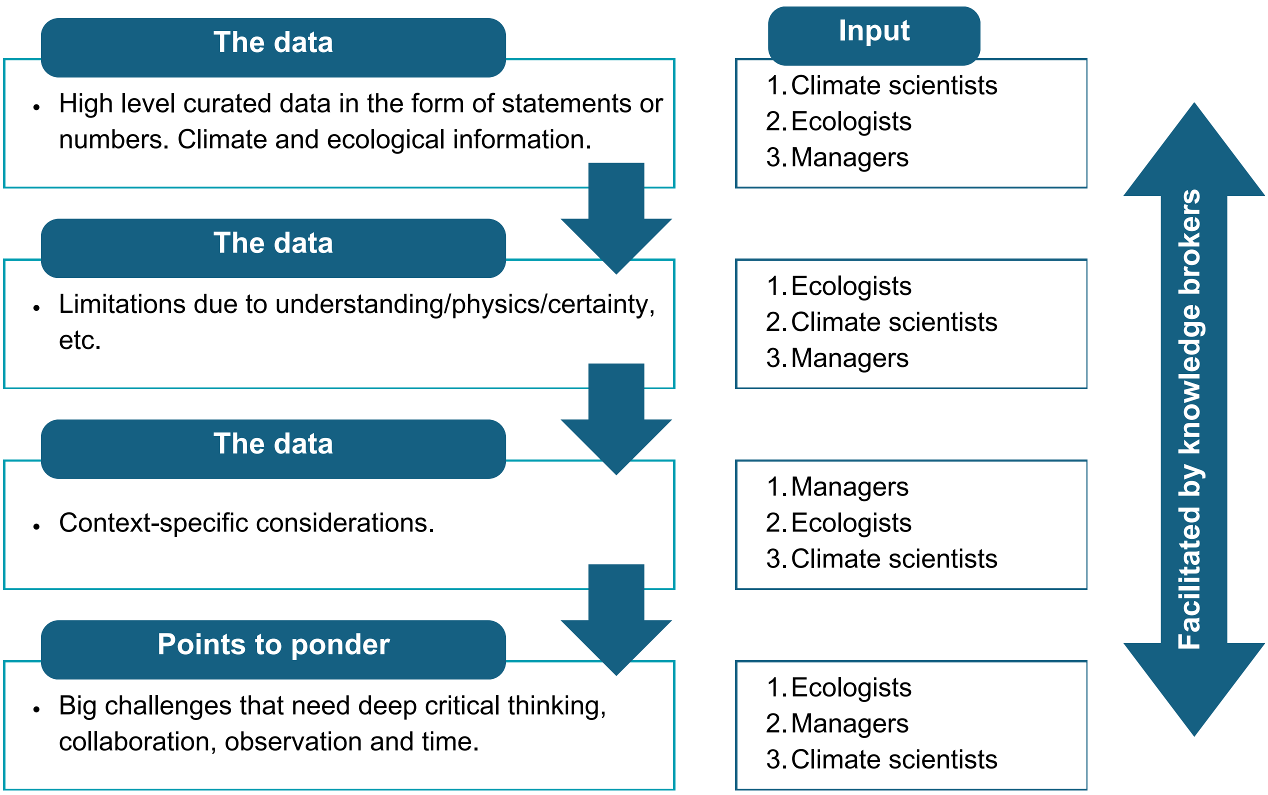


Figure 2: Hierarchy of data input for understanding climate impacts on natural systems.

Delivering solutions

To address the above issues, we worked with fire managers from the Brigalow Belt South (BBS) IBRA bioregion to understand the tasks they perform and decisions they make. This was undertaken through a participatory action research approach (University of Tasmania Human Research Ethics application H0029843), where the land managers were central to understanding, tackling and suggesting solutions (Cornish et al. 2023). The experiential knowledge of the land managers was combined with the scientific expertise of the NESP researchers to communicate limitations, challenges and solutions from different perspectives.

Collectively, the research group held the following expertise:

- Physical climate science and modelling
- Climate data analysis and management
- User experience and graphic design
- Climate adaptation
- Ecology
- Fire behaviour science
- Fire operations
- Reserve planning.

The region

The Brigalow Belt South (BBS) bioregion extends from the mid-Queensland Coast to south of Dubbo in New South Wales. The region sits in the transition zone between the coast to the east, the arid interior to the west, the tropics to the north and the more temperate south. The placement of the region in this transition zone provides a large variety of landforms and natural habitats. The native vegetation of the bioregion is predominately mixed eucalypt forest woodland with areas of brigalow (Acacia harpophylla) scrubs and open Mitchell grasslands while the landforms include mountain ranges, sandstone gorges, undulating hills and alluvial plains (Australian Government 2024).

The BBS bioregion contains 21 threatened ecological communities (approximately 20 per cent of all listed communities) and more than 200 threatened animal and plant species and is one of the Australian Government's 20 priority places. The historical climate of the BBS varies from hot to warm subhumid with summer dominant rainfall to semi-arid (Australian Government 2024).

The public reserve system within the Queensland portion of the BBS bioregion is managed by the Queensland Parks and Wildlife Service.

Queensland Parks and Wildlife Service management framework

The Queensland Parks and Wildlife Service manages its reserve estate under the internationally aligned Values-Based Management Framework (VBMF). The VBMF uses evidence to inform priorities and evaluate effectiveness of management actions (Queensland Government 2024). The VBMF operates through a series of subservient management thematics, allowing structure and opportunity for future climate-related input at a number of entry points.

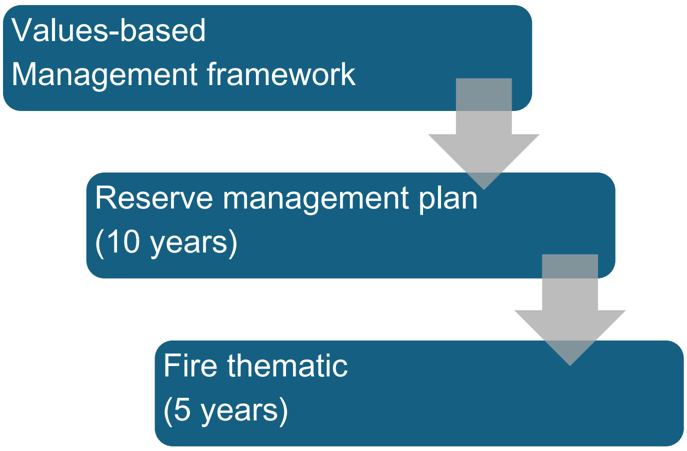


Figure 3: Queensland Parks and Wildlife Service Values-Based Management Framework, subservient management plans and thematics and their stipulated timeframes.

Tailoring climate information

Through a participatory action research approach, we explored why climate information is not being incorporated into the strategic and operational plans of the Queensland Parks and Wildlife Service.

Engagement between NESP researchers and BBS fire managers occurred through a series of online and face-to-face workshops as well as regular communication over email. Through this, researchers gained an understanding of the climate information required for operational decision making. These include:

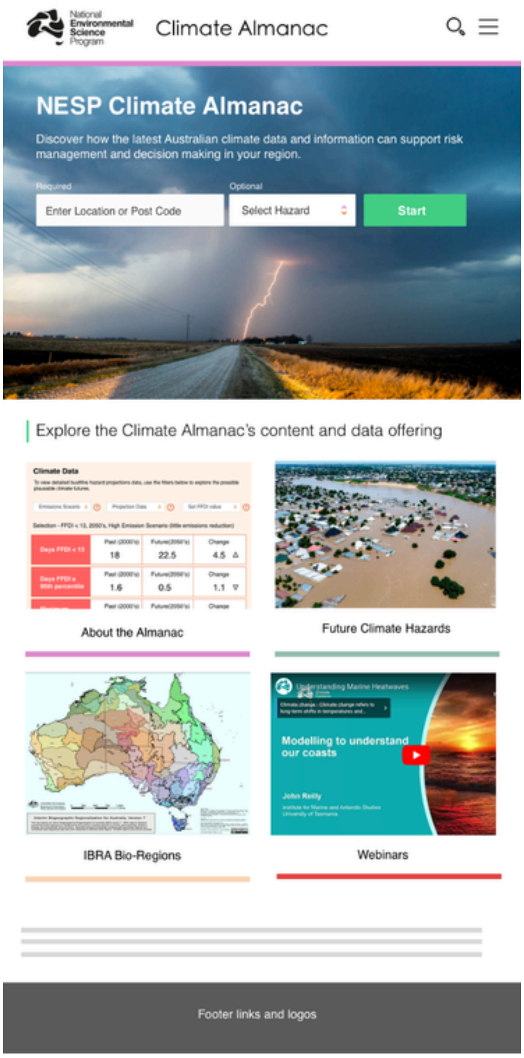
- Forest Fire Danger Index values appropriate for planned burning (preferred index over the AFDRS for its wide-spread application of FFDI over a very long period of time).
- Monthly shifts in the planned burning windows.
- What future bushfire conditions may look like based on the 95th percentile Forest Fire Danger Indices.

This information provides operational level insight into the future climate and can help strategic planners consider how present-day actions may impact future decision making. These include:

- Actions that provide future protection for fire-sensitive vegetation communities such as fuel breaks, hydrological manipulation or a more intensive present day burning program in associated fire-adapted vegetation communities.
- Insights into future workforce requirements.
- Planning for adjustment to the seasonality of planned burning operations and bushfire suppression requirements.

Co-design

A face-to-face workshop in Brisbane allowed NESP researchers to present nascent climate data and design approaches for input and feedback from QPWS staff. Final design concepts and an interactive Figma prototype for an online Climate Almanac portal were shared with the QPWS staff for feedback.



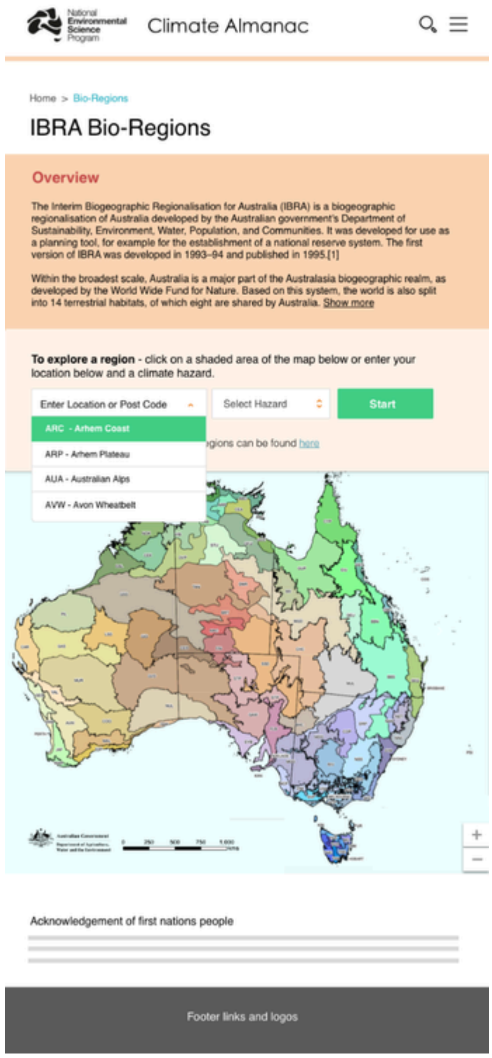


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Table 3: Prototype designs of the climate almanac, allowing users to view the content and do basic navigation: home page (top left), search and view IBRA bioregions (top and bottom right), fire hazard information and present and future climate indices for the BBS (bottom left).

Feedback on the almanac design was collected through a survey. Overall feedback was very positive, in terms of the relevance of scientific climate data and guidance, ease of interpretation, usability of the user interface, information architecture and content structure, level of interest in using the data and assessment of the Climate Almanac as a valuable tool for QPWS in supporting their fire management needs. QPWS staff expressed a desire to see the almanac developed further and beyond a prototype to an operational tool applicable across all IBRA regions.

Key findings

The primary reason reported for not incorporating climate information into planning and actions were the short-term timeframes established within the overarching QPWS management framework (Figure 3). Secondly, fire managers require very specific information and this is not available for easy access on climate information platforms such as the Queensland Future Climate Dashboard which does not offer statistics for subregions and the information is not presented in a way that is easily digestible. Specifically, we found:

- Collaborative approaches that involve ecological managers in the design of climate tools and data systems ensure relevance and usability. Regular dialogue and the involvement of Knowledge Brokers can bridge language barriers between scientists and practitioners.
- Training programs and workshops help to build capacity of managers to interpret and apply climate information effectively. Capacity-building efforts should also address the integration of climate data into broader ecological management plans.
- Data visualisation platforms can simplify complex climate data, making it more accessible and actionable for ecological managers, but this information is worthless if it is not fit-for-purpose.
- For climate information to be useful it often needs to be bespoke to the end-user, considering specific variables or hazard indices that are relevant to their operations. This is time consuming and not easily scalable.

Conclusion

Understanding the specific needs and challenges of particular user-groups is required for the provision of usable and accessible climate information. By investing in tailored approaches that prioritise collaboration, co-design, accessibility and adaptability we can bridge the gap between climate science and ecological management. This will enable managers to protect ecosystems more effectively, ensuring the resilience and sustainability of natural systems in the face of climate change. Knowledge brokers offer a vital service in achieving these aims.

Project reflections

The challenges of a ‘one-stop-shop’ and resistance to a ‘proliferation of portals’

It is clear that no single online resource can provide all the information required by all users, but the concept of a "one-stop-shop" that hub stakeholders can go to as a starting point and gateway with guidance to other information is highly sought after by users and has many advantages.

The project encountered considerable push-back on ‘not another portal’ from funders and senior policymakers. While duplication is clearly neither efficient, effective nor helpful, there is a clear misunderstanding of what constitutes genuine duplication. The project team used the analogy of books in libraries where there can be multiple books on the same topic, with each offering a different verbal style and level of complexity.

Additionally, books frequently target a specific reader or sector – for example, climate science for dummies vs the 3 volumes of the IPCC assessment. Online delivery does not remove the validity of delivering tailored information to specific audience sub-sets. Users are often seeking confirmation from a range of different sources that either helps build their literacy and understanding of a very complex decision-making and assessment process or builds their confidence in the information they are given.

We found that the desire for a ‘one-stop-shop' was less about a single source of truth and more a reflection of the need for help to navigate complexity and find information sources that help answer the ‘so what’ questions. When presented with climate projections and scenarios an immediate response we frequently encountered during in-person training workshops was: What does this information mean for my organisation or area of responsibility (i.e. impacts)? How do I use it in decision making? How can I be confident in the information? Which scenario should I use? How should I treat different scenarios in making decisions? How do I incorporate it into existing risk assessment and reporting? Each of these questions can be very specific to a sector, a job, or a system.

We found that users are looking for linked information to help build their confidence in moving from climate scenarios to application of difficult decisions and actions. Responding to climate change is a constant learning journey and the complexity and implications will have critical implications for all social and economic dimensions of Australia. This reflects the user need to build confidence and certainty in how to tackle decision-making when future scenarios – both climatic and socio-economic – can never be certain and unable to be satisfied by a single source of information.

Project learnings

What worked well

The prior creation and application of the “3 personas” of users was instrumental in being able to frame the delivery of climate information effectively. The Alf, and to a lesser extent Bob, users were identified as those with the greatest unmet need for tailored information, and they became the focus of this project. This has enabled the project to deliver to a cohort of users that has not been well serviced in the past, and one that most keenly felt the “paralysis” of seeing too much climate information that was not designed for their needs, not knowing where to start, and being unsure of how to effectively apply the information they could find to their decision making. Identifying the key personas was key to the project being able to clearly articulate a unique offering that would fill an unmet need in an already busy space. This project, this hub, and even the NESP program, are not alone in finding the personas useful for framing delivery of climate information with ACS being another example.

Co-designed, tailored climate and adaptation training is effective in boosting climate literacy. The training program that was developed in close consultation with the audience organisations, targeting needs that were identified through a co-design process was delivered five times between October 2023 and November 2024. The vast majority of the more than 150 participants felt their confidence level had increased in seven subject areas. However, demand for training is still high, and users seek guidance on how to integrate climate information into decision and planning frameworks. The online training videos and supporting materials hope to meet some of this need, but the quickly growing requirement to incorporate climate into all levels of decision making, as well as high staff turnover in some government areas, means this demand will be difficult to meet. The accompanying project Training Summary Report.docx has more details.

Some challenges

The objective of developing a gateway to give a wide range of users a starting point was ambitious. It is clear that providing useable and accessible climate information is hard. Data visualisation platforms can simplify complex climate data, making it more accessible and actionable, but this information is worthless if it is not fit-for-purpose. For climate information to be useful it often needs to be bespoke to the end-user, considering specific variables or hazard indices that are relevant to their operations. This is time consuming and not easily scalable. Every user has unique requirements, and in a values-based approach, a significant time investment is needed to understand and work through user needs and how they could be met. Hence the need for deep engagement with end-users, including ongoing confirmation of their needs and scanning of other offerings. Co-design can lead to useful, useable and used climate information as evidenced by the positive feedback received from fire managers in QPWS. Regular dialogue and the involvement of Knowledge Brokers can bridge language barriers between scientists and practitioners.

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