Climate Systems

National Environmental Science Program

Australia's climate change adaptation research needs

Workshop Report - July 2025

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The hub would like to acknowledge the contributions of all workshop participants. Special thanks to Jean Palutikof, Elissa Waters and Jason Mundy for their contributions to the workshop.

The Climate Systems Hub acknowledges the Tradition Custodians of the land across Australia where this work occurred. We pay our respects to Elders past, presents and future and recognise the important role traditional knowledge plays in understanding Australia's climate.

*All images are creative commons unless otherwise referenced

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Climate Systems
National Environmental Science Program

Report summary

Context: 2008 - 2025

- Past investment in research positioned Australia as a global research leader but subsequent investment gap has seen a decline
- Program of useful and useable research underpinned by process to identify research priorities
- Australia has international commitments and policy goals for adaptation

Workshop July 2025

NESP Climate Adaptation Initiative held a workshop of 40 researchers, policymakers and practitioners. The workshop kicked-off investigation of adaptation research progress and gaps.

Q1. Who needs adaptation research?

Doers

- all levels of government
- community groups
- First Nations people
- landholders
- NRM regions
- industry peak bodies
- private enterprise

Enablers

- research bodies
- educators
- consultants
- financiers
- government
- philanthropy
- markets
- private enterprise
- regulators
- knowledge brokers

Influencers

- government
- IPCC
- Australian climate service
- First Nations peoples
- funding bodies
- industry
- community
- media
- politicians
- researchers

Q2. Australia's current state of knowledge and action?

A classification of Australia's adaptation state of knowledge suggests that critical topics can be mapped against three 'comfort' levels. In the 'comfortable' zone, adaptation knowledge is comprehensive and in-depth; on the 'edge', we have substantial knowledge, though not always enough to reliably support action; and in the 'uncomfortable' zone, knowledge is insufficient, with many questions still to be answered.

Comfortable

- adaptation need and users
- values at risk and risk assessment
- physical risks
- sectorial responses
- local adaptation actions
- community engagement on defined risks
- financial insurance sector action

Edge

- managing uncertainty
- maladaptation risks
- making climate information useful and accessible
- capacity building & knowledge brokering
- innovation
- testing new approaches
- measuring impact and uptake

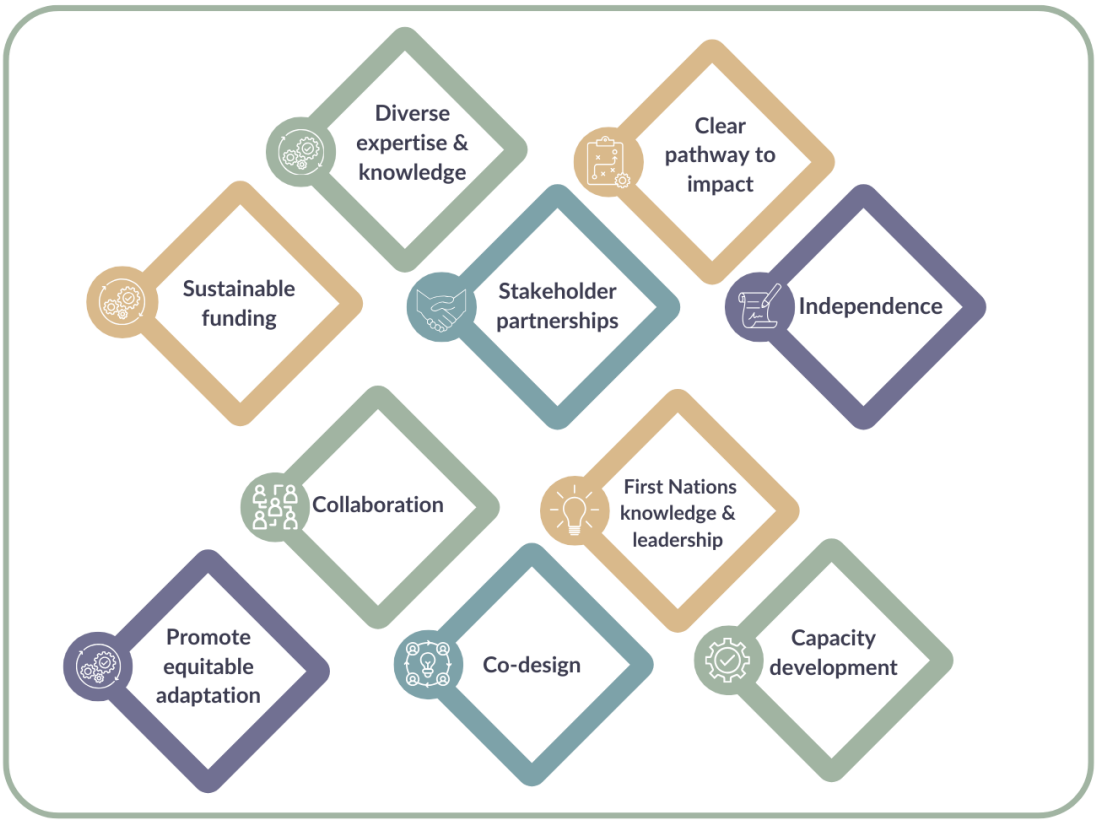
Uncomfortable

- fit for purpose governance
- decision support
- responding to complex impacts
- funding and private investment
- complex ecological impacts
- compounding cascading risks.

Q3.Where are the opportunities and challenges of existing funding pathways?

Exisiting options for researchers are limited, highly academic or focused on specific needs (e.g. private sector investment commercially oriented), lack end-user buy-in and mostly short-term.

The ideal model for adaptation research funding would include:



Next steps

NESP Climate Adaptation Initiative to build on workshop by:

- *desktop review of research investment & progress*
- *focused engagement to enhance review and develop criteria for prioritisation*
- *prioritisation of adaptation research questions for Australia*

Background

Climate change adaptation as a field of research in Australia

Climate change adaptation has emerged over the last 50 years as an important policy concept and body of research.

As global greenhouse gas emissions have increased, and measurable change to the world's climate is experienced, actors have responded or begun preparing to respond for the warming future. It is against this background that we see an increasing international (e.g. Paris Agreement Article 7) and domestic (e.g. Australia's National Adaptation Plan) policy environment to facilitate increased adaptation.

The rapidly developing field of climate change adaptation research looks to inform and support implementation and practice. Efforts to define and map the research discipline highlight the vast scope and diversity of work. Research draws on a wide range of disciplines reflecting the diversity of entities at risk from climate change impacts – from single species and individuals, to communities, culture and place from local to continental (Palutikof et al. 2014, Nalau & Varrall 2021). It spans theoretical (pure) science, analytical framing, and applied 'learning-by-doing' processes; and large bodies of cognate work that were never intended to be framed as climate change adaptation but that nevertheless underpin and support climate change adaptation from climate science, behavioural science, engineering, environmental sciences, health sciences, and social and policy sciences. In addition, there are important knowledge systems outside of the peer reviewed literature that are often at the heart of adaptation practice and success (Nalau & Varrall 2021). This includes Indigenous knowledge, people's lived experience, and the expertise of those in management and practice.

The Australian experience of climate change adaptation research investment

Globally, there is a significant research effort focused on adaptation in developing countries and while Australia shares many common adaptation challenges, particularly with the Pacific, it has very different social and economic contexts. Australia is a developed country and a wealthy, well-educated liberal democracy. Its economy and development indicate a high adaptive capacity. But, in common with many developing countries, it is exposed to high levels of climate variability and is already experiencing climate change fuelled extreme weather events, increasing average temperatures, and regional drying and wetting trends (Palutikof et al. 2015).

Major investment programs

In Australia, the first targeted investment in adaptation research can be traced back to the 2004 National Climate Change Adaptation Program (NCCAP). In 2008, the Australian Government invested in a significant program of adaptation research. A competitive grant of $48 million was awarded to a consortium led out of Griffith University to establish the National Climate Change Adaptation Research Facility (NCCARF). NCCARF invested $30 million of the grant in 121 research projects across all states and territories.

Under the same 2008 Australian Government investment, an initial $44 million was provided to establish the CSIRO Climate Adaptation Flagship, with an increased annual budget of $43 million from 2010 – 2014. From 2014 – 2017 a further $8.8 million was funded to NCCARF, a substantial decrease on previous funding.

Under the second phase of the Australian Government's National Environmental Science Program (NESP) Climate System Hub running from 2020 - 2027, a cross-cutting Climate Adaptation Initiative was established but not granted a specific budget allocation. While this has been a successful method of better integrating climate science and developing approaches for delivering climate services with adaptation thinking, the very limited scope and investment has meant the research potential has been extremely limited. Under NESP only 4 specifically adaptation focused projects were funded, compared to over 120 from a broad range of sectors funded under NCCARF. This reflects the climate system focus for the NESP program.

On top of these dedicated research programs, some discrete individual projects focused on adaptation are funded by industry and government focused on adaptation. In addition, some state governments support their own small research grants programs.

As of 2024, the Australian Government made a commitment to deliver the National Climate Risk Assessment. The first assessment was developed by the Australian Climate Service and published in 2025. The methodology will be revisited every 3-5 years to inform adaptation planning. This represented a significant investment in understanding Australia's future climate risks.

Investment impact

A review of evidence suggests that investing in research boosts Australia's leadership in global thinking, and ensures research activities benefit Australian end-users, but this wanes when funding decreases. Australian researchers authored 12% of peer reviewed journal articles on adaptation globally between 1978-2020, and Australia is the second most common subject of studies focused on a particular country after the United States (Nalau & Varrall 2021).

A search of journal papers in the Web of Science for the terms 'climate change'; 'adaptation'; 'Australia' (from 1991 to 2025) show a strong uptick in research publications in the years following the Australian Government's investment in adaptation research and policy in 2008 (Figure 1).

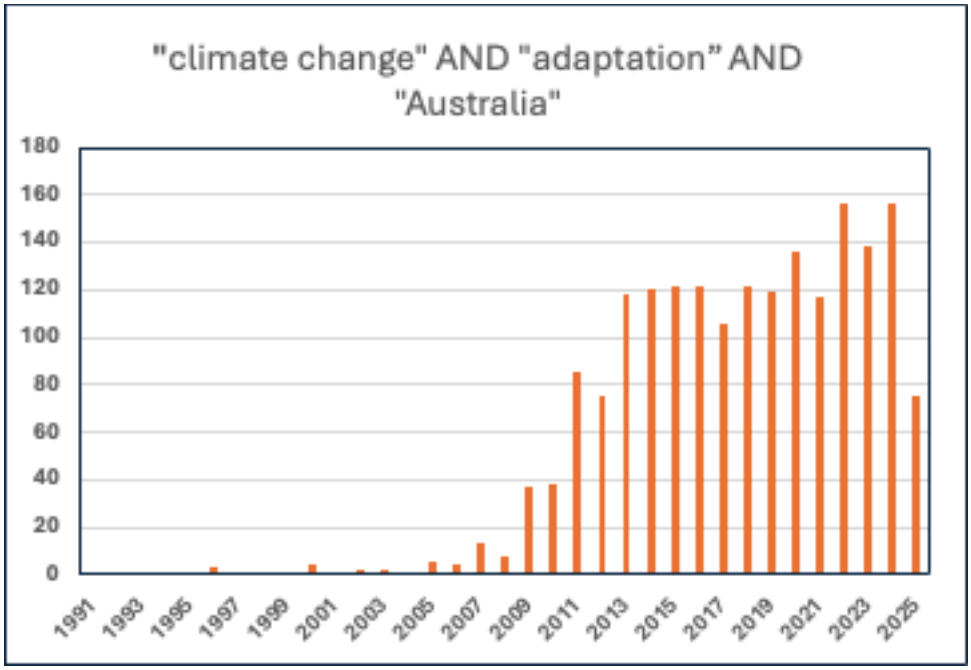


Figure 1: The number of journal articles by year from a search of the Web of Science database using the terms 'climate change'; 'adaptation'; 'Australia' from 1991 to 2025.

In the same time frame, we do also see a global increase in climate change adaptation research papers (Figure 2), however the proportion that is Australian has steadily decreased since 2014 (Figure 3).

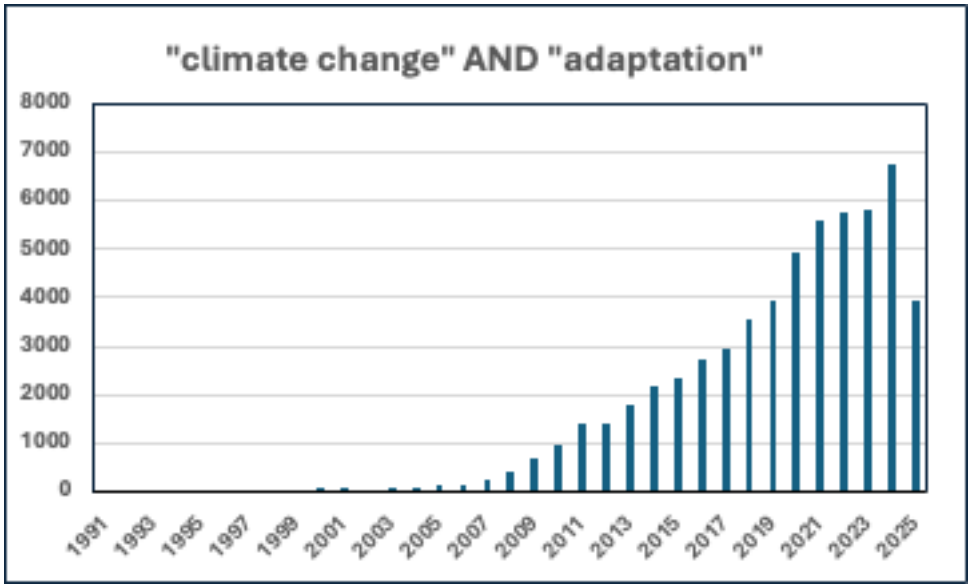


Figure 2: The global trend in adaptation research publications shown as the number of journal articles by year from a search of the Web of Science database using the terms 'climate change'; 'adaptation' for the years 1991 to 2025.

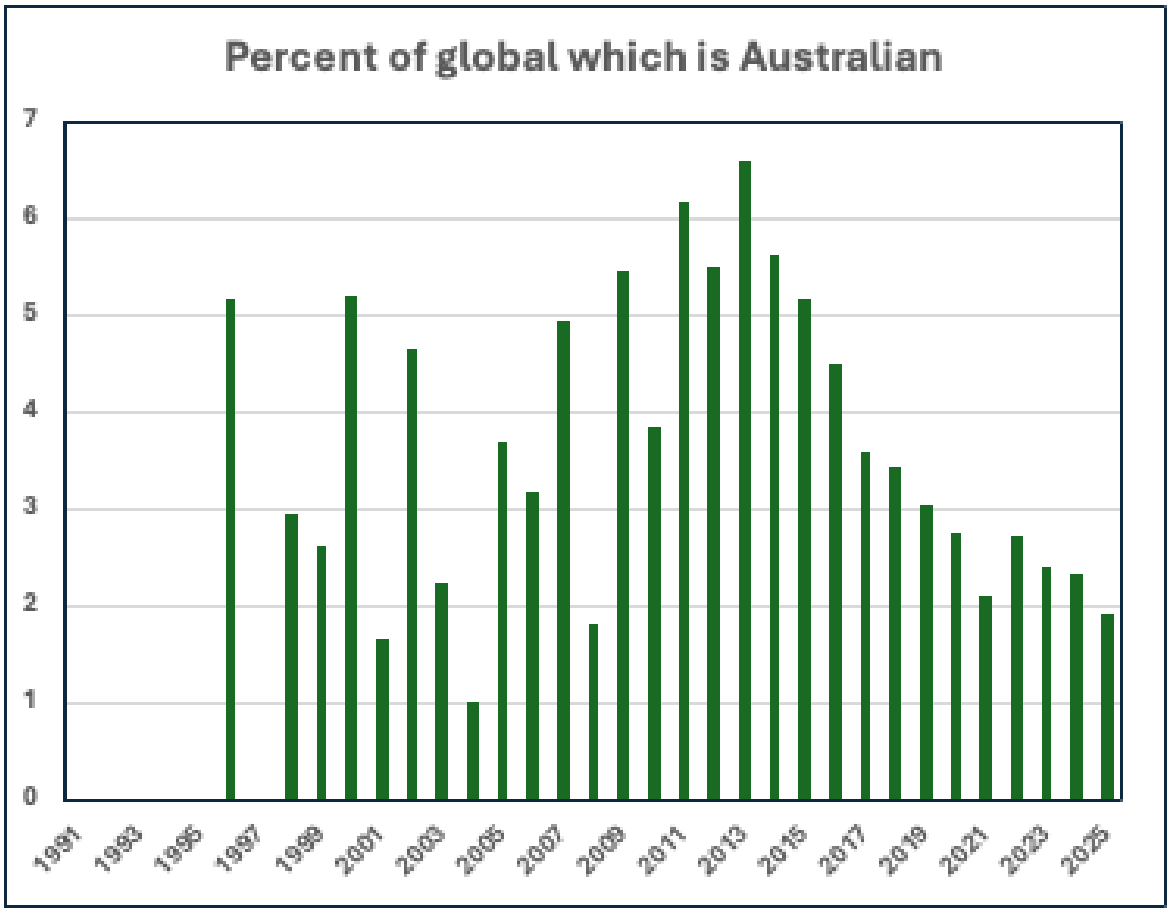


Figure 3: The percentage of climate change adaptation journal articles that are Australian by year from a search of the Web of Science database for the years 1991 to 2025.

While these are simple analyses, it's likely that the modest investment in adaptation research established Australia as an adaptation research leader. Further analysis of global trends by Nalau & Varrall (2021) show this has declined more recently, with Australia producing 14.3% of all adaptation research papers between 2011-2015, falling to 11.5% in 2016-2020.

Australia's policy goals and objectives for adaptation

As a signatory to the Paris Agreement to the United Nations Framework Convention on Climate Change (UNFCCC), Australia has committed to enhancing adaptive capacity, strengthening resilience, and reducing vulnerability to climate change. For the first time under the UNFCCC Conference of the Parties (CoP), the Paris agreement aims to significantly strengthen national adaptation efforts. The Paris agreement requires Australia to formulate and implement a national adaptation plan and submit and periodically update adaptation reporting around priorities, needs, plans and actions.

The recently released National Adaptation Plan (NAP) outlines the Federal Government's intention to address priority climate risks that emerged from the National Climate Risk Assessment (NCRA - Australian Climate Service 2025). It contains '*a framework for adapting to the physical climate risks that are nationally significant within Australia's Exclusive Economic Zone and external territories*' and focuses on summarising the Federal

Government's roles and responsibilities for adaptation, prioritising action areas, and outlining work already underway. It places emphasis on the '*risk to adaptation from maladaptation and inaction from governance structures not fit to address changing climate risks*' (DCCEEW, 2025).

This is the first National Adaptation Plan for Australia, and therefore a significant step forward in adaptation policy. It reveals helpful insights into current adaptation progress in Australia but also highlights gaps in knowledge and action that can inform research priorities. It acknowledges the need for additional research and development and the role of the Australian Government in providing information to help others adapt.

Determining research priorities and needs

To develop an adaptation research plan, it is necessary to understand the landscape of existing research and the gaps in knowledge. We can look at NCCARF, who was tasked with funding a large program of substantial, useful and usable adaptation research, as an example of how this identification and prioritisation process was approached. NCCARF was the first effort to build a national research program for Australia. It began by seeking to understand the landscape of research on the one hand, and the gaps in knowledge on the other. The research program was constructed around groups of sectors, and a National Adaptation Research Plan (NARP) developed for each sector. The plans were developed by a panel of 5-6 experts with input from researchers and end users. Each research plan went through an intensive period of consultation and review to ensure it properly reflected the views of the adaptation research and research and practice community. Each NARP identified knowledge gaps and ranked priorities for research based on common criteria of severity, immediacy and practicality (Figure 4). Each NARP was accompanied by an implementation plan. The NCCARF program also invested in a cross-discipline synthesising and integrative research program, often short projects responding to real-world events.

Sub-theme/ Research activity	Severity/ Benefit	Immediacy	Need to change intervention/ Practicality	Potential co-benefits	Distributional justice/ Equity issues	Conclusions
Heat Understanding heat risks, based on location, health status, age and other factors	Impact: High and well understood Potential for thousands of additional deaths	High Expected impacts now and in future	Good reasons to believe interventions will be practicable	Beneficial for addressing existing problems with heat stress	Some groups more vulnerable, e.g., the elderly, sufferers from other health conditions	**Medium–high priority** Well understood but further information required in critical areas
Early warning systems, including applicability or adaptability of	Benefit: Medium-high Correlation between	Medium-high Heat waves already	Intervention practical — evidence that EWS can trigger	Benefits in other areas as well (e.g., early	Some groups more vulnerable, e.g., the elderly,	**High priority** Research needed on details

other forms of community surveillance of vulnerable individuals	heat and increased morbidity/ mortality — capable of being addressed through effective strategies	occur, so benefit could be immediate	effective public health strategies	warning for potential impacts on food/ water quality)	sufferers from other health conditions Relevant to design of effective system	of effectiveness and design of the EWS
OH&S standards	Benefit: Medium-high	Medium-high	Changes may be required to some interventions; interventions will be practicable	Benefits in OH&S domains	Outdoor workers and workers in poorly ventilated/ cooled environments likely to be more seriously affected	**Medium priority** Some research needed on adequacy of existing OH&S standards

Figure 4: An example of the priority criteria in ranking research need for the Human Health NARP.

The nine NARPS were:

- Freshwater biodiversity
- Terrestrial biodiversity
- Marine biodiversity and resources
- Primary industries
- Human health
- Settlements and infrastructure
- Emergency management
- Indigenous communities
- Social, economic and institutional dimensions

The NARPs were all updated at least once, except the one for Indigenous Communities that was developed last and was a more involved process to develop.

There has been no other national research planning for adaptation exercise since the final update of some of the NARPs in 2017. The recently released National Adaptation Plan

(Commonwealth of Australia 2025) acknowledges the need for additional research and development and the role of the Australian Government in providing information to help others adapt.

Developing a climate change adaptation research priorities snapshot

Since the NARPs were published, there has continued to be progress in adaptation thinking and uptake by a diversity of organisations (many examples can be found in the Australian Adaptation Database https://australianadaptationdatabase.unimelb.edu.au/).

The NESP Climate Adaptation Initiative is developing an update of adaptation research needs and priorities for Australia. While we do not have the resources or time to update the 9 NARPs, the intention is to provide a snapshot of what has changed since the NARPs, how investment and progress have changed the research landscape, and to identify new or persisting research gaps and user needs.

An initial workshop was held at the national Climate Adaptation conference in Perth in July 2025. This was a unique opportunity to bring together a diverse, but self-selected group of researchers and practitioners from a range of sectors, organisations and locations across Australia.

The rest of this paper reports on the outcomes of those discussions.

Workshop design overview

Guided by input from key adaptation policymakers, practitioners and researchers, the workshop discussion focused on three discussion topics. The session deliberately did not ask what research was needed, knowing this can be very difficult for users to identify. We worked through 3 interactive sessions:

- First, we asked who might benefit from the outcomes of adaptation research, what their values and objectives are and to consider if research might help identified actors meet those values and objectives.
- Second, the workshop explored the current state of evidence and knowledge for adaptation. This was tackled by identifying where actors were comfortable with knowledge, the limits of knowledge and the 'uncomfortable' zone.
- Third, as the audience was a mix of policy and practice, we also explored the opportunities and challenges of existing funding models.

The session ran for 90 minutes and was attended by approximately 40 people with representation from federal government policymakers, state government, adaptation practitioners or policymakers, and researchers (in the field of climate science, environmental science or climate change adaptation). Few local government, regional government or private industry attendees were present.

Participants were invited to join one of four groups, based on their identification with pre-defined stakeholder groups:

1. research and academic inquiry
2. policy and governance to enable adaptation
3. on-ground action and practice
4. a mixed group from above (Figure 5).

We set-up these targeted discussion groups recognising that views on adaptation research needs were likely to differ across the groups, and to ensure each had an equal voice.

Following the workshop, participants were invited to contribute further through feedback to this discussion paper.

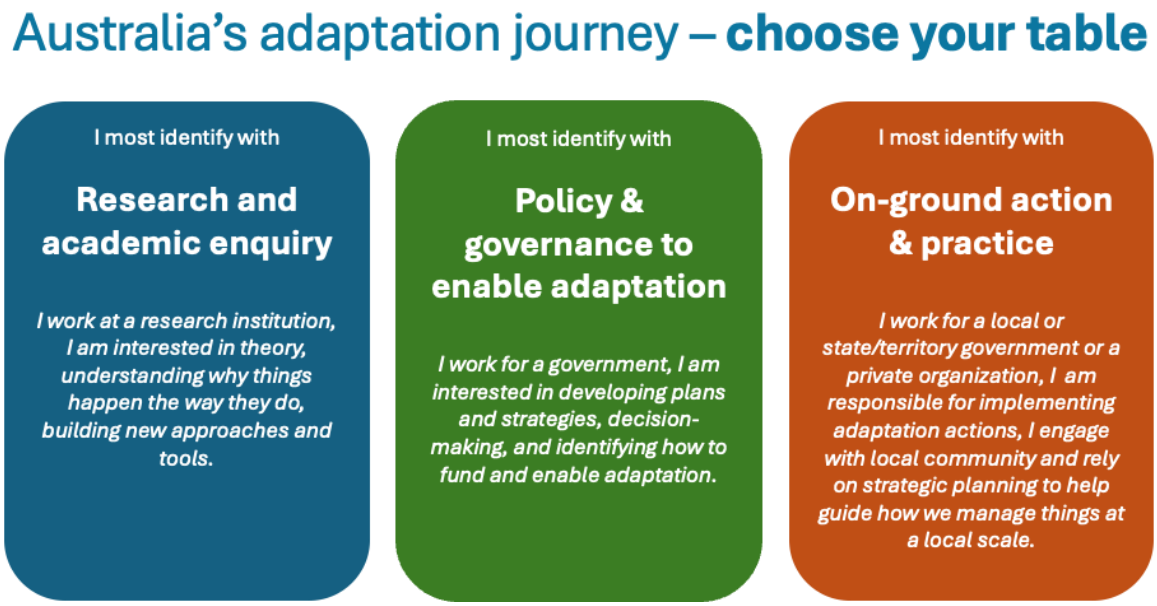


Figure 5: Workshop participants were invited to self-identify as one of three groups.

Workshop outcomes

Discussion 1: Mapping those who need adaptation research

The workshop began by consider the ‘who' of adaptation research outcomes.

Each break-out group was asked to consider:

1. Who needs the outcomes of adaptation research?
2. What are their values and objectives?
3. Can research help them meet those values and objectives?

The intention was to review each group’s (i.e. research, policy, practice, Figure 5) observation of who needs adaptation research.

Who needs the outcomes of adaptation research?

To help the groups tackle such a broad question we suggested groups categorise users into three categories termed: ‘doers’, ‘enablers’ and ‘influencers’.

- The **doers** are the frontline actors, noting that in Australia implementation of adaptation most often falls to local actors. This includes landholders, local government, community organisations, the Natural Resource Management (NRM) sector, First Nations people and community leaders. They are responsible for implementing adaptation strategies and live with their outcomes. Their work is grounded in place, culture, and lived experience.
- The **enablers** provide the scaffolding. This includes those engaged in facilitation, funding, policy, research and training. Their support for doers is most effective when built on trust, mutual respect and two-way knowledge exchange. Although barriers exist, successful outcomes can be achieved through genuine co-design between enablers and doers.
- The **influencers** shape the context in which adaptation takes place. They set the research agendas, funding priorities, and public narratives. They play a critical role in framing adaptation as a cultural, social, and economic imperative, not just a scientific or technical one.

This also allowed groups to discuss links between actors and to consider individual actors playing more than one role. Key actors identified by the four groups are summarised in Table 1.

While some actors play one role (e.g. research bodies were important enablers), some actors, particularly government, play all roles. For example, local, state and federal governments all play roles as the doers, enablers and influencers. We would expect these actors to have a diversity of knowledge needs.

Table 1: A summary of the key adaptation actors identified, categorised into doers, enablers and influencers.

"Doers"	"Enablers"	"Influencers"
• Community groups • Federal government departments • First Nations Peoples • Industry, industry bodies and associations • Landholders • Local Governments • Natural Resource Management organisations • Peak bodies • Private enterprises • State governments • Funding bodies	• Adaptation focused research bodies (e.g. NCCARF, NESP) • Consultants • Educators • Federal government departments (e.g. the Department of Climate Change, Energy, the Environment and Water (DCCEEW)) • Financers • Knowledge Brokers • Local governments • Markets • Philanthropists • Private enterprises (through funding, support, or insurance levers) • Regulators • State governments	• Advocacy groups • Australian Climate Services • Intergovernmental Panel on Climate Change (IPCC) • Federal government departments (e.g. the Department of Climate Change, Energy, the Environment and Water (DCCEEW)) • First Nations Peoples (ideally, but not always given voice) • Funding bodies • Industry and industry bodies • Local communities • Local governments • Media • Politicians • State governments • Researchers

What are the values and objectives of users?

Groups talked through the values and objectives of different actors, and some groups expressed qualities they looked for in research.

Identified values/objectives of those undertaking adaptation were:

- **Stability and progress opportunities**. This was expressed by on-ground practitioners as a value for 'doers'. It reflects the long-term investment and planning associated with adaptation and the need for a stable pathway to an agreed future ambition.
- **Wellbeing and health**. This was acknowledged as a social and environmental objective of adaptation planning and action.
- **Stay in place, maintain culture and cultural autonomy**. First Nations participants were clear that this was a value at the heart of their culture and advocacy.
- **Evidence informed progress**. There was a clear desire to ensure adaptation was evidence informed and represented best practice.

The discussions also touched on important research qualities that users were looking for:

- **Actionable knowledge**. Translating adaptation research into practical guidance.
- **Best practice.** Guidance on robust, well-tested approaches to undertaking adaptation.
- **Real world evidence.** Practical case studies and examples to demonstrate approaches and progress that work.
- **Translated information.** Co-designed, place-based interpretation of data and information. Addressing 'what does this mean here' or 'for us'.
- **Risk thresholds**. Interpreted information to understand when thresholds might be reached, rather than simple projections of change. Again, advocating and translating information for users.
- **Searchable access to information**. An appetite for research and risk information to be searchable and accessible.

Can research help users meet their values and objectives?

The workshop highlighted that many adaptation needs can be addressed by research *if* that research is co-designed and conducted with practitioners and delivers 'actionable research'. Participants discussed identified important attributes of actionable research as follows:

- **Practitioner-first approaches** where research projects are built around the needs of practitioners and draw on disciplines and methods necessary to achieving specific and identified outcomes (i.e. transdisciplinary approaches). This contrasts with a common user experience: researchers look for practitioners who are interested in their pre-planned research, often toward the end of a project.

- **Indigenous-led approaches** which integrate Traditional Knowledge of adaptation and cultural understanding of Country in compliment to scientific approaches.

- **Bespoke and place-based research** building experience of and learning from real world examples. This is alongside the need for national and international research rather than replacing it.

- **Funding models that support and reward practitioner-first and co-designed research** which entails long-term commitments, relationship building, and investments in both practitioner and research organisations.

- **Enhancing and scaling the role of knowledge brokers** who can transcend research and practice barriers and boundaries.

The discussions also discussed barriers that persist and make adaptation implementation challenging (Productivity Commission 2012, Waters et al., 2014). Barriers and enablers of adaptation are important to consider when thinking about whether research can help meet values and objectives. Finding ways to ensure actionable research is cognisant of, and actively addressing barriers, is critical in defining whether research is 'helpful'. The workshop discussions identified the following implementation barriers:

- A lack of long-term policy and investment pathways that are fit for the slow, iterative, and place-based nature of adaptation.
- Push back from stakeholders such as community groups, on policy and adaptation planning measures.
- Limited guidance for practitioners on understanding and working with climate science and projections. Concepts of uncertainty, tipping points and thresholds, for example, challenge decision makers.
- Uncertainties around roles and responsibilities within and between governments, and between public and private actors for some adaptation tasks.
- Risks to decision makers arising from maladaptation (including fiscal, legal, and political risks).
- A lack of staffing, skills and expertise - particularly in local government.
- Difficulties in evaluating adaptation success, which create challenges in communicating and upscaling adaptation projects.
- Investments in research that does not prioritise actionable knowledge and pathways from research to impact.

Discussion 2: What is the current state of evidence and knowledge for adaptation?

In this second workshop activity, groups were asked to think about our existing adaptation knowledge and action. Rather than asking for research needs, we wanted to look to flush these out by asking participants to consider where they are 'comfortable' versus 'uncomfortable' (Figure 6). For ease of providing a summary, we consider these under three groups: comfortable, edge, uncomfortable, but the workshop discussion reflected the continuum and blurring among these groupings. We also found nuance between groups, for example practitioners expressed comfort with a sufficiency of physical climate change knowledge, while researchers considered that knowledge was good for heat extremes, while we are at the edge of our knowledge on water availability extremes.

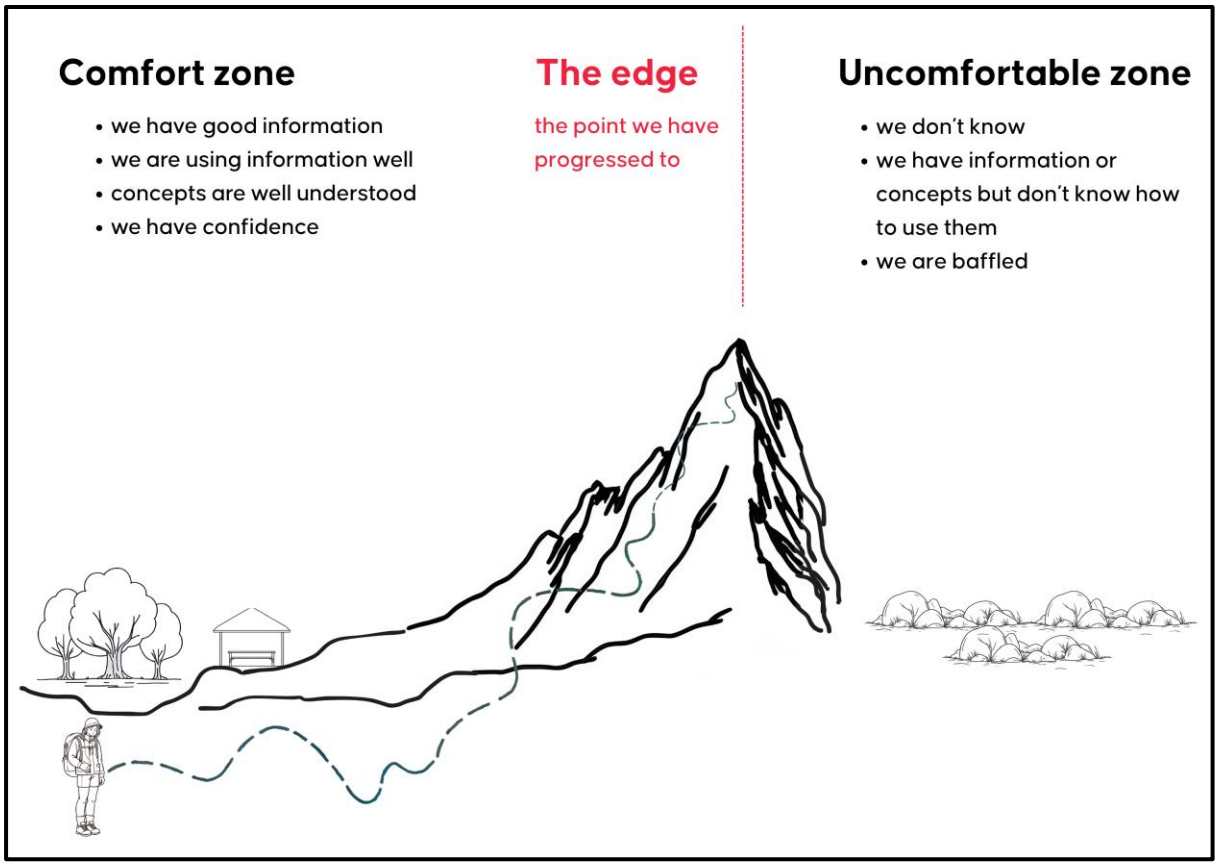


Figure 6: Workshop participants were asked to reflect on where the felt they were 'comfortable' and 'uncomfortable' in the adaptation knowledge they have and action they are taking.

Where participants felt comfortable in knowledge and action

Participants identified several areas of knowledge and practice where they felt in their 'comfort zone' (Table 2). We described the comfort zone as being where they felt they had good information, were using that information well, concepts were well understood, and they were feeling confident in knowledge or action.

Participants felt technical knowledge of physical climate changes was reasonably sufficient for the purposes of undertaking adaptation and there was adequate knowledge of climate risks for the purposes of making adaptation decisions. There was reasonable confidence in the likely impacts, and who or what might be impacted. There was confidence in who needed adaptation knowledge and how to engage them. The process of risk assessment was well understood and competently applied.

There was differing levels of confidence within-sector responses, showing that experience within sectors was important knowledge. Some sectors were noted as possibly being further ahead. This included the insurance and finance sectors who are risk experts and have been investing in research and knowledge development as core business. One participant noted 'we are good at building things', indicating that engineering solutions are well understood and can be a default response.

Table 2: Summary of the knowledge and action 'comfort zone' identified by workshop participants

Comfortable	Rationale or context
The need for adaptation	There is no doubt that we need to work to adapt to the changing climate
Know who the end users are	Who needs information and action
What values are at risk	We have a good understanding of what might change or be lost through the changing climate
Undertaking risk assessments	The process is well established across most actors
Climate risks	Adequate knowledge of climate risks for the purposes of making adaptation decisions
Technical knowledge of physical changes in climate	Reasonably sufficient for the purposes of undertaking adaptation
Heat extremes	Researchers constrained their comfort with physical changes to heat extremes
Sectoral responses	Practitioners know what they can do in their own sectors
Effective adaptation actions at a local level	Local actors have good ideas of what is needed to respond
How to grow resilience in landscapes, cities and country	Past understanding of response to disasters and disturbance have given a good understanding of how to grow resilience
How to engage the community on discrete risks	Methods of engagement and co-design well understood
How to build things	Good engineering and building knowledge – although this may not be what is needed all the time
Finance and insurance sector know what to do	They have resources, access to data and know what levers to pull

Where participants felt we are at the 'edge' of our knowledge and action

Participants identified many more areas of knowledge and practice where they felt at the 'edge' of their knowledge and action (Table 2). These often reflect our current progress and may indicate priorities for immediate research or better guidance.

We identified several common themes across the discussion as follows:

- Managing and overcoming uncertainty
- Maladaptive responses or potential for maladaptation
- Communication, knowledge brokering and capacity building
- Measuring impact and uptake
- Innovation
- Decision support tools and information.

Managing and overcoming uncertainty was discussed in several different contexts. First, high uncertainty still exists in many climate models, for some climate variables, and for many locations. Much of this can be accommodated in the adaptation decision making process, but the expression of climate model uncertainty could be better communicated, for example participants discussed the potential value of confidence and likelihood approaches like those adopted in IPCC reports and the NCRA, to improve clarity.

There is also the challenge of forecasting big social transitions. These social shifts can be enabling by removing barriers or providing new opportunities. Anticipating and planning for them can create its own uncertainty around when and how to act.

Finally, participants highlighted the uncertainty around when to act and the costs of not acting.

Maladaptive responses or potential for maladaptation were seen at the edge of knowledge and action. Participants considered how maladaptation fits within the decision framework. This also linked to uncertainty – particularly around when to act. Decision makers need to consider the risks arising from maladaptation including fiscal, legal and political risks. The recently released National Adaptation Plan (NAP) emphasised the '*risk to adaptation from maladaptation and inaction from governance structures not fit to address changing climate risks*' (DCCEEW, 2025).

Communication, knowledge brokering and capacity building was a common theme in several different contexts. First, as one participant expressed it, was 'how to use the pile of knowledge we have?'. A clear message was that much valuable knowledge, and data is underutilised and difficult to access. Climate science was notable for this challenge and leads to the common frustrated comments of 'we have enough climate science'. Much of the emphasis in the workshop was on making this information useful and useable rather than generating new information.

Practitioners expressed the importance of having climate impacts information[1] that is locally or regionally relevant. Many shared first-hand experiences of using generic products that, while well-intentioned, ultimately proved to be of limited value because they attempted to be all things for all users. These 'one-size-fits-all' approaches often fail to account for changes in local environmental conditions, context, priorities, and decision-making needs. Participants placed emphasis on the critical importance of co-design and using a range of environmental and social science approaches to ensure knowledge is context-specific and genuinely useful in practice.

Discussion of the importance of traditional knowledge and Indigenous-led climate change adaptation research, planning and action highlighted the need to better support and integrate these approaches. Australian Aboriginal and Torres Strait Islander peoples are climate adaptation knowledge holders and scientists – they have been adapting to changes in climate for tens of thousands of years and continue to adapt to the impacts of colonization. Indigenous leadership of climate adaptation research and planning enhances opportunities for equitable and culturally appropriate knowledge sharing about climate change and adaptation across knowledge systems, as well as enabling Indigenous knowledge of caring for Country to be embedded in climate change adaptation. Yet participants provided the example of cultural burning as being restricted by insurance, time, season, whose Country, resources and so on.

Measuring impact and uptake came up in several contexts. Participants expressed the challenges of articulating what a 'well adapted society' means, and how we can measure how well adapted we are. This is an important step in deciding where further effort and investment is needed and for directing adaptation action from local to national scales. Discussions focused on policy relevant metrics – necessary for example in implementing the National Adaptation Plan (DCCEEW 2025). Attached to this was the more complex underlying theme of a lack of clarity on the purpose of adaptation. Clear identification of intended outcomes is a difficult but necessary precursor to measuring success.

Participants also noted the need to learn from poor outcomes, reflecting on the need for opportunity to trial and experiment as well as the need for tools to measure outcomes.

Mainstreaming of adaptation into policy and practice was also raised as desirable for progress but often difficult to successfully achieve.

Finally, our ability to measure the impact of research itself is underdeveloped.

Innovation was identified as important for adaptation. The scope and scale of climate change demand innovative, novel, and broad scale approaches – without them the options we will have for adapting to climate change impacts may be limited. Participants reflected that when it comes to adaptation practice there is often a bias towards familiar tangible interventions that are readily understood and so more easily implemented. For example, building projects or engineering solutions might be easier to imagine while more innovative, behavioural, and social interventions may be more difficult to justify and hence implement.

[1] In talking about 'climate impacts information', participants were thinking about the broader context and impacts information beyond simply climate information. Information included social, psychological as well as broad physical dimensions.

Participants discussed the likely limit to imagined adaptation options. Certainly, new approaches or large changes can be met with scepticism or back-lash.

Innovative or new approaches often require testing, refining, and learning from experimental approaches.

Decision support tools and information are a persistent and underpinning need. Participants discussed the need for tools to better estimate or express return on investment. Others spoke of the need to quantify the relative importance of adaptation versus other policies. In a constrained resource environment, a business case must be made for investment of time and money. Better tools or guidance can support that. Again, the importance of regionally relevant information was raised. This ranges from physical data such as geomorphology, climate, asset assessment, through to social information including demographic, identifying needs of vulnerable community members and desired future outcomes.

Where participants felt 'uncomfortable' in our knowledge and action

Participants identified many areas where they felt uncomfortable in their knowledge and practice. We described the 'uncomfortable zone' as being where they felt they did not know something or had the information and concepts but did not know how to use them, or were simply put - 'baffled'.

Many of the discussion points were similar to those seen as at the limit of information and action but pushed further into gaps and challenges. Again, we have identified themes to the discussion as follows:

- Governance and institutions
- Decision support
- Responding to complex impacts
- Anticipating the future
- Funding

Governance and institutions were discussed as needing to better accommodate adaptation. Challenges identified included:

- How do we build adaptive governance?
- How can institutional arrangements accommodate fairness?
- How do we create institutions for innovation?
- How do we build systems that can operationalise change?
- How can we create a co-ordinating body with consistent funding?
- How do we create government systems that can adapt to cultural knowledge?

Decision support was again discussed. Participants discussed how to understand and overcome 'decision paralysis'. Participants spoke of how to identify 'best' options, how to balance short-term vs long-term options and the role of cost-benefit analysis in this. Other discussions focused on how quantifying loss and determining trade-offs might be incorporated into decision making.

Anticipating the future was a common thread across several discussions. It built on the discussion of uncertainty, bringing in questions around 'what are we adapting to', and 'what can adaptation achieve'. Participants asked, 'what will the new normal look like?' and 'where will we land?'. There was an awareness of known unknowns that impact the need to adapt and the potential success of any implemented actions, with participants highlighting physical and social tipping points as possible known unknowns. Additionally, the question of how to respond to the risk of compounding and cascading events was highlighted in this context.

Funding cut across the 'uncomfortable' zone, with acknowledgement that funding adaptation was currently very difficult and that new models of funding are needed. Attention turned to the role of the private sector and how to develop private investment models.

Responding to complex impacts was discussed, particularly in the context of ecological systems. Estuaries were highlighted for their complex ecosystem role, and the poor understanding of possible climate change impacts on them. The levels of complexity in these systems make it very difficult to, first, understand the full extent of climate impacts and, second to develop adaptation options in response. Complexity also ties into the social context of decisions, with emotional ties or long-standing conservation beliefs difficult to abandon if required.

Discussion 3: Where are the opportunities and challenges of existing funding pathways?

Workshop participants were asked to reflect on the fitness of existing funding models for investing in adaptation research. Individual experiences of funding models were explored. Participants were prompted to consider the opportunities and challenges that arose in existing and past programs: ARC Centre of Excellence, the NESP Program, Government ad hoc grants and private partnerships etc. (Table 3).

Strengths of the ARC Centre of Excellence model were political independence, its long project timeframe (seven-years), and potential to leverage funding from multiple sources. Identified weaknesses for adaptation research included strong focus on academic rather than applied and co-produced research, limited flexibility, and minimal evaluation of impact.

The NESP model shows promise in that it operates at a national scale, is cross-sectoral, is focused on the public good, has some focus on end users, and has integrated knowledge brokers. However, it was felt that embedding adaptation as a small subcomponent within a larger climate science program places adaptation research in direct competition for funding with climate science, despite their vastly different approaches, methods and cost structures. It risks implicitly prioritising climate science over adaptation research, when there is an explicit need for both areas of research to be adequately funded. Program investment priorities of the NESP program are always uncertain and contingent on the government of the day when grant guidelines are established. This can be an impediment to the kind of sustained investment required for effective adaptation research and creates the risk of political influence. NESP emphasises co-produced research with end users, but implementing this approach could be improved.

Governments at both the state and federal levels have invested in one-off research grants or programs (e.g. NCCARF). These grants can allow for greater flexibility, end-user led activities and strong community connection. They are, however, often short-term, reactive and subject to changes in governments and their priorities.

Table 3: Workshop participants response to the opportunities and challenges of several existing funding channels for climate change adaptation research.

Existing funding pathways	Opportunities	Challenges
ARC Centre of Excellence	• Enables significant scale of interdisciplinary and partner collaboration • Seven years of stable funding • Politically independent • Emphasis on training the next generation	• Initiated by small number of universities, can be highly academic • CSIRO and BoM can't be funded for their contributions • Limited flexibility • Not designed for co-produced researcher • No end-user buy-in • Response-time and lead-time • Lack local/industry involvement • No monitoring and evaluation • Uncertain longevity
NESP Program	• Strong relationship between researchers and Australian Government • Multi-agency across CSIRO, BoM, Universities. • Works across both Federal and State needs • Investment in capability • Public good research • Support of end-users • Closer connection to grant • Tackle a range of adaptation issues • Local level engagement • National focus	• Lack ability to invest beyond government and partners • Co-contributions • Not always balance of engagement between local and national • Primarily research driven • Uncertain longevity • Administrative burden
State/Territory/Federal *ad hoc* grants	• Flexible, targeted, can meet immediate need • End-user led • Grants for communities for ongoing work • On-going role even if strategies/plans are short-term funded	• Short-term • Reactive • Not well disposed to systems or deeper thinking • Change in government
Private partnerships	• Direct uptake • Scaling potential • Need consortium of researchers	• Focused on specific needs and values, not comprehensive • Can be unbalanced

	• Government-private partnership • More flexibility in funding	• Can reflect where money sits, not where the need is • Uncertain strategic value • Short-term
Philanthropy	• Flexible • Hands-off	• Can be mis-directed, counter productive
Australian Climate Service	• Stable investment in providing a service	• Lack of co-design • Changes in funding priorities • Not necessarily a research body

Private partnerships were seen as having similar opportunities and challenges to *ad hoc* government grants. They are often local, have greater flexibility, offer direct uptake and demand consortiums of researchers, but they can be short-term and focused on specific needs and where money is rather than where the greatest need lies.

Participants added several other funding sources. Philanthropy was seen as a flexible, hands-off funding source, but one that can be mis-directed and counter-productive.

More recently, the Australian Climate Service has taken up research in this space. However, criticisms highlight a failure to effectively implement the fundamental principles of co-design processes, knowledge brokering or sustained funding, among other challenges (O'kane et al, 2024).

The ideal model (and what to avoid)

Workshop participants touched on what the ideal model for research funding might include. The following was captured from those discussions.

- **Funding organised in a way that supports co-produced research** that meets the knowledge and capacity needs of practitioners. In the case of First Nations Peoples, this includes their leadership of research.
- **Funding that supports genuine disciplinary diversity and non-research-based expertise.** Research of this kind requires the participation and time of diverse knowledge-holders - not only specialised researchers. Funding should support ***all*** contributors.
- **Sustained investment.** This research takes many years and enduring partnerships and so requires sustained investment.
- **Prioritised investment support for practitioners who have responsibility for those who are most vulnerable** to enable and promote equitable adaptation.
- **Funding without strings: independence is desirable if adaptation is to be innovative**, and for Australia to learn from and improve upon success and failures.
- **Funding support for the enablers and influencers of adaptation**. This requires active contributions to its governance and conduct from all three levels of government, and where necessary the private sector and civil society.
- **Funding actionable research** to empower doers and accelerate adaptation

- **Investment in research that tackles clear problems and demonstrated need.** delivering on a clear pathway to impact**.**
- **Funding for evaluation of research impact** to demonstrate value proposition of investment.

To this end, participants expressed a desire for a national climate change adaptation authority of some kind, similar to that of the Climate Change Authority, which would have responsibility for guiding and funding research, and which might be well suited to supporting the monitoring, evaluation, learning and reporting necessary for implementing the National Adaptation Plan. Natural Hazards Research Australia was identified by some participants as an example of a good funding model.

Figure 7: A summary of the key elements for a future adaptation research program in Australia, as identified during the workshop.

Workshop reflections

Initial research directions

The workshop was a first opportunity for a small, self-selected group of adaptation researchers, policy makers and practitioners to reflect on progress and needs of adaptation research in Australia. Given the short time frame and the self-selection of participants we looked at underpinning drivers and knowledge gaps of potential research priorities. The workshop gave an initial sense-check of who we might engage with further to understand research needs and the limits and challenges of current knowledge to inform policy and practice.

From the discussion we identified some areas where adaptation research might usefully enhance knowledge. This list included:

- methods for quantifying return on investments in adaptation action (and the cost of inaction), including ways to capture non-financial values and benefits, for example, incorporating alternate knowledges such as First Nations values in valuing adaptation
- effective incorporation of traditional adaptation practices and knowledge systems and research and enquiry led by First Nations communities
- how Monitoring, Evaluation, Learning and Reporting (MERL) practices could be used to advance understanding and tracking of success, effectiveness, maladaptation and fair adaptation
- lessons from failed adaptations or maladaptive strategies
- Research to foster effective take-up and sustained application of adaptation approaches and interventions. The potential role of existing platforms like the Australian Adaptation Database, Adapt Land & Sea, CoastAdapt and AdaptLog could be investigated, for example.
- the effects of complex, overlapping vulnerabilities on communities including ways to adapt to concurrent, compounding and cascading risks.
- developing and testing best practice approaches to support implementation of adaptation planning and action
- exploring socioeconomic and biophysical climate impact tipping points and thresholds where adaptation actions will not work or will need to be reconsidered - including understanding what these might be and when they might be triggered
- testing ways to be more agile to respond to rapid changes in climate or relevant social drivers
- exploring and testing ambitious and untested or innovative adaptation actions and ways to minimise unintended consequences.

Throughout the discussions we heard an overriding need for adaptation capacity building and decision support. There is a persistent need to support training, resource development, dissemination of research, peer learning networks, resource directories and other capacity development activities for climate change adaptation. Much of this capacity building needs to be focused on adaptation decision support, helping practitioners to overcome decision paralysis and undertake informed adaptation actions.

Participants identified the poor fit of existing funding models and identified key attributes of more fit-for-purpose models.

Next steps

The workshop provided an initial rapid consideration and starting point for understanding research progress and future research opportunities for adaptation. To build a better understanding of the research landscape and the gaps in knowledge, and to formulate research priorities, the NESP Climate Adaptation Initiative is proposing undertaking a rapid assessment process to identify research priorities.

This will involve 3 broad steps:

Desktop review. A review of literature evidencing adaptation research progress in Australia using the NARPs as a reference point. Analysis of investment in adaptation research including *ad hoc* projects beyond large programs investments. This will expand our understanding of research progress against previous priorities and the quantum of current investment. Given limited resources, it cannot be a sector-by-sector review, so we'll look at the 'edge' and 'uncomfortable zones' identified in the workshop to help prioritise topics for expansion.

Focused engagement. Following the desktop study, we will look to hold a small number of meetings with key informants to help build on the desktop review and build criteria for ranking research priorities.

Prioritisation. Using pre-defined criteria, we will look to articulate and rank priority research questions.

The outcome of this investigation is expected to deliver a short report and journal paper to support future research planning and investment.

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Appendix: Workshop agenda

Time	Activity	Who	How
3.30pm	Introductions	Aillie/Sarah	Describe purpose and outcome of workshop Introduction activity at tables
3.40pm	Developing research priorities	Jean Palutikof	Short presentation (10mins): • How NCCARF created NARPS • Key messages at that time
3.55pm	Break-out 1: (10 mins) **Who** needs the outcomes of adaptation research? What are their values and objectives? Can research help them meet those values and objectives?	Aillie to introduce activity	Poster size Template #1(one per table) Looking at the 3 questions: 1. Who needs the outcomes of adaptation research? 2. What are their values and objectives? 3. Can research help them meet those values and objectives? Use the template poster and start responding to the 3 questions for individual or categories of actors If the circles aren't helpful, use blank side!
4.10pm	Break-out 2: Australia's adaptation journey (so far)	Sarah to introduce activity	Poster size Template #2 on each table At your table brainstorm where our knowledge and action on adaptation sits from the comfort zone to uncomfortable zone For researchers it might be that we have good theories of 'values' but we are not good at implementing We talked a lot about barriers and are starting to develop our understanding of enablers Practitioners might feel we have good tools for developing adaptation plans, but we struggle to translate into

			action or build a good business case for action Etc Work in your group to identify progress, where you think the 'edge' of that is and where we don't know
4.35	What research says about research needs	Elissa Waters	Short presentation (5 mins)
4.40	What are the policy needs & goals at a national level?	Jason Mundy	Short presentation (5 mins)
4.45	Break-out 3: How might adaptation research in Australia be best administered?		Where are the opportunities and challenges of existing funding pathways? Template #3
4.55	Final words	Sarah & Aillie	We will take these ideas and turn them into a NESP discussion paper Add you name to our list to stay in contact
5.00	Session closes		

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