National Environmental Science Program

Climate Systems Hub research plan 2025 – Attachment B project plan

Contents

Project CS5.1 – ACCESS development and delivery to CMIP7

Project type: • Hub research project	
Project status: • New project submitted for approval	
Cross-cutting initiative:	No
Project start date: 01/01/2025	**Project end date**: 31/12/2026
Total project budget: $4,165,168 (GST exclusive)	**NESP funding:** (GST exclusive) 2025 $1,068,075 2026 $1,067,211 **Co-contributions (cash and in-kind):** (GST exclusive) 2025 $1,011,697 2026 $1,018,185
Project leader details:	Name: Tilo Ziehn Organisation: CSIRO Phone: 03 9239 4560 Email: tilo.ziehn@csiro.au

Project summary

Australia's Climate and Earth System Model (ACCESS) is one of the few models actively developed in the Southern Hemisphere. ACCESS is a research tool tailored to Australian conditions and needs, supporting policy and decision making.
This project will contribute to finalising the configuration design of the next generation ACCESS Earth System Model (ACCESS-ESM3) in preparation for the Coupled Model Intercomparison Project 7 (CMIP7).

The project will also deliver selected simulations to the CMIP7 Fast Track with a new ACCESS-ESM1.6 configuration, underpinning the next Intergovernmental Panel on Climate Change (IPCC) 7th Assessment Report (AR7). The project is part of a larger community effort coordinated by a consortium which is led by CSIRO and includes the ACCESS-NRI, Universities and the Bureau of Meteorology.

Pathway to impact

Outcomes
Having a climate model running in Australia is critical for the ability to do extra analysis beyond what is available from other institutes contributing to CMIP. Further, having a model that is owned and developed by Australia (rather than running another institutes climate model) takes us to a new level by allowing us to refine the model for local Australian attributes and features critical to our region of the world. These local attributes (such as elements of Southern Ocean dynamics, and Australian land features) may not be priorities in other modelling communities around the world. Details of the benefits and outcomes of further developing ACCESS include: • The ability to focus and further improve the performance of ACCESS over regions of interest. For example, ACCESS-ESM1.5 is already one of the best performing models over the Southern Ocean and we need to maintain and expand on this capability given the crucial role the Southern Ocean plays in absorbing CO2 and heat and in impacting the global and our regional climate. • The ability to integrate components or processes important for Australia. For example, ACCESS-ESM1.5 is one of the very few ESMs that includes a phosphorus cycle on the land. This might be a critical limiting factor on plant growth and carbon uptake by plants given Australia's old soil, which is generally low in nutrients. Other components important for Australia (and therefore to be considered in future ACCESS versions) include tree demography, fire and dynamic ice sheets. These components are critical to assess the adequacy of Australia's mitigation approaches as we transition to net zero. • The ability to perform tailored simulations and to provide the required output. For example, ACCESS-ESM1.5 has performed large ensembles of simulations and provided additional output for specific ensemble members at the temporal resolution required for downscaling. Novel climate stabilisation simulations have been designed with ACCESS-ESM1.5 providing unique insights into the impacts of net-zero CO2 emissions on the future regional climate and the role of the Southern Ocean. To be relevant at International negotiations on climate and emissions reductions, we must have internationally credible tools at our disposal. ACCESS and previous versions of the model have provided this confidence throughout COP negotiations and for other international decisions and local policy. Updating ACCESS to this new configuration, will maintain its credibility as a world standard model which will continue to let our Government have these discussions, and to make policy decisions knowing they have the best information available, that is tailored for Australian conditions (which other international models do not allow for). Without the ACCESS model, the Australian Government would be negotiating and deciding on climate and net zero pathways advised by tools that do not account for our unique landscape or location on the globe. This project will make the new ACCESS model configurations available to the Australian research community (in collaboration with the ACCESS-NRI), which will underpin research within the hub, across other NESP hubs and in other projects now and in the future. ACCESS simulation results performed for CMIP7 will underpin the next IPCC assessment report AR7. Simulation results will also be used by researchers in the hub and by other research users, including Australian universities and the Australian Climate Service, for example, for

regional downscaling (projections); for the analysis of extreme events such as heatwaves, droughts and floods; for carbon management and for assessing CO2 removal strategies; for improving our understanding on how Australian climate will respond to future changes in greenhouse gas and aerosol emissions, and how these changes impact modes of variability and their teleconnections to Australia.

Continued co-design and engagement with research users will ensure that future ACCESS developments will benefit next users and end users, and it will also ensure that performed experiments including analysis are tailored to research needs within the hub and the Australian research community.

Note that the ACCESS-NRI has a comprehensive process of user engagement for the design and support of the ACCESS model. They communicate regularly to users, including State and Territory groups. Our intent is to work closely with them, rather than duplicate.

Research-user	Engagement and communication	Impact on management action	Outputs
ACCESS-NRI	Strong engagement and communication around general ACCESS development (including in-kind contribution from project members), collaboration on model evaluation and forcing data generation, participation of project members in ACCESS-NRI working group meetings and workshop	Provides user access to ACCESS model configurations including documentation and facilitate uptake of ACCESS model by research community	Final configurations of ACCESS for CMIP7 and community release
Australian Climate Services (ACS)	Engage in decisions around requirements for specific ACCESS experiments or priorities around data needs Communicate release and publication of ACCESS simulation results through meetings and emails	ACCESS simulation results to support better information of climate impacts on regional Australia	ACCESS simulation results published for CMIP7

CS5.2 - Global carbon budgets and the role of terrestrial carbon sinks

Research-user	Engagement and communication	Impact on management action	Outputs
University of Melbourne	Engage in decisions around requirements for specific ACCESS experiments or priorities around data needs Communicate release and publication of ACCESS simulation results through meetings and emails	ACCESS simulation results to support analysis of extreme events globally and for Australia	ACCESS simulation results published for CMIP7
Climate Change Authority (CCA)	Engage in discussions around requirements for specific ACCESS experiments Communicate release and publication of ACCESS simulation results through meetings and emails	ACCESS simulation results to inform policy and decision making	ACCESS simulation results published for CMIP7
University of New South Wales (UNSW)	Engage in decisions around requirements for specific ACCESS experiments or priorities around data needs Communicate release and publication of ACCESS simulation results through meetings and emails	ACCESS for paleo climate and priorities for CMIP7 related experiments	ACCESS simulation results published for CMIP7
CORDEX / CCAM Modelling communities	Engage in decisions around requirements for specific ACCESS experiments or	ACCESS simulation results for downscaling	ACCESS simulation results published for CMIP7 and non-

Research-user	Engagement and communication	Impact on management action	Outputs
	priorities around data needs Communicate release and publication of ACCESS simulation results through meetings and emails		published output as required
National Partnership for Climate Projections Including State and Territory Engagement	Engage with WG1 and WG2 (in partnership with ACCESS-NRI) around requirements for specific ACCESS configurations and experiments including data needs	ACCESS simulation results for projections	Broader Australian research community has had input to the design and outputs of ACCESS through NPCP papers.
ARC Centre of Excellence 21st Century Weather	Engage in discussions around requirements for specific ACCESS high resolution configurations Communicate release and publication of ACCESS simulation results through meetings and emails	Use of high-resolution ACCESS configurations	Release of ACCESS configurations (through ACCESS-NRI)
DCCEEW	Engage in discussions around ACCESS for CMIP7 and needs for Australian Earth System Modelling capability Communicate ACCESS CMIP7 plans	Promote use of ACCESS including support of policy and decision making	ACCESS simulation results published for CMIP7 and non-published output as required
Additional outputs • 1° ocean ACCESS-ESM3 configuration evaluated			

CS5.2 - Global carbon budgets and the role of terrestrial carbon sinks

Research-user	Engagement and communication	Impact on management action	Outputs
• Spin-up and final tuning for ACCESS-ESM1.6 completed • 0.25° ocean ACCESS-ESM3 configuration evaluated • CMIP7 production runs for control and selected idealised experiments with ACCESS-ESM1.6 completed • Model description paper for ACCESS-ESM1.6 submitted • CMIP7 production runs with ACCESS-ESM1.6 that were in scope completed • Historical trial simulation with ACCESS-ESM3 evaluated • CMIP7 simulation output with ACCESS-ESM1.6 published on ESGF Datasets produced for CMIP7 will be publicly available (through the National Computing Infrastructure (NCI) and the Earth System Grid Federation (ESGF))			

Project description

Project description

This project will contribute to maintaining and further developing ACCESS for Australia and will deliver ACCESS simulation results to CMIP7. Two model versions are being prepared for CMIP7, one to meet the Fast Track timeline (for use by the IPCC and AR7) and one for the longer timescale CMIP7 effort. Since ACCESS-ESM3 updates all components of the model, configuration design will require more time to ensure robust and quality simulations before spin-up and CMIP7 production runs can then commence. This project is part of a larger effort in Australia to deliver ACCESS to CMIP7. CSIRO is supporting this work through strategic investment and by leading a consortium that includes the ACCESS-NRI, universities and the Bureau of Meteorology.

ACCESS-ESM1.6, based on our successful ACCESS-ESM1.5 CMIP6 submission, will have significant improvements around land surface (CABLE) and ocean biogeochemistry (WOMBAT). Its resource efficiency and simulation speed will allow production runs to be achieved on the Fast Track timeline with the potential (outside this project) to deliver large ensembles and long simulations required for assessing, for example, climate overshoots and stabilisation under net-zero CO2 emissions.

The ACCESS models provide important research capability for the Australian community and are being used, for example, to explore future emissions pathways (including Net-Zero), climate stabilisation and climate overshoots and underpin policy relevant and actionable information for decision makers. The NESP CS Hub is mandated to further develop ACCESS.

There are two in scope activities under this project:

1) Delivering to CMIP7 DECK and Fast Track with ACCESS-ESM1.6

There is a strong focus on emissions driven simulations in CMIP7, which requires an Earth System model with a fully interactive carbon cycle. ACCESS-ESM1.6 retains most components from ACCESS-ESM1.5 (CMIP6 submission), but provides significant upgrades to the land and ocean carbon cycle. This activity will deliver ACCESS-ESM1.6 simulations to CMIP7. The ACCESS-NRI will assist with the preparation of forcing data sets and ancillary files, the evaluation and quality control of the results (by providing ESMValTool and ILAMB) and the release of ACCESS-ESM1.6 to the community.

Year 1 (until Dec 2025)

- Spin-up (~1000 simulation years) and evaluation of ACCESS-ESM1.6 including further tuning (as required)
- Start of production runs for CMIP7 including piControl (minimum 500 years), esm-piControl (minimum 500 years), abrupt-4xCO2 (150 years), 1pctCO2 (150 years), esm-flat10 (150 years)
- Preparation of historical forcing data (with ACCESS-NRI) and set-up and test of historical simulation

Year 2 (until Dec 2026)

- Continue productions runs for CMIP7 including historical (175 years), esm-historical (175 years), amip (36 years), piClim (3x30 years), esm-flat10-cdr (220 years), esm-flat10-zec (220 years)
- Data set quality control and data set publishing (with ACCESS-NRI and NCI)

Note that other CMIP7 Fast Track experiments are out of scope for this project. In particular, future scenario experiments are not included due to resource limitations and uncertainty around forcing data being available in time for delivery under this project, however they will be addressed in other projects outside NESP.

Outputs: ACCESS-ESM1.6 spin-up and final tuning completed. Production runs for selected CMIP7 DECK and Fast Track experiments completed. Model output archived, processed to standardised CMIP7 format and published on NCI and Earth System Grid Federation (ESGF). Model description paper submitted.

2) Evaluation of ACCESS-ESM3 configurations

The next generation of the ACCESS Earth System Model, ACCESS-ESM3, will have all new or upgraded components, which requires significant testing of possible configuration options and their evaluation. The ACCESS-NRI will assist with all technical aspects of this work, provide the evaluation tools (such as ESMValTool and ILAMB) and support the release of configuration options to the community. This activity will contribute to the scientific evaluation of ACCESS-ESM3 including preparation for participation in CMIP7. This model development is needed for Australia to be running the state-of-the-art assessments of our climate and carbon mitigation option experiments. If funding does not continue beyond this project, the model will likely not be submitted to CMIP7 (which will not allow it to be benchmarked internationally) however it will still be needed by Australian researchers for climate and carbon assessments.

Year 1 (until Dec 2025)

- Evaluation of potential N96 (1.875°x1.25°) atmosphere and 1° ocean resolution configurations focussing on ENSO and other climate drivers and performance over Australia (with ACCESS-NRI supported tools). The set up and running of the test simulations is being conducted by a separate CSIRO project.
- Evaluation of potential N96 atmosphere and 0.25° ocean resolution configurations focussing on ENSO and other climate drivers and performance over Australia (with ACCESS-NRI supported tools). The set up and running of the test simulations is being conducted by a separate CSIRO project.
- Preparation of historical forcing data (with ACCESS-NRI)

Year 2 (until Dec 2026)

- Set-up and evaluation of historical simulation with N96 atmosphere and either 1° or 0.25° ocean resolution (with ACCESS-NRI)
- Evaluation and comparison of initial ACCESS-ESM3 simulation results with ACCESS-ESM1.6

Outputs: ACCESS-ESM3 configurations evaluated and results available and documented on ACCESS-hive forum. Trial simulations using CMIP7 forcings including spin-up, piControl and historical set-up evaluated.

Preparing a model version/configuration for CMIP is a long and time-consuming process. Every model needs to be spun up to reach an equilibrium and to create a stable starting point that reflects the climate conditions before human influences. The spin up can take thousands of simulation years (due to slow climate processes and long turn over times of, for example, carbon pools). The piControl run starts from the end of the spin-up (when equilibrium is reached) and acts as a base run for all other simulations in CMIP. These steps are therefore important for the preparation of any CMIP submission.

ACCESS development and submission to CMIP has been supported by previous programs, including the Australian Climate Change Science Program (ACCSP), the NESP Earth Systems and Climate Change (ESCC) Hub, the NESP Climate Systems Hub project CS1.7 “Modelling the future” and project CS2.11 “Towards the next generation Earth System Model”. This project builds on this work by continuing the support for developing the next generation ACCESS-ESM3 and by delivering ACCESS-ESM1.6 simulations to the CMIP7 Fast Track.

This project provides the foundational science and capability for other projects in the hub, across the NESP portfolio, and the Australian research community. It also supports Australia’s involvement in an international model consortium, the UK Met Office-led Momentum partnership. The ACCESS-NRI provides infrastructure to support the development and application of ACCESS through software engineering expertise, user training, documentation and wider community support. Collaboration with the ARC Centre of Excellence for the 21st Century Weather is anticipated around high-resolution configurations of ACCESS.

The project will engage with other Hub projects and the Australian research community on priorities for specific CMIP7 experiments including collaboration on setting up and performing those (additional) simulations. CMIP data sets including those from ACCESS are widely used across the Australian research community and for decisions making in policy, and they underpin research and decision making in other NESP hubs as well as the Australian Climate Service (ACS), the National Climate Risk Assessment, the National Adaptation Policy Office (NAPO) and the Climate Change Authority (CCA).

Experiments in the CMIP7 Fast Track are aligned with the needs of the IPCC and will underpin AR7, which will inform national and international climate negotiations. CMIP7 will include new and novel (CO2 emissions driven) experiments to better inform decision-making in many key areas such as exploring net-zero climate stabilisation pathways and climate overshoots.

Is this a cross-hub project?

No.

Does this project contribute to a cross-cutting initiative?

No.

Indigenous consultation and engagement

The project meets the following revised Three Category approach:	**Category 1** Indigenous led ☐	**Category 2** Co-design ☐	**Category 3** Communicate ☒

This project is a category 3 project under the updated NESP 3 category approach.

This project is aligned to the hub's Indigenous partnerships strategy and adheres to the NESP Indigenous Partnership Principles. These principles will strengthen relationships but also foster positive Indigenous engagements. These engagements will allow for trust, transparency and respect to be strengthened over time. The adoption of these approaches will ensure maintenance of appropriate Indigenous engagement throughout the project's lifecycle, and that the project legacy is available to communities engaged with, and more widely as suitable. Project Indigenous engagement will be measured through the hub's monitoring and evaluation framework and process.

Every Indigenous community in Australia is different. Informed partnership processes reflect responsible and transparent engagement underpinned by Indigenous people having the right to their Indigenous Cultural and Intellectual Property (ICIP), and Free, Prior and Informed Consent (FPIC).

The incorporation of the updated NESP 3 category approach to Indigenous partnerships - Indigenous led, Co-Design and Communicate - during the engagements will optimise the project outcomes and outputs thus allowing for project success to be achieved.

The Climate Systems Hub in partnership with the National First Peoples Platform on Climate Change have called for collaboration with climate scientists. This request is for, but not limited to, current understanding and future projections of seasonal patterns that are impacting or anticipated to impact both natural and cultural indicators within Indigenous knowledge systems.

The project team will seek advice from the Platform to consider pathways through which to communicate the outcomes of this research which may include via organisations suggested by DCCEEW. We note that the Platform has existing links to the Indigenous Desert Alliance and SEED (who participated in the Gathering).

The scientific field work (outside scope of this project) conducted through the various communities will provide valuable data for Indigenous people, thus allowing for adaptation measures to be implemented in caring for Country. Incorporating the National First Peoples Platform on Climate Change in elements of the co-design process will support scientists in the development of specific case-studies.

Project milestones

Milestones	Due date	Responsible person
Year 1 (until Dec 2025)		
Milestone 1 – Project workplan approved by the NESP CSH program management team	15 March 2025	Tilo Ziehn
Milestone 2 – 1° ocean ACCESS-ESM3 configuration evaluated and documented	June 2025	Harun Rashid / Christine Chung
Milestone 3 – Spin-up and final tuning for ACCESS-ESM1.6 completed	June 2025	Tilo Ziehn
Milestone 4 – 0.25° ocean ACCESS-ESM3 configuration evaluated and documented	December 2025	Harun Rashid / Christine Chung
Milestone 5 – CMIP7 production runs for control and selected idealised experiments with ACCESS-ESM1.6 completed	December 2025	Tilo Ziehn
Milestone 6 – Submission of Project progress report	December 2025	Tilo Ziehn
Year 2 (until Dec 2026)		
Milestone 7 – Model description paper for ACCESS-ESM1.6 submitted	June 2026	Tilo Ziehn / Rachel Law
Milestone 8 – CMIP7 production runs with ACCESS-ESM1.6 that were in scope completed	September 2026	Tilo Ziehn
Milestone 9 – Historical trial simulation with ACCESS-ESM3 evaluated and documented	December 2026	Harun Rashid / Christine Chung
Milestone 10 – CMIP7 simulation output with ACCESS-ESM1.6 published on ESGF	December 2026	Peter Dobrohotoff
Milestone 11 – Submission of final project progress report	December 2026	Tilo Ziehn
Milestone 12 – Synthesis report approved by NESP CSH Project Management Team	December 2026	Tilo Ziehn

Data and information management

The project will take an approach to ensure all outputs meet the FAIR data principles – Findable, Accessible, Interoperable, and Reusable – in conjunction with the CARE principles for any Indigenous Cultural and Intellectual Property (ICIP) – Collective benefit, Authority to control, Responsibility, and Ethics. Together, these aim to ensure all data are easily shared and reused, but also used ethically. The project will adhere to principles of ICIP and acknowledge data sovereignty elements in all project outputs for any ICIP.

A data management plan will serve as a record of all datasets and other information used as inputs and outputs for the project, including any models and code/software. The plan will ensure consideration has been given to how the data associated with the project will be managed and that appropriate resources are devoted to data management.

The *NESP data and information guidelines* and the Climate Systems Hub Data Management Strategy detail the fundamental approach to data management and the many aspects projects need to consider, including dealing with ICIP. The Data Wrangler will provide any guidance needed by the Project Lead and the project's Data Custodians.

FAIR Data Principles

While it is acknowledged that projects will not know all the details at the outset, how and where project outputs will be made freely and openly available needs to be considered. Different types of data and information will require different approaches. The principles of the Data Management Strategy on how different data types will be managed are summarised in the following table, noting that not all data types are applicable to every project.

Project output	Data management and accessibility
All data/information products	• Research data and outputs will be well-documented according to accepted and trusted standards, including principles of ICIP. A key requirement for all research products generated by the hub research will be following metadata standards based on accepted best practice • Data will be made publicly available whenever legally, ethically and contractually possible, under an open licence policy except in particular cases, with particular. A record of these exceptions will be kept, and exceptions reported regularly to the Department • Data and other research output will be stored in repositories that are accessible to end-users and other researchers, with the choice of repository based on practicalities of the data and its likely use, and stored in such a way as to endure and remain FAIR well beyond the life of the project • The project will develop its own data management plan, with identified data custodians responsible for managing the data

Project output	Data management and accessibility
	• The nature of research outputs, their formats and repositories, will be developed through a co-design process involving stakeholders and end-users to ensure data meet their requirements and are fit-for-purpose, and will evolve through ongoing consultation • Research outputs and data will be accompanied by documentation providing guidance to users on how best to make use of the data • The hub will maintain a metadata catalogue of all research data, and all metadata will be published on other public metadata catalogues • Outputs such as websites will follow the Web Content Accessibility Guidelines (WCAG), and include an accessibility statement.
Scientific publications and reports	• Publications and reports will be made available through the CS hub website and/or appropriate peer-reviewed scientific journals.
Application ready data sets	• To be published in public repositories. • Data services made available to enable ingestion into end-user models and decision-support tools.
End-user products	• Published in appropriate medium such as print or a scientific journal. • Captured in metadata catalogues. • A copy will be stored on the hub website for public access.
Raw research data	• Stored on infrastructure where generated and where they can be shared, as appropriate under ICIP considerations, with other researchers.

Location of research

The table below describes the scale at which the project will be working, and the location(s) where the majority of the project research will be conducted.

At which spatial scale is the project working	**National** ☒	**Regional** ☐	**Local** ☐
Location(s) – gazetted region /place name	Desktop research will be undertaken in Aspendale, Hobart and Canberra.		
Aboriginal or Torres Strait Islander nation or traditional place name(s)	Desktop research to be conducted on the lands of the Bunurong and Wurundjeri of the Kulin nation, and Nipaluna country.		

Project-specific risks

Risk	Potential impact on project	Likelihood (rare, unlikely, possible, likely, highly likely)	Consequence (minor, moderate, high, major, critical)	Risk rating (low, medium high, severe)	Treatment to reduce or manage risk
Delay in availability of historical forcing data from provider (Input4MIPS)	Delay in setting up and producing historical simulations for CMIP7 DECK; Unable to deliver output/miles tones	possible	high	medium	Ensure internal processing of forcing data is set up and working as required using existing historical data (with ACCESS-NRI)
Model spin-up and/or performance for ACCESS-ESM1.6 not satisfactory	Delay in starting official pre-industrial control run and contribution to CMIP7 DECK and Fast Track; Unable to deliver output/miles tones	possible	high	medium	Early testing and evaluation of performance; re-assignment of priorities within team to identify and fix potential issues
Development in ACCESS and/or components or set-up of experiments delayed due to co-dependence on CSIRO strategic project and funding and partnership with ACCESS-NRI	Delay in evaluation of configuration options for ACCESS-ESM3; Delay in contribution of ACCESS-ESM1.6 to CMIP7 Fast Track; Unable to deliver output/miles tones	possible	high	medium	Outside the control of this project. Continue to communicate to CSIRO and the relevant funding bodies, the critical role of the ACCESS model to Australia.

Risk	Potential impact on project	Likelihood (rare, unlikely, possible, likely, highly likely)	Consequence (minor, moderate, high, major, critical)	Risk rating (low, medium high, severe)	Treatment to reduce or manage risk
Maintaining CSIRO staff and capability (for example,, staff members on term contracts with an end date before end of 2025; not returning from secondment)	Losing capability in key areas important for the delivery of this projects; Unable to deliver output/miles tones	likely	high	high	Continue to communicate to CSIRO and the relevant funding bodies, the critical role of the ACCESS model to Australia.
Broader CMIP7 for ACCESS effort not funded elsewhere including storage and compute.	CMIP7 contribution from Australia will not be realised and efforts from NESP CSH do not contribute apart from Fastrack	likely	Major critical	high	Outside the control of this project. Will endeavour to support the consortium looking for funding.
Risk around availability of HPC, data storage and NCI ESGF node. Risk around disruption due to future infrastructure updates/changes.	Limited capacity for performing CMIP7 simulations and storage of model output, particularly high-frequency output required for projections	likely	Major critical	high	Engagement with NCI around compute, storage, future infrastructure updates and hosting of ESGF node.

Project keywords

Earth System Model; ACCESS; climate modelling; CMIP; global modelling

Project CS5.2 - Global carbon budgets and the role of terrestrial carbon sinks

Project type: • Hub research project	
Project status: • New project submitted for approval	
Cross-cutting initiative:	No
Project start date: 01/01/2025	**Project end date**: 31/12/2026
Total project budget: $1,986,882 (GST exclusive)	**NESP funding:** (GST exclusive) 2025 $533,496 2026 $489,416 **Co-contributions (cash and in-kind):** (GST exclusive) 2025 $524,017 2026 $439,954
Project leader details:	Name: Pep Canadell Organisation: CSIRO Phone: 0408020952 Email: pep.canadell@csiro.au

Project summary

The project will analyse the evolution of terrestrial carbon sinks under different climate futures, land-use/forestation scenarios, wildfire, and spatial scales from farm systems (case study) to Australia and globally.

We will achieve these objectives by using three data-modelling platforms, each one providing key carbon information from the farm-level (DAESim) to Australia-wide and global scales (CABLE, ACCESS-ESM).

The project will support farm-level engagement in carbon sequestration activities, constrain estimates of the terrestrial carbon sink and potential of revegetation under future climates, and produce carbon budgets aligned with the Paris Agreement.

Pathway to impact

Outcomes
By better understanding the changing levels of carbon due to land use at international, national and local scales, this project will improve Australia's ability to monitor its path to net-zero and implement effective land management strategies to help achieve this. In particular, the outcomes for our research users listed below include: • Project results on the carbon budget will support appropriate choices around Australia to maximize carbon sequestration projects both for their total sequestration and regional/local climate implications. It will also identify vulnerable carbon sinks for appropriate conservation actions to be considered. • CCA is a key "agency" providing scientific information to the government to inform and drive policy change. Being able to directly provide information to CCA can translate into real and important changes in the transition to net zero. • The case studies on farming will lead to a larger uptake and higher confidence of the farming community to participate in carbon sequestration programs, and therefore directly leading to additional mitigation contributions towards the 2030 national target of a 43% reduction in GHG emissions over 2005 levels. • The States and Territories inform and drive strategic directions and policy change in their jurisdictions. Being able to share research findings can bring alignment, raise awareness of regional/local climate implications, build capability and could be translated into real and important changes in the Nation's transition to net zero.

Research-user	Engagement and communication	Impact on management action	Outputs
DCCEEW-National Greenhouse Gas Inventory – Land Sector Carbon Modelling Team and Emissions Projections Team	We have built a relationship from regular interaction with the Land Sector team since the beginning of NESP. We held a meeting to get feedback on the EOI. We plan to discuss and share specific plans and products before final or publication for input.	Current NGHGI modelling are not considering the CO2 fertilization effect on plant productivity and terrestrial sinks. This is an area the project will provide information, which will support improving the land sector modelling capability.	Milestone 2 -Australian CH4 and N2O Budgets. Research paper, communication materials, and stakeholder communication. Milestone 7 –Global Carbon Budget 2025 and Remaining Carbon budget and associated engagement
Climate Change Authority (CCA)	We maintain a regular interaction with the CCA and we received feedback on the EOI of the project. We plan to keep this interaction	The project will provide annual updates of the global current and remaining carbon budgets, explain the changes in	Milestone 2 - Australian CH4 and N2O Budgets. Research paper, communication materials, and

Research-user	Engagement and communication	Impact on management action	Outputs
	through emails and by participating in CCA meetings where feedback is requested from the scientific community to understand how best to support their mission.	methodologies, and the implications for Australia's carbon budget. This allows the CCA to provide the most up-to-date advice to the government on in setting national mitigation targets.	stakeholder communication. Milestone 3 - Research paper with data deliver on future C sink trajectories under multiple climate scenarios. Engagement and communication via relevant stakeholder channels. Milestone 7 –Global Carbon Budget 2025 and Remaining Carbon budget and associated engagement
Australian and Global Research Community	Share updates and presentations with primary and secondary research users to raise awareness of data utility, research progress and findings.	The data provided by the ACCESS-ESM1.5 work for TIPMIP will provide a large dataset to the global (including the IPCC) and the Australian community to do further analysis on what is now an unavoidable overshoot pathway if the global temperature is to be kept under well below 2C. The global carbon budget data developed annually with the Global Carbon Project is delivered to the global scientific and climate negotiations (UNFCC COP, SBSTA, UN Climate	Research papers on the global and national carbon budgets, and on overshoot scenarios to stay under well below 2C globally, done by the broader community with the data and analyses will deliver, will form the basis for federal and state level agencies to improve their mitigation plans according to the best available science. Informing 2026 CSIRO-BOM State of the Climate in Australia.

Research-user	Engagement and communication	Impact on management action	Outputs
		Week). We will also provide the data to the World Meteorological Organization for its annual assessments of the state of the global climate, and biannually to the CSIRO-BOM State of the Climate in Australia.	
Australian mix farming community	The initial case study will deal with a specific farming property in NSW, with a direct face-to-face on ground interaction. The owners have accepted to work with the project, provided extensive farm data, and meet with lead research to discuss. The findings, tools developed, and results will be presented in face-to-face meetings. After the first case study we will start a much broader engagement with the farming community across jurisdictions with a web-based interface to attract interest in the modeling applications on other farms with the willingness to share key farming data and	This work will directly lead to additional engagement of the farming community in participating and improving their management practices to improve long term carbon sequestration in soils and vegetation.	Milestone 8 – Delivery of Web based for farm engagement Milestone 9– Farm case study

Research-user	Engagement and communication	Impact on management action	Outputs
	carbon sequestration interest.		
State / Territory Departments including: NSW DCCEEW, QLD DES, WA DWER and DPIRD, Victoria DEECA, SA DEW and PIRSA, Tas ReCFIT, ACT	Share products and research findings via briefings and presentations to primary and secondary research users. Establish a community of practice of biospheric modeling from different research organizations with State/Territory agencies and projects to share experience, data, and tools. State/Territory users to nominate their preferred point of contact at project at commencement.	New modelling and research findings can be used to build and align capability across Australia including to inform specific steps to land sector modelling expertise and application.	Milestone 12 - Synthesis products (explainers, factsheets) to raise awareness. Interactive presentations/webinars provide opportunities to hear from the experts and ask questions.
Additional outputs			

Project description

Project description

Net-zero targets of countries signatory to the Paris Agreement, including Australia, expect to offset GHG emissions from hard-to-abate economic sectors by deploying strategies to remove atmospheric CO2. An early Australian Government assessment showed that as much as 29% of anthropogenic emissions will remain at the point of net-zero in 2050, implying that an equivalent amount of carbon will need to be removed from the atmosphere.

In this context, we ask, what is the contribution of terrestrial carbon sinks and revegetation programs in Australia's net-zero carbon budget and beyond?

We propose the following activities to address this question.

Activity 1. To assess changes in the strength and distribution of Australia's terrestrial carbon sinks under future climates, revegetation scenarios, and overshooting pathways consistent with the Paris Agreement goals of 1.5C and well below 2C (when possible, also higher temperature scenarios).

Activity 1.1. To assess changes in land sinks under future climate and revegetation scenarios using CABLE-BIOS, the Australian's high-resolution setup of CABLE. The selected range of future climates will be guided by the Australian Climate Service (ACS) projections. These cover two main scenarios (ssp-126 and ssp-370; and when possible, also SSP2-4.5 and higher temperature scenarios) and 7 narratives on future climate (Grose et al. 2023). ACCESS-ESM1.5 and ACCESS-CM2 are two of the global climate models chosen by the ACS to provide the global narratives. The selection of future land-use scenarios will be guided by stakeholder engagement – as derived from available projections from the ABARES-CSIRO land-use trade-offs model.

Activity 1.2. To assess changes in land sinks under future climate and revegetation scenarios using ACCESS-ESM 1.5, a coupled carbon-climate model. Future revegetation scenarios will be similarly guided by stakeholder engagement, with the key added value of assessing the regional climate impacts brought by changes on the land surface; this latter information is of high interest to stakeholders as highlighted during pre-proposal consultations and during the first phase of NESP2. A sensitivity analysis of revegetation impacts on carbon and regional climate in the major biome-types of Australia will be undertaken with an emphasis on the extensive semi-arid regions of the continent.

Activity 1.3. To assess the impacts of overshoot scenarios on future carbon sinks and stores, and other related variables, for Australia and globally using the fully coupled ACCESS-ESM1.5. Idealized overshoot simulations will be performed in emissions-driven mode with a fully interactive carbon cycle to explore potential climate overshoots and overshoot characteristics such as peak temperature, overshoot length, and rate of cooling in more detail. These proposed simulations are part of a multi-model initiative (TipMIP), and by following an agreed protocol, we will also be able to contribute to this international effort with an Australian model. Data will be made available to other projects in the Hub (for example, missing narratives) and the Australian research community for further analysis.

Activity 2. To provide contemporary and remaining global carbon budgets to support tracking of the Paris Agreement temperature goal. This activity will support CSIRO's contributions to the Global Carbon Project - Annual Global Carbon Budgets and support the completion of the remaining GHG budgets for Australia (CH4 and N2O); CO2 budget completed under NESP2-C2.9 project.

Activity 3. **To develop the analytical tools, processes, and workflows for modelling carbon sequestration in mix-farming systems in Australia,** and attribute it to specific management practices. This work will include the development of a case study in New South Wales.

Management solutions for climate mitigation such as stubble retention/no till, rotational (cover) cropping, time-controlled intensive grazing, and/or tree shelter belts are being adopted and proposed as an integrated farm and land management method for Australian Carbon Credit Units. To estimate the additional benefits of these approaches over a reference baseline of local conventional practices, there is a need for verification and attribution to separate out changes due to human interventions from those driven by natural environmental variability.

Here, we will use farmer provided data of crop yield and soil carbon along with Sentinel-2 satellite observations to estimate planting and harvest dates and crop phenology transitions, and comprehensive records of planting and harvest dates to calibrate satellite-based measurements. These data will calibrate our Dynamic Agro-Ecosystem Simulation (DAESim2) model, that will estimate carbon and water cycles in agro-ecosystems. The work will include the release a template to get feedback from the farming community that is interested in participating by listing at least 4 paddocks as conventional vs additional practice change, and who will provide yield and soil carbon data at multiple time points per paddock. The project will aim to develop a website to extend farmer enrolment and share local results, so the model can be run online. A number of state-level stakeholders have shown great interest in participating in this activity. Data and Code will be openly available throughout the project on github.

This project will also provide input to project CS5.10 via a case study on cultural burning. The focal points for this case study are still to be confirmed through a co-design process. This project team will participate in, and provide expertise to, a paper on cultural burning.

Is this a cross-hub project?

No but possible connection to RL Hub land use to be explored

Does this project contribute to a cross-cutting initiative?

No

Indigenous consultation and engagement

The project meets the following revised Three Category approach:	**Category 1** Indigenous led ☐	**Category 2** Co-design ☒	**Category 3** Communicate ☐

This project is a category 2 project under the updated NESP 3 category approach.

This project will contribute to CS5.10: *Indigenous-led literature and products to inform national and international processes on climate action*, through co-design of themed case study work related to cultural burning in CS5.10, including contribution to Indigenous-led literature. The case study will have an Indigenous lead and a science lead as determined through the co-design process with CS5.10. Governance of the Indigenous engagement in this project will come through CS5.10 which is Indigenous-led.

Pep Canadell will support the CS5.10 project by providing knowledge on the Intergovernmental Panel on Climate Change (IPCC) process, ways to produce knowledge that can be taken up by IPCC Assessment Report 7, and provide co-leadership for a case study on cultural burning with the goal of publishing a peer-reviewed paper.

This project is aligned to the hub's Indigenous partnerships strategy and adheres to the NESP Indigenous Partnership Principles. These principles will strengthen relationships but also foster positive Indigenous engagements. These engagements will allow for trust, transparency and respect to be strengthened over time. The adoption of these approaches will ensure maintenance of appropriate Indigenous engagement throughout the project's lifecycle, and that the project legacy is available to communities engaged with, and more widely as suitable. Project Indigenous engagement will be measured through the hub's monitoring and evaluation framework and process.

Every Indigenous community in Australia is different. Informed partnership processes reflect responsible and transparent engagement underpinned by Indigenous people having the right to their Indigenous Cultural and Intellectual Property (ICIP), and Free, Prior and Informed Consent (FPIC).

The incorporation of the updated NESP 3 category approach to Indigenous partnerships - Indigenous led, Co-Design and Communicate - during the engagements will optimise the project outcomes and outputs thus allowing for project success to be achieved.

The Climate Systems Hub in partnership with the National First Peoples Platform on Climate Change have called for collaboration with climate scientists. This request is for, but not limited to, current understanding and future projections of seasonal patterns that are impacting or anticipated to impact both natural and cultural indicators within Indigenous knowledge systems.

The scientific field work (outside scope of this project) conducted through the various communities will provide valuable data for Indigenous people, thus allowing for adaptation measures to be implemented in caring for Country. Incorporating the National First Peoples Platform on Climate Change in elements of the co-design process will support scientists in the development of specific case-studies.

CS5.2 - Global carbon budgets and the role of terrestrial carbon sinks

This project will contribute to CS5.10 via ethics approval under CSIRO Social and Interdisciplinary Science Human Research Ethics Committee (CSSHREC 198/24 Climate Systems Hub – Indigenous-led literature and products to inform national and international processes on climate action

Project milestones

Milestones	Due date	Responsible person
Milestone 1 – Project workplan approved by PMT	February 2025	Pep Canadell
Milestone 2 – Australian CH4 and N2O Budgets. Research paper, communication materials, and stakeholder communication.	June 2025	Pep Canadell
Milestone 3 – Research paper with data deliver on future C sink trajectories under multiple climate scenarios. Engagement and communication via relevant stakeholder channels.	December 2025	Ian Harman
Milestone 4 – Research paper and data available with future C sink trajectories with multiple revegetation scenarios. Engagement and communication via relevant stakeholder channels.	December 2025	Tammas Loughran
Milestone 5 – Submit Quarterly Progress Report to hub and research users	Quarterly	Pep Canadell
Milestone 6 – Delivery of ACCESS-ESM1.5 overshoot runs	December 2025	Tilo Ziehn
Milestone 7 –Global Carbon Budget 2025 and Remaining Carbon budget and associated engagement	December 2025	Pep Canadell
Milestone 8 – Delivery of Web based for farm engagement	December 2025	Justin Borevitz
Milestone 9– Farm case study	December 2025	Justin Borevitz
Milestone 10 – Factsheet on Australia's non-CO2 GHGs. Share with stakeholders	December 2025	Pep Canadell
Milestone 11 – written contribution to form part of CS5.10 case study work on cultural burning	December 2025	Pep Canadell
Milestone 12 – Report on future C sink data and implications for future emission targets.	March 2026	Pep Canadell/ Ian Harman /Tilo Ziehn
Milestone 13 – Factsheet published and shared with stakeholders	April 2026	Ian Harman /Tammas Loughran

Milestones	Due date	Responsible person
Milestone 14 – Submission of research manuscript on implications of overshoots globally and for Australia.	September 2026	Tilo Ziehn
Milestone 15 – written contribution to form part of CS5.10 case study work on cultural burning	September 2026	Pep Canadell
Milestone 16 – Final Project Report published and sent to research users. Synthesis materials shared with project stakeholders.	31 Dec 2026	Pep Canadell

Data and information management

The project will take an approach to ensure all outputs meet the FAIR data principles – Findable, Accessible, Interoperable, and Reusable – in conjunction with the CARE principles for any Indigenous Cultural and Intellectual Property (ICIP) – Collective benefit, Authority to control, Responsibility, and Ethics. Together, these aim to ensure all data are easily shared and reused, but also used ethically. The project will adhere to principles of ICIP and acknowledge data sovereignty elements in all project outputs for any ICIP.

A data management plan will serve as a record of all datasets and other information used as inputs and outputs for the project, including any models and code/software. The plan will ensure consideration has been given to how the data associated with the project will be managed and that appropriate resources are devoted to data management.

The *NESP data and information guidelines* and the Climate Systems Hub Data Management Strategy detail the fundamental approach to data management and the many aspects projects need to consider, including dealing with ICIP. The Data Wrangler will provide any guidance needed by the Project Lead and the project's Data Custodians.

FAIR Data Principles

While it is acknowledged that projects will not know all the details at the outset, how and where project outputs will be made freely and openly available needs to be considered. Different types of data and information will require different approaches. The principles of the Data Management Strategy on how different data types will be managed are summarised in the following table, noting that not all data types are applicable to every project.

Project output	Data management and accessibility
All data/information products	• Research data and outputs will be well-documented according to accepted and trusted standards, including principles of ICIP. A key requirement for all research products generated by the hub research will be following metadata standards based on accepted best practice • Data will be made publicly available whenever legally, ethically and contractually possible, under an open licence policy except in particular cases, with particular. A record of these exceptions will be kept, and exceptions reported regularly to the Department • Data and other research output will be stored in repositories that are accessible to end-users and other researchers, with the choice of repository based on practicalities of the data and its likely use, and stored in such a way as to endure and remain FAIR well beyond the life of the project • The project will develop its own data management plan, with identified data custodians responsible for managing the data

Project output	Data management and accessibility
	• The nature of research outputs, their formats and repositories, will be developed through a co-design process involving stakeholders and end-users to ensure data meet their requirements and are fit-for-purpose, and will evolve through ongoing consultation • Research outputs and data will be accompanied by documentation providing guidance to users on how best to make use of the data • The hub will maintain a metadata catalogue of all research data, and all metadata will be published on other public metadata catalogues • Outputs such as websites will follow the Web Content Accessibility Guidelines (WCAG), and include an accessibility statement.
Scientific publications and reports	• Publications and reports will be made available through the CS hub website and/or appropriate peer-reviewed scientific journals.
Application ready data sets	• To be published in public repositories. • Data services made available to enable ingestion into end-user models and decision-support tools.
End-user products	• Published in appropriate medium such as print or a scientific journal. • Captured in metadata catalogues. • A copy will be stored on the hub website for public access.
Raw research data	• Stored on infrastructure where generated and where they can be shared, as appropriate under ICIP considerations, with other researchers.

Location of research

The table below describes the scale at which the project will be working, and the location(s) where the majority of the project research will be conducted.

At which spatial scale is the project working	**National** ☒	**Regional** ☒	**Local** ☐
Location(s) – gazetted region /place name	Desktop research will be undertaken at CSIRO Black Mountain in Canberra and Aspendale and at the ANU in Canberra. Majority of the research is at national scale. A case study in Milgadara, near Young, NSW.		
Aboriginal or Torres Strait Islander nation or traditional place name(s)	Desktop research to be conducted on Ngunnawal country and on the lands of the Bonorong and Wurundjeri of the Kulin nation. Farm system case study in Milgadara, near Young, NSW.		

Project-specific risks

Risk	Potential impact on project	Likelihood (rare, unlikely, possible, likely, highly likely)	Consequence (minor, moderate, high, major, critical)	Risk rating (low, medium high, severe)	Treatment to reduce or manage risk
Schedule slippage	Project deliverable delays	Possible	Moderate	Medium	More time allocated to planning project Establish a high performing team early in the project lifecycle.
No farmer case study produced	Limited information to support the farming industry	Unlikely	Moderate	Medium	Strengthen trust relationships with onsite members Increase planning time for case study success
Delay in hiring new a new Bioapheric Modeler in Aspendale	Activity 1.2 on the use of ACCESS-ESM1.5 to explore the carbon and climate impacts of forestation would be delayed.	Unlikely but possible that the person is not in place by January 2025.	Moderate	Medium	We would divert resources towards more work with CABLE offline to respond to similar research questions.

Project keywords

Carbon budgets, carbon sinks, climate scenarios, climate mitigation, farm systems

Project CS5.3 – Unchartered climate futures

<table>
<tr><td colspan="2">Project type:
• Hub research project</td></tr>
<tr><td colspan="2">Project status:
• New project submitted for approval</td></tr>
<tr><td>Cross-cutting initiative:</td><td>Climate Adaptation Initiative</td></tr>
<tr><td>Project start date: 01/01/2025</td><td>Project end date: 31/12/2026</td></tr>
<tr><td>Total project budget: $4,393,281 (GST exclusive)</td><td>NESP funding: (GST exclusive)
2025 $1,117,566
2026 $1,086,350

Co-contributions (cash and in-kind):
(GST exclusive)
2025 $1,142,888
2026 $1,046,476</td></tr>
<tr><td>Project leader details:</td><td>Name: Sugata Narsey
Organisation: Bureau of Meteorology
Phone:
Email: sugata.narsey@bom.gov.au</td></tr>
<tr><td colspan="2">Project summary

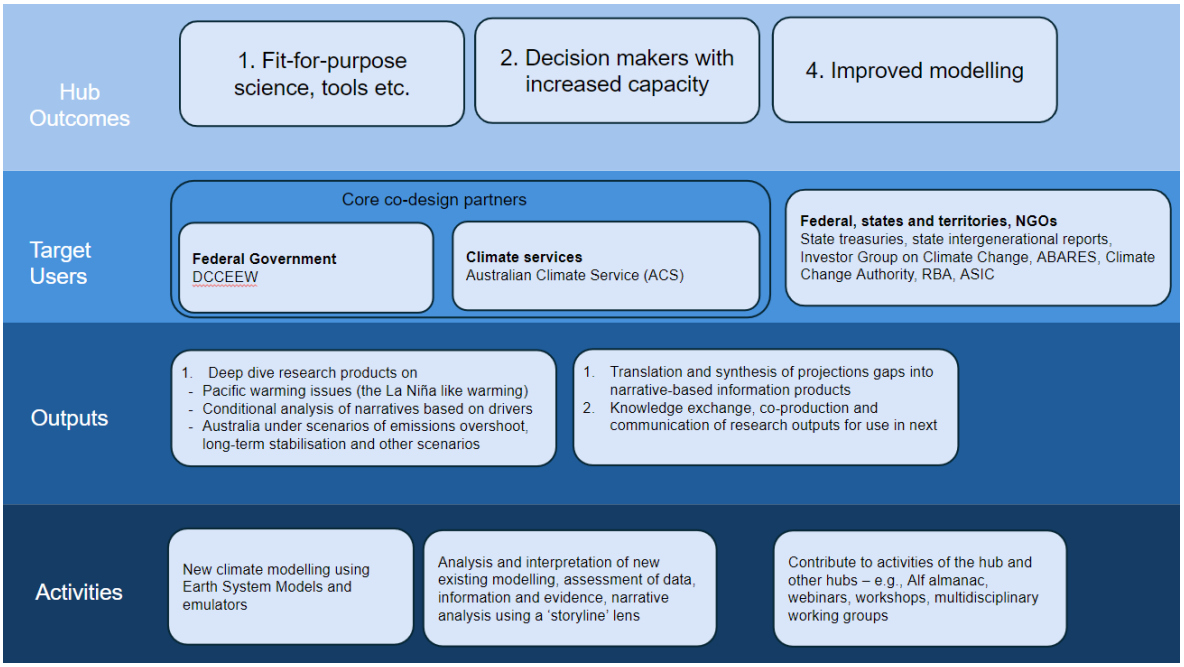
There are known gaps - “uncharted, but still plausible climate futures” - in the climate change projections provided by climate services. Some of these gaps, such as La Niña-like warming patterns and greenhouse gas overshoot and stabilisation scenarios, are outside the range of current climate projections.

We will map the full range of trajectories as well as impactful thresholds and events (such as tipping points and other abrupt changes to climate systems) to provide a more risk-aware view of the future than conventional projections.

We will do this through co-design, innovative research on key gaps in projections, and a co-production of outputs. These outputs will translate new information into fit-for-purpose content for stakeholders in-line with scientific best-practice, improving stakeholders’ capacity to make informed decisions on climate-related risks.</td></tr>
</table>

Pathway to impact

Outcomes
The project contains primary and applied research, as well as a major translation and synthesis component that will leverage a path-to-impact already established by ACS as our key stakeholder and will also build new pathways to impact through our knowledge brokers to help serve the needs of state-based Treasury departments. We will contribute to the translation and synthesis led by ACS, which will draw on the new NESP research as well as the existing body of knowledge to produce an assessment and exploration of what addressing these current gaps in conventional projections looks like for Australia. This translation component will also involve a research aspect from NESP scientists, doing new and rigorous research on how to synthesise different lines of evidence using a narrative-based or 'storyline' framework. The ACS-led translation component will involve input from this project to help with the production of communication and engagement products themselves, with the formats and content designed in collaboration with the ACS and DCCEEW – likely including reports, papers, briefings and infographics or visual representations of the science. This engagement will directly inform the management actions of the core partners identified through the engagement and will affect policy primarily by addressing known gaps and aiming to make policy more robust. Along with the work with the core co-design group, there will be impact for a broader group of users and stakeholders through communication including workshops, briefings and written work, again primarily aimed at filling projection gaps and facilitating management actions to be more robust to the full range of potential futures. Since many of the issues covered in this project may not be familiar to all users, we will produce communication products very early on to raise awareness and illustrate the issues that we are addressing, to communicate the state of knowledge and to set expectations.



Research-user	Engagement and communication	Impact on management action	Outputs
DCCEEW	Co-designer and commissioner of the work	Inform strategy and policy, including climate risk and adaptation through various channels	Milestones 3/8 Codesigned outputs
Australian Climate Service (ACS)	Identified as 'Developers', 'Informants' and 'Reviewers' according to codesign guide – ongoing engagement throughout the project	Outputs and insights for use by ACS in providing services to their stakeholders and customers e.g. APRA and Treasury	Milestones 3/8 Codesigned outputs
State and territory agencies and science partners, including Treasuries	Consultation at inception, periodic communication, seminars, workshop	Raising awareness, informing policy	Milestones 3/8 Seminars, workshop, fact sheet/s, written work
Investor Group on Climate Change	As above	As above	As above
Other Federal agencies – ABARES, RBA, ASIC, CCA	As above	As above	As above
Additional outputs Peer reviewed papers			

Project description

Project description

Conventional climate change projections provided by climate services, such as the Australian Climate Service and state agencies, are based primarily on regional downscaling of the Coupled Model Intercomparison Project (CMIP) state-of-the-art global climate models. These regional projections help inform users of their risks associated with future and current climate states. Since the future climate cannot be exactly predicted, a range of plausible futures are provided in these projections datasets. The coordinated production of global and regional climate change projections has been undeniably crucial for helping users estimate their climate risk, however there are known gaps in the climate information requiring further deep investigation and analysis. In this project we aim to assess and then fill some of these important known gaps in conventional projections for key stakeholders.

Why do these gaps exist? Conventional climate change projections present many possible climate futures, however, we know there are further possibilities to the actual climate we will experience that are not fully captured in such datasets. These possibilities range from different 'forcing' scenarios (the effect imposed on the climate), such as emissions overshoot, or the impact from large volcanoes, and in aspects of the climate response (including high warming outcomes, triggering of tipping points or abrupt changes) - Fig 1 shows a schematic of how these uncharted futures could be expressed in terms of climate warming. Advances in the science mean we can now bring in more lines of evidence and supplementary modelling approaches to explore a fuller and more realistic set of scenarios that may play out this century and beyond.

Why are these gaps important to consider? Climate change adaptation and resilience planning should be robust across the full set of possibilities - if only a partial set of plausible futures are considered, we could be locking-in maladaptation. This possibility of false confidence and false precision inspired a recent report to describe "The emperor's new climate scenarios", referencing the famous fable. The demand to address these gaps already exists, with key users of climate information seeking out information from climate services on currently unavailable plausible scenarios.

Why has this work not been conducted already by climate services themselves? Although this limitation in Conventional regional projections is well-acknowledged, it is difficult for providers of regional projections to address. This is because the production of these gaps in projections is by definition non-standard, and therefore requires a degree of expert-judgement and potentially multiple bespoke efforts. It will also likely result in a spectrum of non-conventional projections formats, for example qualitative information on poorly sampled high impact futures. This project will fill in these knowledge gaps where possible by identifying these "high-impact, low-certainty" missing narratives, identifying their on-ground climate impacts, and translating this knowledge into useable information for stakeholders.

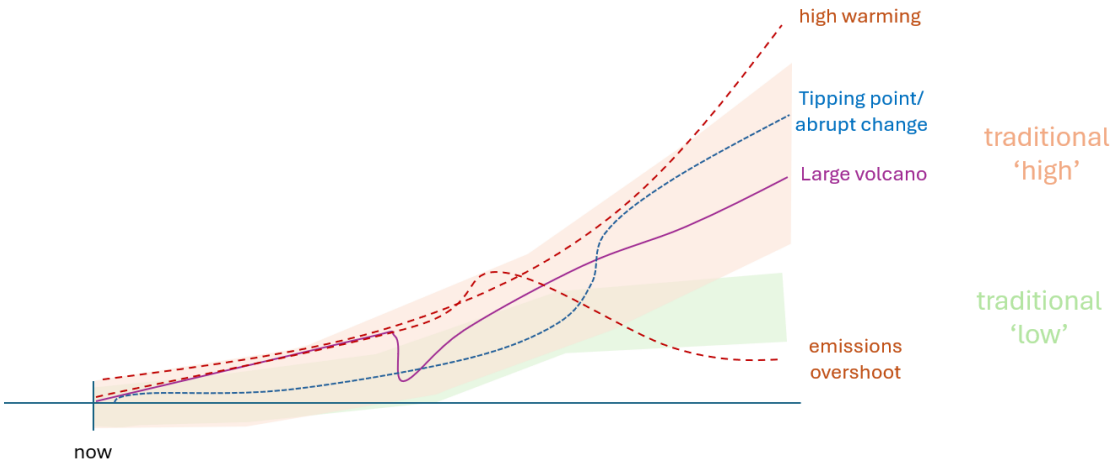


Figure 1: A typical presentation of projections for Australian temperature. The coloured plumes show the multi-model range for two typical scenarios/pathways considered in projections. Overlaid on this is an illustrative schematic/mock-up of some uncharted scenarios in climate forcing or response, proposed for exploration in the present project.

What will we do in this project? This project will consist of three main activities described in detail below.

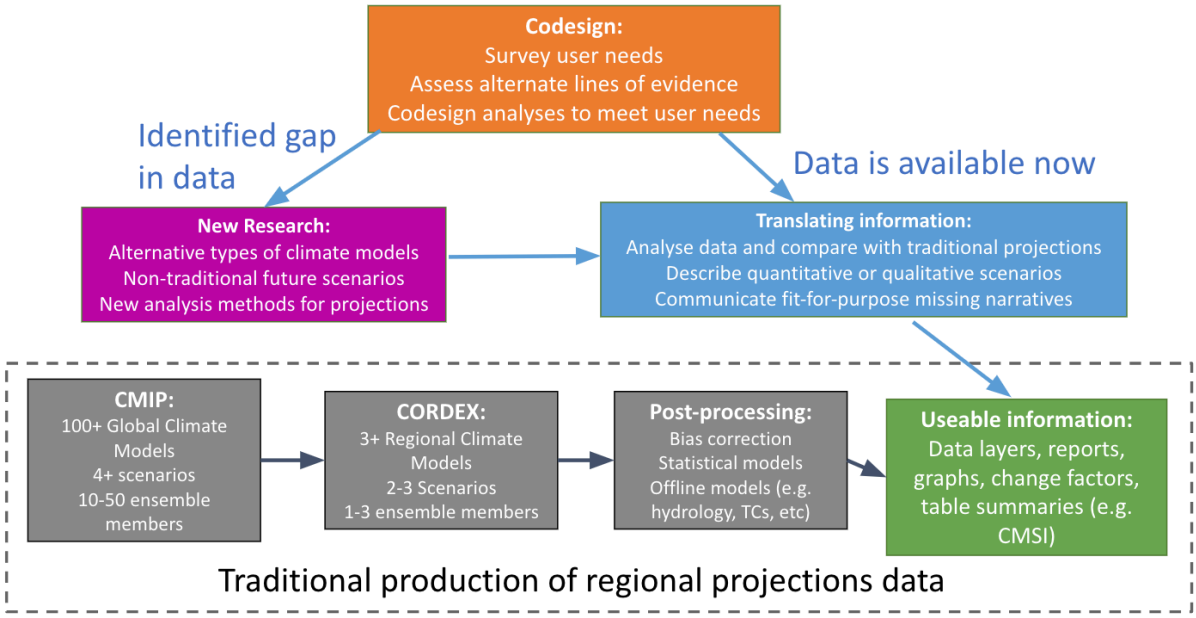


Figure 2: A schematic showing how the outputs from this project will complement conventional projections currently provided by climate services. The Codesign and Translation activities will be led by ACS co-contributors with input from this project.

Activity 1: Codesign with Stakeholders

This activity will be led by ACS co-contributors, with input from NESP scientists and knowledge brokers. With key stakeholders we will survey user needs, assess available lines

of evidence, and design project activities. We will produce information with our key stakeholders that extracts the salient messages that they need for estimating climate risk. The key outcome is to describe and then meet user needs. During the codesign phase we will conduct:

- Deeper co-design with a small group of nominated co-design partners as 'Developers', 'Informants' and 'Reviewers' for the work (following NESP co-design guidelines including targeted conversations and feedback opportunities to foster knowledge sharing and exchange among researchers and end-users).
- Consultation and communication with wider group of users and stakeholders, in three categories: 1) secondary users, 2) expert scientific reviewers, and 3) collaborators and key supporters. This engagement will include community workshops, similar to the global climate tipping points workshop and report organised by the leads of this project.

Activity 2: New scientific research

We will provide new insights into some targeted gaps in regional projections. This will involve assessing existing data in new ways, and running a limited set of new model simulations for key known gaps. The key outcome is to advance science on these topics through the following three components.

Component 1: La Niña-like change. All CMIP6 climate models project a warmer tropical Pacific (El Niño-like) mean state under increased greenhouse gas scenarios. Yet, recent trends in sea surface temperatures indicate a La Niña-like mean state trend over the past few decades, casting doubt on the reliability of these future projections for this key aspect of climate change for the globe, through fundamental factors such as climate sensitivity, and specifically for the regional climate of Australia, for example, rainfall and temperature changes outside the projected range. This component will investigate the projected changes in Australian climate under a scenario in which ENSO frequency, variability, and types vary within a La Niña-like Pacific mean state trend with global warming. We will first investigate available La Nina-like change experiments provided by external collaborators, then build on those results with new experiments to address further gaps using the CSIRO ACCESS climate model. We will explore the remote implications of a La Nina-like change and the resulting changes affecting Australia's climate.

Key outputs: Limited regional projections scenario based on LN-like change (Year 1), followed by an ensemble of regional projections scenarios based on LN-like change that attempt to maximise the illustration of impacts of this type of climate future for Australia (Year 2).

Component 2: Revised storylines. The main advantage of CMIP ensembles is the variety and number of models, yet the first stage of most projections analyses is to sub-select models for use. While the conventional approach has yielded useful scientific insights for regional projections, in this project we propose a different approach that may provide a wider range of plausible futures. Rather than accepting or rejecting models for use in our analysis of regional projections we will instead conditionally use components of each models' future projections, supplementing parts of the projection information with alternate sources of evidence for example, using observations. The key focus areas for these revised regional projections storylines will include adjusted remote driver teleconnections for most parts of Australia, and local processes such as wind-evaporation-rainfall feedbacks for the north of Australia.

Key outputs: New process-based evaluation of climate models (Year 1), followed by a revised set of regional projections for Australia based on conditional storylines (Year 2).

Component 3: New forcing scenarios. Users of climate change projections typically estimate their future risk on available climate model simulations of a core set of forcing scenarios that represent low, medium and high greenhouse gas emissions pathways, referred to as Shared Socioeconomic Pathways (SSPs). However, other scenarios may be important for estimating future climate risk, including overshoot and stabilisation of emissions scenarios, that is, where emissions and global temperatures overshoot end-of-century targets before returning to a stable level. These scenarios are currently unavailable for users to explore through conventional projections. This project will go beyond conventional SSP-driven CMIP6 scenarios by analysing overshoot and stabilisation experiments conducted using the CSIRO ACCESS model, followed by applying an IPCC calibrated emulator as global probabilistic climate model coupled with a newly developed implementation of regional temperature responses - including for Australia.

Key outputs: First set of regional projections scenario based on overshoot and stabilisation experiments, and potentially other scenarios pending review (Year 1), followed by AI emulator tools that can later be leveraged for scenario analyses, including a "best-estimate" scenario for temperature projections (Year 2).

Activity 3: Translating the science for users

Informed by the co-design phase (Activity 1), this component will be led by ACS stakeholders with input from NESP scientists, and will use a combination of output from Activity 2 and existing literature and data to translate the available knowledge on missing narratives into a co-produced format that is useful for the identified research/end-users. The key outcome is to leverage information previously untapped by services and uplift the capacity of our stakeholders. Some example translation activities that may emerge from the codesign phase could include:

- Research or technical papers describing methods and outcomes of the project, for example, applying a storyline lens to the lines of evidence, and developing a framework describing how and where "uncharted climate futures" should be considered.
- Synthesis and summary information - early on in the form of infographics and summaries laying out the topics and what we already know (Year 1), followed by quantitative projections data layers and summary tables, or qualitative projections statements, as assessed to be an appropriate level of precision during the project (year 2).
- Webinars and discussion workshops to build the capacity of scientists, key stakeholders and users on ways to uptake and apply the innovative projections products developed within the project.
- As appropriate, material to be incorporated into Adapt Land and Sea.

How does this project link to other work? The activities described above fit directly alongside the development of conventional climate change projections being advanced through ACS. The choice of ACS as key stakeholders for this project is informed by the need to develop fit-for-purpose information for their customers that ACS is not currently able to provide. The research in Activity 2 on La Niña-like change scenarios has strong synergy with

research in the Centre of Excellence for the 21st Century Weather and involves some of the same scientists. Between the foundational research funded in 21st Century Weather and the applied research conducted here in this project we will provide a critical mass of research to advance this key topic for the interests of Australia. The outputs from this project are relevant to multiple projects proposed for the 2025/26 Research Plan, and we intend to make our results available for use in other projects as we produce them. This will advance the impact of our project outputs to multiple other stakeholders of the NESP2 CSH.

Is this a cross-hub project?

No. But it we will explore how outputs may link to RL Hub – Enhancing climate-adaptation responses in regional NRM planning by incorporating resilience investment

Does this project contribute to a cross-cutting initiative?

Yes, this project contributes to 2 of the Climate Adaptation Initiative outcomes listed in the Climate Adaptation Initiative Strategy as follows:

- Strong end-user capacity, uptake and application of evidence-based climate systems research and adaptation information (Synthesise, communicate, disseminate)
- Decision support tools are delivered that enable application of climate change adaptation on the ground (Planning and decision support)

Many decision-makers are looking to understand their future climate risk in considering how to respond. They seek greater confidence in projections and useable information. This does not necessarily mean greater statistical confidence, but rather a clear and synthesis expression of the multiple lines of evidence and a clearer picture of where the science is at communicated in a way that fits the context of decision making.

The project will work closely with specific decision-makers to understand the context of their decisions a (Activity 1) and how that translates into fit-for-purpose climate information (Activity 3).

Indigenous consultation and engagement

The project meets the following revised Three Category approach:	**Category 1** Indigenous led ☐	**Category 2** Co-design ☐	**Category 3** Communicate ☒

This project is a category 3 project under the updated NESP 3 category approach.

This project is aligned to the hub's Indigenous partnerships strategy and adheres to the NESP Indigenous Partnership Principles. These principles will strengthen relationships but also foster positive Indigenous engagements. These engagements will allow for trust, transparency and respect to be strengthened over time. The adoption of these approaches will ensure maintenance of appropriate Indigenous engagement throughout the project's lifecycle, and that the project legacy is available to communities engaged with, and more widely as suitable. Project Indigenous engagement will be measured through the hub's monitoring and evaluation framework and process.

Every Indigenous community in Australia is different. Informed partnership processes reflect responsible and transparent engagement underpinned by Indigenous people having the right to their Indigenous Cultural and Intellectual Property (ICIP), and Free, Prior and Informed Consent (FPIC).

The incorporation of the updated NESP 3 category approach to Indigenous partnerships - Indigenous led, Co-Design and Communicate - during the engagements will optimise the project outcomes and outputs thus allowing for project success to be achieved.

The Climate Systems Hub in partnership with the National First Peoples Platform on Climate Change have called for collaboration with climate scientists. This request is for, but not limited to, current understanding and future projections of seasonal patterns that are impacting or anticipated to impact both natural and cultural indicators within Indigenous knowledge systems.

The project team will seek advice from the Platform to consider pathways through which to communicate the outcomes of this research which may include via organisations suggested by DCCEEW. We note that the Platform has existing links to the Indigenous Desert Alliance and SEED (who participated in the Gathering).

The scientific field work (outside scope of this project) conducted through the various communities will provide valuable data for Indigenous people, thus allowing for adaptation measures to be implemented in caring for Country. Incorporating the National First Peoples Platform on Climate Change in elements of the co-design process will support scientists in the development of specific case-studies.

Project milestones

Milestones	Due date	Responsible person
Milestone 1 – Project workplan approved by CS Hub leader	1 Feb 2025	Sugata Narsey
Milestone 2 – Co-design workshop with primary co-design stakeholder groups	15 April 2025	Sugata Narsey
Milestone 3 – Co-design documented outputs	15 May 2025	Sugata Narsey
Milestone 4 – Drafted desktop review of gaps in projections	15 June 2025	Sugata Narsey
Milestone 5 – Initial delivery of new scenario information to stakeholders via outreach activities (for example, workshop/webinar)	15 Jan 2026	Sugata Narsey
Milestone 6 – Technical report on process-based evaluation of climate models for conditional storylines	15 Jan 2026	Sugata Narsey
Milestone 7 – Technical report detailing project outputs on new projections scenarios and conditional storylines	15 Sept 2026	Sugata Narsey
Milestone 8 – Capacity building activity to uplift stakeholder usage of new scenario information	15 Nov 2026	Sugata Narsey

Data and information management

The project will take an approach to ensure all outputs meet the FAIR data principles – Findable, Accessible, Interoperable, and Reusable – in conjunction with the CARE principles for any Indigenous Cultural and Intellectual Property (ICIP) – Collective benefit, Authority to control, Responsibility, and Ethics. Together, these aim to ensure all data are easily shared and reused, but also used ethically. The project will adhere to principles of ICIP and acknowledge data sovereignty elements in all project outputs for any ICIP.

A data management plan will serve as a record of all datasets and other information used as inputs and outputs for the project, including any models and code/software. The plan will ensure consideration has been given to how the data associated with the project will be managed and that appropriate resources are devoted to data management.

The *NESP data and information guidelines* and the Climate Systems Hub Data Management Strategy detail the fundamental approach to data management and the many aspects projects need to consider, including dealing with ICIP. The Data Wrangler will provide any guidance needed by the Project Lead and the project's Data Custodians.

FAIR Data Principles

While it is acknowledged that projects will not know all the details at the outset, how and where project outputs will be made freely and openly available needs to be considered. Different types of data and information will require different approaches. The principles of the Data Management Strategy on how different data types will be managed are summarised in the following table, noting that not all data types are applicable to every project.

Project output	Data management and accessibility
All data/information products	• Research data and outputs will be well-documented according to accepted and trusted standards, including principles of ICIP. A key requirement for all research products generated by the hub research will be following metadata standards based on accepted best practice • Data will be made publicly available whenever legally, ethically and contractually possible, under an open licence policy except in particular cases, with particular. A record of these exceptions will be kept, and exceptions reported regularly to the Department • Data and other research output will be stored in repositories that are accessible to end-users and other researchers, with the choice of repository based on practicalities of the data and its likely use, and stored in such a way as to endure and remain FAIR well beyond the life of the project • The project will develop its own data management plan, with identified data custodians responsible for managing the data • The nature of research outputs, their formats and repositories, will be developed through a co-design

Project output	Data management and accessibility
	process involving stakeholders and end-users to ensure data meet their requirements and are fit-for-purpose, and will evolve through ongoing consultation • Research outputs and data will be accompanied by documentation providing guidance to users on how best to make use of the data • The hub will maintain a metadata catalogue of all research data, and all metadata will be published on other public metadata catalogues • Outputs such as websites will follow the Web Content Accessibility Guidelines (WCAG), and include an accessibility statement.
Scientific publications and reports	• Publications and reports will be made available through the CS hub website and/or appropriate peer-reviewed scientific journals.
Application ready data sets	• To be published in public repositories. • Data services made available to enable ingestion into end-user models and decision-support tools.
End-user products	• Published in appropriate medium such as print or a scientific journal. • Captured in metadata catalogues. • A copy will be stored on the hub website for public access.
Raw research data	• Stored on infrastructure where generated and where they can be shared, as appropriate under ICIP considerations, with other researchers.

Location of research

The table below describes the scale at which the project will be working, and the location(s) where the majority of the project research will be conducted.

At which spatial scale is the project working	**National** ☒	**Regional** ☐	**Local** ☐
Location(s) – gazetted region /place name	Most activities will be desktop analysis conducted across various offices across Melbourne and Sydney		
Aboriginal or Torres Strait Islander nation or traditional place name(s)	Project members will work out of Naarm and Sydney on the lands of the Bonorong and Wurundjeri of the Kulin nation, and Bidjigal (UNSW Kensington campus) and Gadigal (UNSW City and Paddington Campuses).		

Project-specific risks

Risk	Potential impact on project	Likelihood (rare, unlikely, possible, likely, highly likely)	Consequence (minor, moderate, high, major, critical)	Risk rating (low, medium high, severe)	Treatment to reduce or manage risk
Poor end user information adoption	Impact realisation will be limited	Possible	Moderate	Medium	End user evolvement in co-design process. KB work closely with end users Adopt change management processes
Schedule slippage	Project deliverable delays	Possible	Moderate	Medium	More time allocated to planning project Establish a high performing team early in the project lifecycle. Limited the scope of the project to a few selected uncharted futures that we have capacity to investigate.
Change of direction for ACS	Codesign and Translation components reduced in scope	Possible	Moderate	Medium	Regular interaction and coordination at the scientist level, as well as at the management level of both programs.
Staff turnover	Project deliverable delays or	possible	Moderate	Medium	Clear link between outputs and individual staff in the work plan. Regular

Risk	Potential impact on project	Likelihood (rare, unlikely, possible, likely, highly likely)	Consequence (minor, moderate, high, major, critical)	Risk rating (low, medium high, severe)	Treatment to reduce or manage risk
	requested changes				interaction with project manager on timelines and progress.

Project keywords

Climate projections, climate change scenarios, tipping elements, storylines, climate risk.

Project CS5.4 – Projection verification

Project type: • Hub research project	
Project status: • New project submitted for approval	
Cross-cutting initiative:	No
Project start date: 01/01/2025	**Project end date**: 31/12/2026
Total project budget: $2,139,828 (GST exclusive)	**NESP funding:** (GST exclusive) 2025 $544,518 2026 $556,961 **Co-contributions (cash and in-kind):** (GST exclusive) 2025 $513,420 2026 $524,930
Project leader details:	Name: Pandora Hope Organisation: Bureau of Meteorology Phone: Email: pandora.hope@bom.gov.au Name: Surendra Rauniyar Organisation: Bureau of Meteorology Phone: Email: surendra.rauniyar@bom.gov.au
Project summary Global and regional climate models are used to understand the climate hazards and extreme events that we should prepare for in our future, warmer world. These determinations assume that the climate models are correctly simulating the climate processes (for example, SAM, ENSO), and how these processes affect climate extremes and hazards (for example, extreme rain, tropical cyclones). This project goes a step beyond simulating global climate change and assesses these assumptions. It will examine the change in the details of the frequency and properties of the trends, hazards and extreme events we need to understand and plan for in our future climate.	

Pathway to impact

Outcomes
The findings from this project, with other Hub projects, will provide model evaluation and understanding to other research-users that use climate model projections in the Hub and more widely, including the Australian Climate Service. This will mean that community confidence in projections for Australia will improve. Through case studies - developed from discussions with end-users - this project will also increase the awareness of climate in the experience of recent extremes to ensure community, governments, ecosystem managers and industry are well informed. Ultimately, the suite of research of the Climate System's Hub provides enhanced understanding of how Australia's weather and climate is changing and why. Together with the Australian Climate Service, findings should incorporate climate risk responses into legislation and planning tools to enable informed change across many areas, including in ecological management, infrastructure location and design, timing of asset upgrades, and improved emergency response. Specifically, climate model experiments (including with corrected biases), trend analysis, driver component evaluation will underpin these outcomes. Results from the specific case-studies will inform the current and future state of risk of extreme rainfall events in eastern Australia for RL Hub project 3.19, and rainfall linked to tropical cyclones across the north shared with DWER and WA Climate Science Initiative and their stakeholders. The research findings will further inform ACS, NCRA and DCCEEW on the current and future state of risk of multi-year wet/dry periods and extreme rainfall events across Australia and be shared via webinars, reports or papers.

Research-user	Engagement and communication	Impact on management action	Outputs
WA Department of Water and Environmental Regulation (DWER) and WA Climate Science Initiative	– Very interested in flooding linked to tropical cyclones such as tropical cyclone Ellie or Jasper. Could it be more extreme in future? Can our projections capture the changing intensity of a Tropical Cyclone/Low?	Information about changes to intense tropical rainfall can be drawn from multiple sources. This project will add to those, enhancing the confidence in projected changes. Will the warming land surface influence the rainfall extent or track	Milestones 6, 8 and 9

Research-user	Engagement and communication	Impact on management action	Outputs
	The latitude of the Antarctic polar jet can influence the state of the Southern Annular Mode (SAM) which is very important for south-west WA rainfall trends. We will continue conversations as we develop the experimental design. Regular quarterly meetings, including sharing of methods, results and department needs.	of the storm? Is associated rainfall more extreme? Will a correction to the latitude bias of the Antarctic polar jet have implications for the trend towards high SAM and lower rainfall in south-west WA? These findings may reveal a different projected future for the south-west.	
Australian Climate Service(ACS) Methods2Service Team	ACS – link to UNSEEN, attribution for services and decision makers. What is the most extreme rain possible in the models?	Under ACS, methods are being developed to quantify the climate risk now and in the future. Currently, large climate model ensembles are used. Maps of attributed trends across Australia – highlighting the contribution from internal variability and climate change.	Milestones 3 and 5
ACS Flood hazard Teams	Keep the team aware of Climate Systems Hub activity in this space to ensure linkages are maintained.	As needed, the ACS team can incorporate our findings. They can inform us of any emerging needs or significant events.	Milestones 3, 4, and 6
Resilient Landscape Hub Project 3.19. Climate-resilient landscapes: an adaptation case study in NSW's Northern Rivers region	Northern Rivers – what are the most extreme floods? Are these linked to La Nina? If not, are they linked to the latitude of the jets? If those are wrong in the climate models, what does that mean for rain here?	In consultation with Resilient Landscape Hub, and other CS Hub projects, provide information about the drivers of importance for rainfall on the east coast. This will inform planning, and longer-term ecosystem and	Milestones 9 and 10

Research-user	Engagement and communication	Impact on management action	Outputs
		infrastructure planning.	
DCCEEW (Leanne Haupt, NAPO)	Regular project updates (biannially?)	Improvements in climate models will inform national level risk assessments and adaptation planning	- Milestones 1, 2, 7, and 11
Additional outputs Peer reviewed papers			

Project description

Project description

Flooding of the Fitzroy River in January 2023 was the largest on record and exceeded the previous 1 in 100 average recurrence interval for the Fitzroy Valley. The floodplain extended out more than 10 kilometres for 300 kilometres downstream of Fitzroy Crossing and caused significant impacts. On the other side of Australia, in the Northern Rivers region of the east coast in NSW, extreme flooding in recent years led to loss of lives and livelihoods. Flooding events like these are due to heavy rainfall – *is rainfall getting heavier, are storms moving more slowly, is this the new normal, or will the next storm be even more intense?* Current research-users (for example, Wet22 surveys, DWER/WA CSI, RL Hub, NEMA/ACS, Attribution surveys) are keen to know answers to questions like these.

Climate change can influence the intensity and frequency of rainfall events, the trends and also La Niña and the phase of SAM. How might those changes affect recent and future rainfall extremes and their impacts? Results from this project, combined with other research across the Hub, will inform climate modellers and those assessing climate risk including ecosystem and flood managers, government and remote communities.

Building on science developments and stakeholder engagement through NESP CS Hub to date, clear gaps and opportunities have been identified. The scope for this project is to apply attribution methods developed under Project 2.6 (Extreme Events Explained) more broadly for climate model evaluation and forecast validation. Global climate models (GCMs) are a powerful tool to help answer these questions about rainfall and their projections, however they have some important limitations. There are several approaches to assess whether the projections are reliable:

3) Assess aspects of the modelled Historical climate against observations or reanalyses (trends or events).
4) Assess linkages of Australian rainfall to large-scale modes of variability like La Niña or Southern Annular Mode (SAM).
5) Compare patterns of change with known responses to forcing – for example, greenhouse gases, aerosols, ozone hole.
6) Physical understanding of the influence from limitations and biases (for example, positioning of the polar jet high above Antarctica) in the models.

This project will use these approaches to address challenges specific to the Australian context by:

- Firstly describing, Australia-wide, where the climate models capture observed rainfall or temperature trends, the contributions from climate change (greenhouse gases vs aerosols) and where and why the trends are modelled well, or are lacking.
- Similarly, examine, Australia-wide, where large-scale modes of variability like La Niña are important for rainfall extremes, but also identify where other factors are at play, and where the greatest hazard risks are.

- Examine observed co-designed case-studies of extremes to describe the contributions from land-surface interactions, climate change, or La Niña – for example, Tropical Cyclone Jasper/Ellie.
- Run experiments to examine known biases in the jet positions that then influence the future trend of the SAM, which affects south-eastern Australian climate variability and change. These experiments will inform our confidence in the future interactions between SAM and La Niña? What does the projected high phase of SAM mean in the context of these biases?

Case studies

Utilise contextualisation and attribution methods to examine the influences from weather, modes of variability and climate change on events nominated of interest by NESP research users, for example, heavy rainfall across eastern Australia; rainfall linked to Tropical Cyclones (For example, TC Jasper/TC Ellie).

We will identify recent rainfall extremes of concern, and through observational- and model-based research characterise any trends, the influences from the land surface, La Niña, the Southern Annular Mode (SAM) and the role of climate change.

Further development is needed on each of the methods to analyse those specific events - current methods used for temperature extended to hydrological variables; Use ACCESS-MICAS to understand the changing dynamics and links to soil moisture and temperature; Develop more robust quantification of the influence of La Niña and SAM on extreme rainfall, including under a La Niña-like future from Project CS5.3 Uncharted Climate Futures or when the model bias in the polar jet latitude is corrected.

Attribute trends and changing likelihoods

Detecting trends in rainfall and attributing the causes of those trends is made easier in high-resolution data – apply detection event and trend attribution techniques in various datasets, possibly including those developed under ACS and WA CSI as they become available.

Climate modelling

Support understanding of sources of forecast skill and climate model biases. For example, the novel use of modelling frameworks such as ACCESS-MICAS allows the exploration of the projected trend to high SAM. Many climate models incorrectly position the Antarctic stratospheric jet. Using ACCESS-MICAS, we will explore the impacts of this bias, and what it means for future east-coast and south-west WA rainfall. Inform ACS via regular meetings.

In the last 5 years the Antarctic stratospheric polar vortex has experienced extraordinary variability, significantly impacting the SAM anomalies and associated eastern Australian warm season rainfall anomalies. Therefore, understanding how the polar vortex and its downward impact will change in the future is an important research topic. The CMIP6 models suffer from significant biases in the location of the winter stratospheric jet and its seasonal progression, which is a source of uncertainty for understanding the polar vortex and its impact changes in the future. As ACCESS-MICAS, a system developed in earlier phases of the CS Hub, generally has less mean biases, we will use this system to understand the future changes of the stratospheric processes and their impact on the Southern Hemisphere circulation and Australian rainfall.

Links to other Hub research Project leads and researchers are aware of the linkages to other projects and we will continue to work closely with each other to broaden the influence of the findings from this project. For instance, within the NESP Climate Systems Hub, the 5.7 High-resolution rainfall project will address limitations in modelling convection using high-resolution modelling. The project 5.6 Compound events will identify important compound or drought-breaking rain events and associated weather systems. These could form further case-studies to examine here, or they could draw on our experimental results to explore how the correction of model biases might influence those rainfall events in models. Similarly, the connections to La Nina might change under the potential La Nina-like future to be explored in CS5.3 Uncharted Climate Futures project. Collaborations to draw on expertise around tropical cyclones will also be sought.

Key Project Outputs

These analyses will result in four key outputs:

1) Quantify expected changes in risk of rain events for specific regions around Australia that have high flood risk – from both climate change and phase of other drivers.
2) Nation-wide, identify trends in rainfall and quantify the contribution from climate change.
3) Report/paper on influence of land surface on rainfall and track of extreme storms linked to each case study; Link to Impacts (working with Research User); Webinar or targeted presentations to share findings.
4) Examine how improved jet location affects each case study

We will also continue to develop MICAS systems.

For future development – this project will underpin discussions that could lead to future work beyond the scope of this project, for example:

- Use these techniques in ACS-developed datasets
- Assist in developing downscaled, naturalised climate model simulations
- Attribute changes in sea level and marine heatwaves
- Attribute flood directly and attribute impacts
- Extend the application of attribution techniques to model and forecast validation packages
- Address other needs as co-design and discussions continue

Is this a cross-hub project?

No, but links to RL Hub Northern Rivers project Climate-resilient landscapes: an adaptation case study in NSW's Northern Rivers region

Does this project contribute to a cross-cutting initiative?

No.

Indigenous consultation and engagement

The project meets the following revised Three Category approach:	**Category 1** Indigenous led ☐	**Category 2** Co-design ☐	**Category 3** Communicate ☒

This project is a category 3 project under the updated NESP 3 category approach.

This project is aligned to the hub's Indigenous partnerships strategy and adheres to the NESP Indigenous Partnership Principles. These principles will strengthen relationships but also foster positive Indigenous engagements. These engagements will allow for trust, transparency and respect to be strengthened over time. The adoption of these approaches will ensure maintenance of appropriate Indigenous engagement throughout the project's lifecycle, and that the project legacy is available to communities engaged with, and more widely as suitable. Project Indigenous engagement will be measured through the hub's monitoring and evaluation framework and process.

Every Indigenous community in Australia is different. Informed partnership processes reflect responsible and transparent engagement underpinned by Indigenous people having the right to their Indigenous Cultural and Intellectual Property (ICIP), and Free, Prior and Informed Consent (FPIC).

The incorporation of the updated NESP 3 category approach to Indigenous partnerships - Indigenous led, Co-Design and Communicate - during the engagements will optimise the project outcomes and outputs thus allowing for project success to be achieved.

The Climate Systems Hub in partnership with the National First Peoples Platform on Climate Change have called for collaboration with climate scientists. This request is for, but not limited to, current understanding and future projections of seasonal patterns that are impacting or anticipated to impact both natural and cultural indicators within Indigenous knowledge systems.

The project team will seek advice from the Platform to consider pathways through which to communicate the outcomes of this research which may include via organisations suggested by DCCEEW. We note that the Platform has existing links to the Indigenous Desert Alliance and SEED (who participated in the Gathering).

The scientific field work (outside scope of this project) conducted through the various communities will provide valuable data for Indigenous people, thus allowing for adaptation measures to be implemented in caring for Country. Incorporating the National First Peoples Platform on Climate Change in elements of the co-design process will support scientists in the development of specific case-studies.

Project milestones

Milestones	Due date	Responsible person
Milestone 1 – Project workplan approved by the NESP CSH program management team	15 March 2025	Pandora Hope, Surendra Rauniyar
Milestone 2 – Internal NESP CS Hub extreme rain needs/events NESP survey – KB, comms, Adaptation and researchers. Summary of findings provided to participants.	15 May 2025	Helen Bloustein/ Pandora Hope / Surendra Rauniyar
Milestone 3 – Draft literature describing the interactions between the polar vortex and 3 consecutive La Niña events of 2020–2022	15 August 2025	Eun-Pa Lim/ Lynn Zhou
Milestone 4 – Paper and summary Explainer highlighting regions where La Nina and other climate drivers are a significant contributor to intense rainfall throughout the year, and times and places where they have little effect	15 October 2025	Peter van Rensch
Milestone 5 – Presentation on attribution of multi-year dry and wet events and their future likelihood	15 March 2026	Surendra Rauniyar/ comms
Milestone 6 – Drafted literature on the influence of land temperature and moisture on the track and rainfall of a severe storm	15 July 2026	Lynn Zhou/ Sharmila Sur/ Pandora Hope
Milestone 7 – Rainfall modelling webinar or tailored presentation to share findings with interested stakeholders	15 September 2026	Pandora Hope/ Comms / Helen Bloustein
Milestone 8 – Drafted literature of attribution of rainfall trends over Australia plus climate model strengths/concerns, and communication product	15 September 2026	Surendra Rauniyar
Milestone 9 – Drafted literature on rainfall over Australia from corrected jet position experiments and communication product	15 September 2026	EunPa Lim/ Lynn Zhou
Milestone 10 – Provide and present Australian regional maps of rainfall and temperature compound hazards from climate drivers showing high-risk regions across Australia	15 October 2026	Peter van Rensch
Milestone 11 – Synthesis report	15 December 2026	Pandora Hope/ Surendra Rauniyar and project team

Data and information management

The project will take an approach to ensure all outputs meet the FAIR data principles – Findable, Accessible, Interoperable, and Reusable – in conjunction with the CARE principles for any Indigenous Cultural and Intellectual Property (ICIP) – Collective benefit, Authority to control, Responsibility, and Ethics. Together, these aim to ensure all data are easily shared and reused, but also used ethically. The project will adhere to principles of ICIP and acknowledge data sovereignty elements in all project outputs for any ICIP.

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Project output	Data management and accessibility
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Aboriginal or Torres Strait Islander nation or traditional place name(s)	Project members will work out of Naarm on the lands of the Bunurong and Wurundjeri of the Kulin nation		

Project-specific risks

Risk	Potential impact on project	Likelihood (rare, unlikely, possible, likely, highly likely)	Consequence (minor, moderate, high, major, critical)	Risk rating (low, medium high, severe)	Treatment to reduce or manage risk
Schedule slippage	*Project deliverable delays*	*Possible*	*Moderate*	*Medium*	*More time allocated to planning project* *Establish a high performing team early in the project lifecycle.*
Staff Turnover	*Inability to complete key sections of the project, depending on which staff are allocated to the project.*	*Possible*	*Moderate*	*Medium*	*Ensure communication of the value of the project to senior managers. Maintain a great working environment with interesting interactions and exciting science.*

Project keywords

Climate model evaluation, rainfall, circulation, attribution, land-surface interactions

Project CS5.5 – Impact of marine heatwaves on coastal resources of southeast Tasmania

Project type: • Hub research project	
Project status: • New project submitted for approval	
Cross-cutting initiative:	Yes Protected places Threatened & migratory species and threatened ecosystems
Project start date: 01/01/2025	**Project end date**: 31/12/2026
Total project budget: $1,003,655 (GST exclusive)	**NESP funding:** $ (GST exclusive) 2025 $179,007 2026 $184,162 **Co-contributions (cash and in-kind):** $ (GST exclusive) 2025 $316,235 2026 $324,251
Project leader details:	Name: Julio Salcedo Castro Organisation: University of Tasmania Phone: (03) 6226 2973 Email: julio.salcedocastro@utas.edu.au

Project summary

Marine heatwaves are becoming more prevalent due to climate change, posing grave threats to the fishery and aquaculture industry and challenging environmental managers. This project aims to increase our understanding of how Australia's coastal areas that sustain fisheries and aquaculture will respond in a warming climate where marine heatwaves (MHWs) are becoming more impactful on habitats and species.

We will present three case studies in southeastern Australia combining in situ observations, ultra-high resolution model outputs and particle tracking for investigation of larval dispersion and settlement of key species. Each case study will provide the industry and environmental managers with guidance for management and decision-making, based on more detailed baseline information on coastal MHWs and assessment of possible conditions associated with future climate change scenarios.

Pathway to impact

Outcomes
This project will contribute to an integrated vision of the impact of marine heatwaves on coastal ecosystems and increase awareness of the local effects of climate change on Australia's coastal communities. Sector specific outcomes include: Fisheries: • Identification of retention areas and zones for lobster larvae and estimation of the hazard associated with MHWs (intensity, frequency). • Estimation of the projected influence of MHWs on the long-spined sea urchin larvae extension, connectivity and spread along Australia's southeast coastline under conditions associated with future climate scenarios. Aquaculture: • Increased understanding and capacity for aquaculture managers to interpret local and large-scale environmental conditions to guide long-term management decisions. • More reliable information on historical MHW distribution and intensity to understand the impact on season-specific activities, for example, harvest, feeding, stock movement, etc. • Contribute to better planning for upcoming MHWs and increased level of awareness and preparedness. Environmental/ecological monitoring/impact: • Zoning of vulnerable areas according to MHW characteristics and local circulation/topographic conditions to balance natural and commercial values. • Identification of potential impacts of MHW on already low dissolved oxygen conditions in estuaries. • Information to engage with and present findings to community (for example, Derwent Estuary Program) and improve awareness about the vulnerability of estuaries. • Evaluate the potential ecological impact of southward spreading of long-spined sea urchin larvae under MHW influence.

Research-user	Engagement and communication	Impact on management action	Outputs
Salmon Tasmania (Technical Director)	Engaged in the development of project. Provided access to dataset during the first part of NESP project on MHW. Research findings and project updates	Results will: Contribute to Climate Change Plan. Future operational and management considerations assisted through updates and outputs of project for example, stock movements, new	Reports and co-designed factsheets to communicate impacts of MHWs. Guidance to interpret environmental indicators that are associated to marine heatwave occurrence.

Research-user	Engagement and communication	Impact on management action	Outputs
	will be provided by quarterly project update emails and periodic meetings. Feedback and suggestions from research users will inform future iterations of research. Provide additional data from other regions around the state as it relates to broader project.	season inputs, locations of focus etc. Animal Health departments will rely on this information in different areas of the state. Contribute to improve planning of relevant diet changes and reduce risks in relation to marine heatwaves occurrence. Project information will be used in relation to regulatory monitoring programs and unusual findings in ongoing broadscale monitoring programs.	Webinars.
Oyster Tasmania (Industry Development Office)	Engaged in the development of project. Provided access to dataset during the first part of NESP project on MHW. Research findings and project updates will be provided by quarterly project update emails and periodic meetings. Feedback and suggestions from research users will inform future iterations of the research.	Results will: contribute to Oyster Tasmania Climate Change Plan. Build capability to interpret local and large-scale environmental conditions to guide long-term management decisions. Inform timing for specific adaptation activities	Milestone 2/3/6 Reports and co-designed factsheets to communicate impacts of MHWs. Guidance to interpret environmental indicators that are associated with marine heatwave occurrence. Webinars or tailored presentations.
Derwent Estuary Program	Engaged in the development of project. Provided access to dataset during the first part of	Results will contribute to improve the Monitoring and Science Program.	Milestone 2/3/6 Reports and co-designed factsheets to communicate impacts of MHWs.

Research-user	Engagement and communication	Impact on management action	Outputs
	NESP project on MHW. Research findings and project updates will be provided by quarterly project update emails and periodic meetings. Feedback and suggestions from research users will inform future iterations of the research.		Guidance to interpret environmental indicators that are associated to marine heatwave occurrence.
Department of Natural Resources and Environment Tasmania	Engaged in the development of project. Research findings and project updates will be provided by quarterly project update emails and periodic meetings. Feedback and suggestions from research users will inform future iterations of the research.	Results will provide scientific basis to complement the Marine Farming Development Plans and may contribute to strategies that will help build resilience and adaptation opportunities for wild fisheries	Milestone 2/3/6 Reports and co-designed factsheets to communicate impacts of MHWs, including potential hazards for other species like Tasmanian Rock lobster. Guidance to interpret environmental indicators that are precursors to marine heatwave occurrence.
DCCEEW Oceans and Wildlife Branch and Environment Data and Analysis Branch, Biodiversity Conservation Division	Research findings and project updates will be provided by quarterly project update emails and periodic meetings	Exploring the applicability of this research to several marine species to help inform the recovery strategies.	Milestone 2/3/6 Co-designed factsheets and data to communicate impacts of MHWs, including potential hazards for other species like Tasmanian Rock lobster.
Fisheries Branch, Department of Agriculture, Fisheries and Forestry	Research findings and project updates will be provided by quarterly project update emails and periodic meetings	Exploring the applicability of this research inform the development of commercial sea	Milestone 2/3/6 Co-designed factsheets and data to communicate impacts of MHWs.

Research-user	Engagement and communication	Impact on management action	Outputs
		urchin fishery in Tasmania	
Additional outputs • Webinars and tailored presentations • Plain English communication products • Peer reviewed papers			

Project description

Project description

The problem

Fisheries and aquaculture are a 3.4-billion-dollar industry in Australia, with export values led by salmonids and abalone and an aquaculture sector employing 7,000 people. The oceans around Australia are warming rapidly due to climate change, impacting on the coastal ecosystems and the biodiversity. Some impacts include a significant decline of the giant kelp and a poleward extension of the long-spined sea urchin. One of the impacts of climate change are marine heatwaves, which have had devastating effects on Australian coastal waters.

Marine heatwaves can have negative effects on organisms that sustain important fisheries and the aquaculture industry. They can affect the physiology of some species, including changes in aquatic metabolism (that is, production and respiration), reproduction, growth rate and resistance to diseases. Ecological effects may include predator-prey interactions, shifts in community composition to heat tolerant organisms, and increased spatial distribution and competition with exotic species. For instance, some harmful algal blooms have been associated with the occurrence of MHWs. However, in contrast to oceanic regions, MHWs on the inner continental shelf are much less understood, because large scale remote sensing and climate models do not properly represent the coastal conditions and, therefore, field observations and high-resolution models are more appropriate to study the impact of MHWs in coastal and estuarine areas. A further complication for the inner continental shelf is co-occurrence of hazards. For instance, a recent study described the combined effect of heatwaves with lower dissolved oxygen and pH events in United States estuaries, demonstrating the co-occurrence of atmospheric and estuarine hazards.

The project seeks to better characterise the baseline marine heatwave hazard as a critical component of baseline risk for marine species in Tasmania's southeast region. Risk for marine species from marine heatwaves comprises understanding the hazard (that is, marine heatwave characteristics, including changes in frequency, duration, intensity, cumulative intensity) and species exposure to the hazard: species sensitivity + adaptive capacity = their vulnerability. This project does not seek to characterise overall species risk, as these risks are species-dependent, based on their sensitivity and adaptivity (adaptive capacity). Rather, we seek to develop a baseline of the marine heatwave hazard for the D'Entrecasteaux Channel, Huon and Derwent estuary systems based on historical ultra-high-resolution simulations evaluated against available in situ observations. This information will be of enormous value to fisheries, aquaculture and marine biodiversity conservation management as they will be much better placed then to investigate the potential vulnerability of their species with appropriate knowledge of the marine heatwave hazard spatial and temporal variability. Importantly, this project will provide critical information for those projects examining adaptation of marine species, including in the NESP Marine and Coastal Hub, which focuses on marine ecosystems and species.

This project is a priority as we do not have appropriate baseline information about marine heatwaves and the hazard they present in the coastal zone where there is a dearth of observations. The coastal zone is highly complex, with rich biodiversity, fisheries and aquaculture operations, as well as human pressures on estuarine systems. Changes in

coastal currents and water conditions under the influence of marine heatwaves and long-term ocean warming threaten larval survival and settlement of recruits in currently productive fisheries.

How the research will be undertaken

This project will focus on the coastal response to MHWs on the eastern and southeastern coasts of Tasmania. This region is characterised by a latitudinal range and geographic patterns that include open coastal areas, semi-enclosed systems, and estuarine areas. In this geographic setting, this project will focus on three different aspects of MHW impacts: the impact on the rapid distribution of a benthic species, the larval survival and connectivity and the impact on the estuarine physics.

We will combine *in-situ* observations, satellite remote sensing and high-resolution modelling in the coastal zone to characterise the spatial patterns and time evolution of marine heatwaves. A particle-tracking model will simulate the larval dispersion and survival of Eastern Rock Lobster and Long-spined Sea Urchin under conditions in the historical record to draw conclusions on possible future climate scenarios. This approach could be replicated in future for other commercial species, such as the Southern Rock Lobster, which our fisheries collaborators at IMAS are studying. The geographic differences will allow an intercomparison and contribute to a better understanding about the impact of MHWs on regional coastal areas and the potential implications under climate change.

The project will use a range of model simulations, including a global ocean model and finer-scale regional and coastal model outputs, to examine the forcing and response to coastal marine heatwaves. The project will take advantage of the Australian Community Climate Earth System Simulator suite of models which could be combined with CMIP6 historical and future climate projections to examine the impacts of the changing nature of marine heatwaves in coastal waters off southeastern Tasmania in future projects. For studies of the larval connectivity (Eastern Rock Lobster and Long-spined Sea Urchin), we will use a Lagrangian particle-tracking tool to model larval drift. Combining the simulated larval dispersion with the hydrodynamic fields from the models, validated against observations of species distributions, we will describe larval dispersion and survival under marine heatwave conditions in the historical period and under future climate scenarios.

We will use a combination of high-resolution model outputs and observations to study the response of Tasmania's estuaries (Huon estuary, Derwent estuary) to describe the evolution of MHWs. This approach will allow us to establish a baseline in terms of the impact of MHWs on the physical and environmental conditions in estuaries and their effects on variables like stratification and dissolved oxygen solubility.

Two coastal models and their simulations will be analysed, ETAS model and TASSE model. The Eastern TASmania (ETAS) ocean model was developed to simulate the hydrographic and hydrodynamic conditions of the nearshore and continental shelf waters off eastern Tasmania, over the 1993-2014 period. The model resolution ranges between ~1 to ~3.5 km on average. The model was forced and initialised with Bluelink ReANalysis and OceanMAPS analysis. The surface boundary forcing was obtained from the National Centers for Environmental Prediction (NCEP) Climate Forecast System Reanalysis and the Climate Forecast System Version 2 analysis.

The TASSE model was developed by CSIRO. This model has a curvilinear horizontal grid with a resolution from around 450 m on the offshore boundary to around 130 m in the upper reaches of the Huon and Derwent Estuaries. This model is run through a downscaling process using the Southeast Tasmania Model output (SETAS) as an intermediate step to link a global forcing to a local model (TASSE). SETAS open boundary forcing, and initial conditions are from the global OceanMAPS. Thus, the TASSE model open boundary conditions are from SETAS outputs, while the surface heat and freshwater fluxes are derived from the Australian Community Climate and Earth-System Simulator (ACCESS-R) (Australian Bureau of Meteorology, 2014). ETAS and TASSE models are based on the Sparse Hydrodynamic Ocean Code (SHOC) developed at the CSIRO Marine Laboratories in Hobart (Australia).

In the Huon Estuary-D'Entrecasteaux Channel, the model outputs will be complemented and compared with observations from the Broadscale Environmental Monitoring Program (BEMP) (2009-2023) and the Shellfish Market Access Program (ShellMAP). The Broadscale Environmental Monitoring Program (BEMP) was initiated in 2009 to provide knowledge and information on ecosystem function in the D'Entrecasteaux Channel and Huon Estuary. The program's objective was to document broad scale spatial and temporal trends for key environmental parameters, allowing assessment of the environmental effects of finfish aquaculture in the region. Water quality analytes include physico-chemical parameters (temperature, dissolved oxygen, salinity), nutrients, chlorophyll and cell count of phytoplankton species. Fifteen sites are included in the monitoring program, including nine sites in the D'Entrecasteaux Channel region, five in the Huon River/Port Esperance region and one control site at Recherche Bay. The Shellfish Market Access Program (ShellMAP) is a partnership agreement between the Tasmanian Government, Oysters Tasmania, and Seafood Industry Tasmania to ensure the safe harvesting of Tasmanian bivalve molluscs and abalone.

In the Derwent Estuary, the ETAS and TASSE model outputs will be complemented with the historical data from the Derwent Estuary Program (DEP), a partnership between the Tasmanian Government, local governments, industry, scientists, and the community. Similar to the BEMP program, the DEP was established in 1999 and is a comprehensive, integrated monitoring program that includes physical and chemical parameters (temperature, dissolved oxygen, salinity, nutrients, and chlorophyll), along with sediment and estuarine habitats and species.

This project will build on advances made in Project CS2.10 - Oceans and Coasts. These include the framework we developed in our previous marine heatwave hazard assessment, high-resolution, regional model simulations through the PhD project of John Reilly, and Lagrangian particle tracking methods (Roach et al., submitted to Geophysical Model Development). Together, these advances provide the groundwork to deliver a more refined and detailed characterisation of the marine heatwave hazard around southeastern Australia.

This project will also provide input to project CS5.10 via a Marine Heatwaves case study. The geographical focal point for this case study is still to be confirmed through a co-design process, but could include an area around the south-west coast of Western Australia. This

project team will participate in, and provide expertise to, a paper on the effects of marine heatwaves.

Is this a cross-hub project?

No. However as the project will provide critical marine heatwave hazard information in the D'Entrecasteaux Channel, Huon and Derwent Estuary systems, we can explore potential contributions to projects within the NESP Marine and Coastal Hub, in order to better develop risk analyses for marine species. A discussion has been held with Rebecca Morris - leader of project 5.10 in MAC Hub. Project MAC4.10 will consider climate change risks on the long term outcomes of nature repair work. Outputs from CS5.5 may be of use to this analysis. The project teams will continue exploring the options as both projects progress.

Does this project contribute to a cross-cutting initiative?

Yes. The project will contribute to the Threatened and Migratory Species and Threatened Ecosystems, and Protected Places Initiatives.

The project will focus on impacts of marine heatwaves on species and ecosystems important to both industry and the environment. Understanding these impacts is important managing threatened and migratory species, and threatened ecosystems, including those in protected places. The project team will engage with the Initiative leads to understand how results can be best delivered to their programs.

Indigenous consultation and engagement

The project meets the following revised Three Category approach:	**Category 1** Indigenous led ☐	**Category 2** Co-design ☒	**Category 3** Communicate ☐

This project is a category 2 project under the updated NESP 3 category approach.

This project will contribute to CS5.10: *Indigenous-led literature and products to inform national and international processes on climate action*, through co-design of themed case study work related to Sea Country in CS5.10, including contribution to Indigenous-led literature. The case study will have an Indigenous lead and a science lead as determined through the co-design process with CS5.10. Governance of the Indigenous engagement in this project will come through CS5.10 which is Indigenous-led.

This project is aligned to the hub's Indigenous partnerships strategy and adheres to the NESP Indigenous Partnership Principles. These principles will strengthen relationships but also foster positive Indigenous engagements. These engagements will allow for trust, transparency and respect to be strengthened over time. The adoption of these approaches will ensure maintenance of appropriate Indigenous engagement throughout the project's lifecycle, and that the project legacy is available to communities engaged with, and more widely as suitable. Project Indigenous engagement will be measured through the hub's monitoring and evaluation framework and process.

Every Indigenous community in Australia is different. Informed partnership processes reflect responsible and transparent engagement underpinned by Indigenous people having the right to their Indigenous Cultural and Intellectual Property (ICIP), and Free, Prior and Informed Consent (FPIC).

The incorporation of the updated NESP 3 category approach to Indigenous partnerships - Indigenous led, Co-Design and Communicate - during the engagements will optimise the project outcomes and outputs thus allowing for project success to be achieved.

The Climate Systems Hub in partnership with the National First Peoples Platform on Climate Change have called for collaboration with climate scientists. This request is for, but not limited to, current understanding and future projections of seasonal patterns that are impacting or anticipated to impact both natural and cultural indicators within Indigenous knowledge systems.

The scientific field work (outside scope of this project) conducted through the various communities will provide valuable data for Indigenous people, thus allowing for adaptation measures to be implemented in caring for Country. Incorporating the National First Peoples Platform on Climate Change in elements of the co-design process will support scientists in the development of specific case-studies.

This project will contribute to CS5.10 via ethics approval under CSIRO Social and Interdisciplinary Science Human Research Ethics Committee (CSSHREC 198/24 Climate Systems Hub – Indigenous-led literature and products to inform national and international processes on climate action

Project milestones

Milestones	Due date	Responsible person
Milestone 1 – Project workplan approved by the NESP CSH program management team	1 Feb 2025	Julio Salcedo-Castro
Milestone 2 – First research-user online informative meeting: Summary of project methodology, inputs and databases to be used along with expected project outcomes to be shared with participants.	31 March 2025	Julio Salcedo-Castro and project team
Milestone 3 – Co-designed factsheet and guidelines to interpret environmental indicators that are precursors to marine heatwave occurrence.	30 June 2026	Julio Salcedo-Castro and project team
Milestone 4 – Webinar to present co-designed factsheet and guidelines to interpret environmental indicators that are precursors to marine heatwave occurrence.	3 July 2026	Julio Salcedo-Castro and project team
Milestone 5 – Reports on larval connectivity under the present normal and marine heatwave conditions.	14 December 2025	Chris Roach and Helen Phillips
Milestone 6 – Webinar to present results on larval connectivity under the present normal and marine heatwave conditions.	18 December 2025	Chris Roach and Helen Phillips
Milestone 7 – written contribution to form part of CS5.10 case study work on marine heat waves	December 2025	Neil Holbrook
Milestone 8 – Report on marine heatwave hazard analysis for southeast Tasmania	30 June 2026	Neil Holbrook, Julio Salcedo-Castro and John Reilly
Milestone 9 –Final Project Report published and sent to research users	1 September 2026	Julio Salcedo-Castro
Milestone 10 – written contribution to form part of CS5.10 case study work on marine heat waves	September 2026	Neil Holbrook
Milestone 11 – Synthesis report approved by NESP CSH Project Management Team	15 November 2026	Julio Salcedo-Castro

Data and information management

The project will take an approach to ensure all outputs meet the FAIR data principles – Findable, Accessible, Interoperable, and Reusable – in conjunction with the CARE principles for any Indigenous Cultural and Intellectual Property (ICIP) – Collective benefit, Authority to control, Responsibility, and Ethics. Together, these aim to ensure all data are easily shared and reused, but also used ethically. The project will adhere to principles of ICIP and acknowledge data sovereignty elements in all project outputs for any ICIP.

A data management plan will serve as a record of all datasets and other information used as inputs and outputs for the project, including any models and code/software. The plan will ensure consideration has been given to how the data associated with the project will be managed and that appropriate resources are devoted to data management.

The *NESP data and information guidelines* and the Climate Systems Hub Data Management Strategy detail the fundamental approach to data management and the many aspects projects need to consider, including dealing with ICIP. The Data Wrangler will provide any guidance needed by the Project Lead and the project's Data Custodians.

FAIR Data Principles

While it is acknowledged that projects will not know all the details at the outset, how and where project outputs will be made freely and openly available needs to be considered. Different types of data and information will require different approaches. The principles of the Data Management Strategy on how different data types will be managed are summarised in the following table, noting that not all data types are applicable to every project.

Project output	Data management and accessibility
All data/information products	• Research data and outputs will be well-documented according to accepted and trusted standards, including principles of ICIP. A key requirement for all research products generated by the hub research will be following metadata standards based on accepted best practice • Data will be made publicly available whenever legally, ethically and contractually possible, under an open licence policy except in particular cases, with particular. A record of these exceptions will be kept, and exceptions reported regularly to the Department • Data and other research output will be stored in repositories that are accessible to end-users and other researchers, with the choice of repository based on practicalities of the data and its likely use, and stored in such a way as to endure and remain FAIR well beyond the life of the project • The project will develop its own data management plan, with identified data custodians responsible for managing the data

Project output	Data management and accessibility
	• The nature of research outputs, their formats and repositories, will be developed through a co-design process involving stakeholders and end-users to ensure data meet their requirements and are fit-for-purpose, and will evolve through ongoing consultation • Research outputs and data will be accompanied by documentation providing guidance to users on how best to make use of the data • The hub will maintain a metadata catalogue of all research data, and all metadata will be published on other public metadata catalogues • Outputs such as websites will follow the Web Content Accessibility Guidelines (WCAG), and include an accessibility statement.
Scientific publications and reports	• Publications and reports will be made available through the CS hub website and/or appropriate peer-reviewed scientific journals.
Application ready data sets	• To be published in public repositories. • Data services made available to enable ingestion into end-user models and decision-support tools.
End-user products	• Published in appropriate medium such as print or a scientific journal. • Captured in metadata catalogues. • A copy will be stored on the hub website for public access.
Raw research data	• Stored on infrastructure where generated and where they can be shared, as appropriate under ICIP considerations, with other researchers.

Location of research

The table below describes the scale at which the project will be working, and the location(s) where the majority of the project research will be conducted.

At which spatial scale is the project working	**National** ☐	**Regional** ☒	**Local** ☐
Location(s) – gazetted region /place name	The project will provide critical marine heatwave hazard information in the D'Entrecasteaux Channel, Huon and Derwent Estuary systems. Project team are based in Nipaluna and Naarm		
Aboriginal or Torres Strait Islander nation or traditional place name(s)	The project will be focused on Lutriwita		

Project-specific risks

Risk	Potential impact on project	Likelihood (rare, unlikely, possible, likely, highly likely)	Consequence (minor, moderate, high, major, critical)	Risk rating (low, medium high, severe)	Treatment to reduce or manage risk
Poor end user information adoption	*Impact realisation will be limited*	*Possible*	*Moderate*	*Medium*	*End user involvement in co-design process.* *KB work closely with end users* *Adopt change management processes*
Schedule slippage	*Project deliverable delays*	*Possible*	*Moderate*	*Medium*	*More time allocated to planning project* *Establish a high performing team early in the project lifecycle.*

Project keywords

Marine heatwaves, climate change, threatened species, aquaculture, climate risk

Project CS5.6 – Extreme rainfall in compound events

Project type: • Hub research project	
Project status: • New project submitted for approval	
Cross-cutting initiative:	Yes Climate Adaptation Initiative
Project start date: 01/01/2025	**Project end date**: 31/12/2026
Total project budget: $1,443,205 (GST exclusive)	**NESP funding:** (GST exclusive) 2025 $407,377 2026 $293,889 **Co-contributions (cash and in-kind):** (GST exclusive) 2025 $434,060 2026 $307,878
Project leader details:	Name: Acacia Pepler Organisation: Bureau of Meteorology Phone: 02 9296 1568 Email: acacia.pepler@bom.gov.au

Project summary

Research has highlighted that in Australia extreme rainfall is becoming more intense. But not all extreme rainfall events are the same, and some extreme events have much larger impacts on Australians. This might be when the rainfall covers a large spatial extent, when it interacts with other hazards such as extreme winds, or when several extreme events occur in close succession, including clusters of heavy rainfall events or rapid transitions between from periods of extreme drought and fire to periods of intense rainfall.

In this project we will work with stakeholders to understand the extreme rainfall events that matter most to them and identify a small number of case studies to pursue. Informed by these case studies, we will develop new metrics for the identified high impact compound rainfall events, and test their effectiveness with stakeholders in capturing the events which matter most. Using these new methods, we can map the occurrence of some types of high impact compound rainfall events across Australia, and assess how these critical events are changing. This will provide information that better resonates with the identified case study stakeholders and the decisions and plans they need to make

Pathway to impact

Outcomes
Via a number of case studies, the project will develop and deliver innovative definitions and risk hazard datasets of some types of temporally compounding and multivariate compound rainfall events associated with major impacts, such as drought-breaking rainfall events, clusters of extreme rainfall, and compound wet/windy events. The project will deliver new methods including well-documented code around the frequency and drivers of rainfall hazards of high impact to the case study communities, including compound and clustered rainfall events. These will be used to provide more detailed and useful maps and datasets of projected changes in hazardous rainfall events to support planning and decision-making. The case studies will be chosen via discussions with the Research Users listed below and the list narrowed accordingly.

Research-user	Engagement and communication	Impact on management action	Outputs
Climate Science DCCEEW	Engage in co-design to identify key case studies and rainfall hazard types. Identify opportunities to lead intercomparison projects through the National Partnership for Climate Projections Findings and outputs to be communicated via meetings, workshops, project update emails and presentations.		Milestone 8 & 12 Synthesis products and guidance notes on changes in impactful rainfall events
Other CS projects and other Hubs	Collaborate on identifying key case studies with the projection verification and extreme sub-daily rainfall products		TBC - Co-designed project plans and collaborative research, including providing data and guidance material

Research-user	Engagement and communication	Impact on management action	Outputs
	Methods developed in this project will be used to assess new modelling from the Projection Verification and Uncharted Futures projects Results feed into capacity-building and adaptation projects		produced by this project to them.
Australian Climate Service (ACS)	ACS models and expertise including the NCRA will inform projections in this project Methods and code developed in this project will be applied to ACS models and supplied to the ACS to support future NCRA work	Improved risk information on extreme and compound rainfall hazards available in ACS portals and documentation	Milestone 10 - Code and methods Datasets of future changes to feed into ACS data portals Model evaluation to support future regional model development
State, territory and local government groups in the water and emergency sectors *For example, WaterNSW and VIC DEECA (including VIC Catchment Management Authorities), as well as overlapping local government areas such as Gold Coast*, Noosa and/or Sunshine Coast	Engage in co-design through stakeholder workshops to identify key case studies and rainfall hazard types. Briefings of research progress and findings. Key partners identified to develop specific case studies of high local importance and advise on indices and methods	Future planning for water supply management that balances short-term flood control with longer-term storage to meet the needs of communities, industry and the environment. Flood and wet/windy emergency response measures that account for changing compound event hazards	Milestone 8 - Co-designed research outputs including data sets and synthesis reports to support planning and decision-making. TBC -Informing the Co-designed applications of future climate projections for decision-making (NEMA funded UTAS-led companion project)
Energy sector for example, Ausgrid	Engage in co-design through stakeholder workshops to identify	Planning for the location of future power infrastructure,	Milestone 8- Co-designed research outputs including

Research-user	Engagement and communication	Impact on management action	Outputs
	key case studies and rainfall hazard types. Briefings of research progress and findings.	which is sensitive to wet/windy events.	data sets and synthesis reports.
Current list of webinar attendees from session on extreme rainfall.	Subset of attendees engaged early in determining appropriate case studies. Developed indices/metrics circulated to full list for comment via a briefing note or webinar	With chosen users, a deep investigation into case study events including historical climatologies and identified long-term changes, to inform user in developing their adaptation options.	Milestone 8- Co-designed research outputs including data sets and synthesis reports.
Additional outputs • At least 3 research papers establishing new methods and the current state of specific high-impact compound events in Australia. • New methods and documented code, for easy adoption by secondary users, including the ACS and collaborators within academia • Presentations of research outcomes and implications for hazard and risk in both research forums (for example, AMOS) and forums relevant to key stakeholders, such as the MODSIM or HWRS for drought-breaking rainfall and flood hazard, or the Catastrophe and Risk Symposium for wet/windy compound events. • Plain English synthesis/summary of research findings for publication on hub website			

Project description

Project description

The negative impacts of extreme rainfall events are exacerbated when they occur in conjunction with a related hazard such as extreme winds (“multivariate compound event”) or occur as part of a series or cluster of individual events (“temporally compounding event”) such as drought-breaking rains. These compound extreme rainfall events result in impacts that are greater than the sum of the parts, such as from enhanced flooding or widespread tree falls which cause damage to property and power infrastructure. The co-design process in the RP2022-24 NESP Climate Systems Hub project CS2.5 Regional climate projections for local action demonstrated that there is unmet stakeholder appetite for understanding changes in these impactful rainfall events, such as clusters of extreme rainfall and the impact of antecedent conditions; interactions between heavy rainfall and other hazards such as strong winds; or particularly widespread or long-duration events.

This project will work with stakeholders and other NESP projects including Projection Verification and High-Resolution Rainfall Extremes to identify case studies of compound extreme rainfall events with high impacts. These case studies will be assessed to understand the critical factors that enhanced their impacts such as spatial extent, antecedent conditions, clustering, or compounding with other hazards such as strong winds. These case studies and the accompanying stakeholder engagement will be used to identify key types of compound extreme rainfall events with large impacts, and develop and test innovative thresholds and indices for capturing these events that are impact-informed and co-designed. The innovative definitions and methodologies developed will be evaluated in collaboration with users, and used to evaluate the relative frequency of these hazards across Australia, including areas where such events might be expected to occur in the future.

In addition, the project will use a range of weather system datasets to identify the key atmospheric processes involved in these high-impact case studies, noting that the likelihood of such high-impact, compound rainfall events is highest in cases where multiple driving factors co-occur. It will assess the capacity of models and reanalyses to accurately simulate these patterns and the sensitivity of results to the dataset used, to highlight gaps in current model skill for future development and event types which may not be well represented in current projections. The new methods developed will be application-ready and able to be adopted by future rounds of the Australian Climate Service (ACS) National Climate Risk Assessment or similar programs how these hazardous events are changing in a changing climate

This project will focus on extreme rainfall events at daily to multi-day timescales and will complement research on short-duration rainfall extremes using high-resolution modelling in project CS5.7, High-Resolution Rainfall Extremes.

In the first three months of the project, a small number of stakeholders with strong interest in compound extreme rainfall events will be approached from a list of interested parties generated in NESP2.5. In collaboration with these stakeholders, a small number of case studies of compound extreme rainfall events will be identified, and used to inform the co-

development of new indices of the relevant impactful extreme event. Once these indices have been established and tested, they will be used to inform a range of project outputs including:

- new methods, codes and datasets for at least two types of compound extreme rain events that can be provided to the Australian Climate Service for their further development and delivery via climate portals, and will be made easily accessible for other interested parties.
- model evaluation of key processes that generate, and are related to, extreme rainfall events, which will inform future regional modelling development for Australia that better captures extreme compound and interacting rainfall hazards.
- identification of the current risk of impactful concurrent and compound extreme rainfall events, to help inform current planning and event readiness, particularly in the emergency management sector
- assessment of how the risk of some types of impactful and compound rainfall hazards are changing in a warming climate
- increased capacity of key stakeholders to identify and manage the rainfall events of most relevance to their communities through stakeholder workshops and targeted presentations.
- synthesis products including at least one briefing note to communicate project results to key stakeholders and the broader public, including providing relevant material for the Adapt Land & Sea website.

Throughout the project an ongoing process of stakeholder engagement will be undertaken and the project will evolve in response. The co-design and stakeholder engagement processes will be supported by the Hub knowledge brokers building on the process started under in the RP2022-24 NESP Climate Systems Hub project CS2.5 Regional climate projections for local action, and other projects including State and Federal Government led initiatives.

- Recent stakeholder engagement exercises conducted by both the hub and the Bureau of Meteorology have identified a large number of stakeholders with interest in understanding compound extreme rainfall events, as well as potential case studies. This list of stakeholders will be engaged throughout the project through stakeholder workshops and briefing notes, but we will primarily focus on our chosen case studies as examples.
- From the larger stakeholder group, we will identify 2-3 priority stakeholders with overlapping areas of interest for in-depth co-design, with priority given to stakeholders or case studies that are relevant to multiple hub projects. These stakeholders will include state and/or local governments, who have local knowledge on the complex hazard interactions with large impact
- We will work closely with these selected stakeholders to co-design up to 2 case studies co-developing new methodological approaches and ways to translate research findings into decision-ready information. The case studies will demonstrate how these co-developed project outputs (for example, datasets and synthesis products) can be used

to help inform future planning, and results will be communicated to the broader stakeholder group.

- The Australian Climate Service is a key partner for this project, and the project will respond to knowledge gaps emerging through the program and be informed by developing code and data standards. This will allow output and insights to be easily integrated into ACS products and portals, while addressing hazards that are beyond the immediate scope of ACS work
- The project will work with the knowledge broker team to engage in meaningful co-design with end users, and to inform the development of project outputs and communication that can be used by stakeholders to inform decision-making.

Is this a cross-hub project?

No.

Does this project contribute to a cross-cutting initiative?

Yes. This project contributes to the Climate Adaptation Initiative.

Many decision-makers are looking to understand their future climate risk in considering how to respond. Compounding and cascading risks present a particular challenge for practitioners. Understanding where and when these compound extreme events might occur will be important for considering scenarios of risk.

Co-development and co-delivery of synthesised findings through summary factsheets and workshop/webinar will target increasing stakeholder capacity, uptake and application of research into adaptation processes and thinking.

Indigenous consultation and engagement

The project meets the following revised Three Category approach:	**Category 1** Indigenous led ☐	**Category 2** Co-design ☐	**Category 3** Communicate ☒

This project is a category 3 project under the updated NESP 3 category approach.

This project is aligned to the hub's Indigenous partnerships strategy and adheres to the NESP Indigenous Partnership Principles. These principles will strengthen relationships but also foster positive Indigenous engagements. These engagements will allow for trust, transparency and respect to be strengthened over time. The adoption of these approaches will ensure maintenance of appropriate Indigenous engagement throughout the project's lifecycle, and that the project legacy is available to communities engaged with, and more widely as suitable. Project Indigenous engagement will be measured through the hub's monitoring and evaluation framework and process.

Every Indigenous community in Australia is different. Informed partnership processes reflect responsible and transparent engagement underpinned by Indigenous people having the right to their Indigenous Cultural and Intellectual Property (ICIP), and Free, Prior and Informed Consent (FPIC).

The incorporation of the updated NESP 3 category approach to Indigenous partnerships - Indigenous led, Co-Design and Communicate - during the engagements will optimise the project outcomes and outputs thus allowing for project success to be achieved.

The Climate Systems Hub in partnership with the National First Peoples Platform on Climate Change have called for collaboration with climate scientists. This request is for, but not limited to, current understanding and future projections of seasonal patterns that are impacting or anticipated to impact both natural and cultural indicators within Indigenous knowledge systems.

The project team will seek advice from the Platform to consider pathways through which to communicate the outcomes of this research which may include via organisations suggested by DCCEEW. We note that the Platform has existing links to the Indigenous Desert Alliance and SEED (who participated in the Gathering).

The scientific field work (outside scope of this project) conducted through the various communities will provide valuable data for Indigenous people, thus allowing for adaptation measures to be implemented in caring for Country. Incorporating the National First Peoples Platform on Climate Change in elements of the co-design process will support scientists in the development of specific case-studies.

Project milestones

Milestones	Due date	Responsible person
Milestone 1 – Project workplan approved by the NESP CSH program management team	15 March 2025	Acacia Pepler
Milestone 2- Determine case studies and complete initial Co-design	31 March 2025	Acacia Pepler
Milestone 3 – Resubmission of project plan to RP26 to detail chosen case studies and stakeholders in pathway to impact section	30th June 2025	Acacia Pepler
Milestone 4 – presentation to stakeholders highlighting preliminary results and informing priorities for year 2	30 September 2025	Acacia Pepler
Milestone 5 – 1st draft research paper on methods for defining one impactful or compound rain hazard prepared	31 December 2025	Chiara Holgate
Milestone 6 – 2nd draft research paper on the characteristics of one impactful or compound rain hazard prepared	31 January 2026	Pallavi Goswami
Milestone 7 – Online workshop or AMOS special session on Compound events	28th February 2026	Acacia Pepler
Milestone 8 – Co-designed product on projected changes in impactful extreme rain events prepared for broad audience	30 September 2026	Acacia Pepler
Milestone 9 – Project outcome presentation to stakeholders	31 October 2026	Chiara Holgate
Milestone 10 – project code published and documented on github	31 November 2026	Chiara Holgate
Milestone 11 – 3rd draft research paper on the drivers of one impactful or compound rain hazard prepared	30 November 2026	Chiara Holgate
Milestone 12 – Synthesis report approved by NESP CSH Project Management Team	15 December 2026	Acacia Pepler

Data and information management

The project will take an approach to ensure all outputs meet the FAIR data principles – Findable, Accessible, Interoperable, and Reusable – in conjunction with the CARE principles for any Indigenous Cultural and Intellectual Property (ICIP) – Collective benefit, Authority to control, Responsibility, and Ethics. Together, these aim to ensure all data are easily shared and reused, but also used ethically. The project will adhere to principles of ICIP and acknowledge data sovereignty elements in all project outputs for any ICIP.

A data management plan will serve as a record of all datasets and other information used as inputs and outputs for the project, including any models and code/software. The plan will ensure consideration has been given to how the data associated with the project will be managed and that appropriate resources are devoted to data management.

The *NESP data and information guidelines* and the Climate Systems Hub Data Management Strategy detail the fundamental approach to data management and the many aspects projects need to consider, including dealing with ICIP. The Data Wrangler will provide any guidance needed by the Project Lead and the project's Data Custodians.

FAIR Data Principles

While it is acknowledged that projects will not know all the details at the outset, how and where project outputs will be made freely and openly available needs to be considered. Different types of data and information will require different approaches. The principles of the Data Management Strategy on how different data types will be managed are summarised in the following table, noting that not all data types are applicable to every project.

Project output	Data management and accessibility
All data/information products	• Research data and outputs will be well-documented according to accepted and trusted standards, including principles of ICIP. A key requirement for all research products generated by the hub research will be following metadata standards based on accepted best practice • Data will be made publicly available whenever legally, ethically and contractually possible, under an open licence policy except in particular cases, with particular. A record of these exceptions will be kept, and exceptions reported regularly to the Department • Data and other research output will be stored in repositories that are accessible to end-users and other researchers, with the choice of repository based on practicalities of the data and its likely use, and stored in such a way as to endure and remain FAIR well beyond the life of the project • The project will develop its own data management plan, with identified data custodians responsible for managing the data • The nature of research outputs, their formats and repositories, will be developed through a co-design

Project output	Data management and accessibility
	process involving stakeholders and end-users to ensure data meet their requirements and are fit-for-purpose, and will evolve through ongoing consultation • Research outputs and data will be accompanied by documentation providing guidance to users on how best to make use of the data • The hub will maintain a metadata catalogue of all research data, and all metadata will be published on other public metadata catalogues • Outputs such as websites will follow the Web Content Accessibility Guidelines (WCAG), and include an accessibility statement.
Scientific publications and reports	• Publications and reports will be made available through the CS hub website and/or appropriate peer-reviewed scientific journals.
Application ready data sets	• To be published in public repositories. • Data services made available to enable ingestion into end-user models and decision-support tools.
End-user products	• Published in appropriate medium such as print or a scientific journal. • Captured in metadata catalogues. • A copy will be stored on the hub website for public access.
Raw research data	• Stored on infrastructure where generated and where they can be shared, as appropriate under ICIP considerations, with other researchers.

Location of research

The table below describes the scale at which the project will be working, and the location(s) where the majority of the project research will be conducted.

At which spatial scale is the project working	**National** ☒	**Regional** ☐	**Local** ☐
Location(s) – gazetted region /place name	**Sydney, Canberra, Melbourne**		
Aboriginal or Torres Strait Islander nation or traditional place name(s)	**Dharug/Eora nations** **Ngunnawal-Ngambri land** **Kulin Nations – Bunurong Country**		

Project-specific risks

Risk	Potential impact on project	Likelihood (rare, unlikely, possible, likely, highly likely)	Consequence (minor, moderate, high, major, critical)	Risk rating (low, medium high, severe)	Treatment to reduce or manage risk
Schedule slippage	*Project deliverable delays*	*Possible*	*Moderate*	*Medium*	*More time allocated to planning project* *Establish a high performing team early in the project lifecycle.*
Insufficient compute time at NCI	*Slow progress*	*Unlikely*	*Moderate*	*Low*	*Leverage organisational allocations to get more compute time*
Insufficient data storage at NCI	*Slow progress*	*Possible*	*Major*	*Medium*	*Leverage organisational resources to get more data storage*
Staff Turnover	*Reduction in project deliverables*	*Possible*	*Moderate*	*Medium*	*Ensure positive postdoctoral experience with appropriate mentoring and engagement with Climate College.*

Project keywords

Extreme rain, flood, winds, compound hazards, climate projections

Project CS5.7 – High-resolution rainfall extremes

Project type: • Hub research project	
Project status: • New project submitted for approval	
Cross-cutting initiative:	Yes Climate Adaptation Initiative
Project start date: 01/01/2025	**Project end date**: 31/12/2026
Total project budget: $1,234,141 (GST exclusive)	**NESP funding:** (GST exclusive) 2025 $254,488 2026 $322,898 **Co-contributions (cash and in-kind):** (GST exclusive) 2025 $344,003 2026 $312,752
Project leader details:	Name: Jason Evans Organisation: UNSW Phone: (02) 93857066 Email: Jason.evans@unsw.edu.au

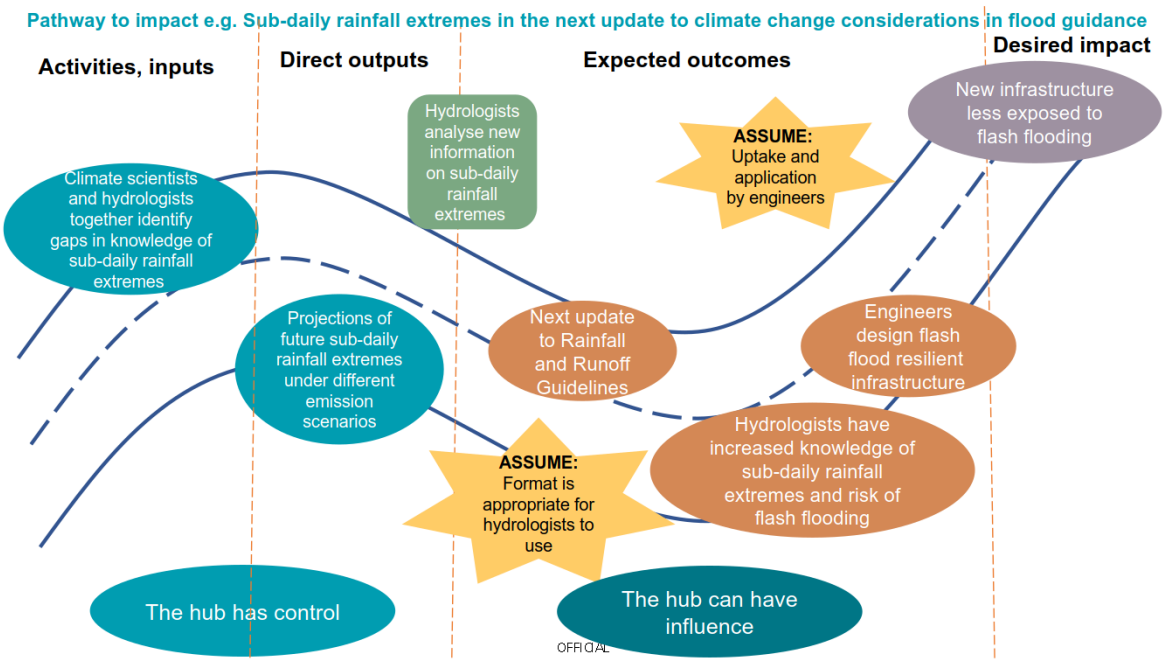
Project summary

Rainfall extremes are associated with storm and flash flood hazards, impacting many human and natural systems. But how have sub-daily rainfall extremes been changing over major Australian cities? And how will future climate change alter these extremes?

We will address these questions through analysis of meteorological station and weather radar observations over major Australian cities, as well as performing some high-resolution regional climate model experiments to simulate a set of extreme storms under various future climate scenarios. The outcomes of this project will contribute to improving the related structure design guidance in the Australian Rainfall and Runoff guidelines and corresponding adaptation decisions

Pathway to impact

Outcomes
This project will fill knowledge gaps identified in research to inform the 2024 update to the climate change considerations of the Australian Rainfall and Runoff guidance (under Climate Systems Hub RP2022-4 project CS2.5 Regional Climate Projections for Local Action) and will improve our knowledge of climate change impacts on sub-daily rainfall extremes and deliver this knowledge in a way that can inform the next update to the Australian Rainfall and Runoff guidance. See infographic below depicting the pathway to impact. This in turn, will be a valuable resource for adaptation decisions to draw from.



Research-user	Engagement and communication	Impact on management action	Outputs
Climate Science Section, National Adaptation Policy Office, DCCEEW	Will be part of a project stakeholder advisory group, engaged in the development and design of project and outputs. Findings and outputs to be communicated via bi-annual meetings.	Research findings will inform the next update of the Australian Rainfall and Runoff climate change considerations for extreme precipitation at short durations, which should lead to more flood resilient infrastructure design	Data on future changes in short duration extreme precipitation under various emission scenarios. Case studies in urban areas. Milestones 3,4,5,6,7,10 – Stakeholder advisory group meetings

Research-user	Engagement and communication	Impact on management action	Outputs
Engineers Australia	Will be part of a project stakeholder advisory group, engaged in the development and design of project and outputs. Findings and outputs to be communicated via bi-annual meetings.	Research findings will inform the next update of the Australian Rainfall and Runoff climate change considerations for extreme precipitation at short durations, which should lead to more flood resilient infrastructure design	Data on future changes in short duration extreme precipitation under various emission scenarios. Case studies in urban areas Milestones 3,4,5,6,7,10– Stakeholder advisory group meetings
Urban Planners, flood/drainage managers from Local or State Governments in the case study locations	Tailored communication of findings and outputs	Co-designed communication of research outputs that can inform their decision making	Co-designed communication of research outputs that can inform their decision making. Milestone 8.
Additional outputs • Scientific journal publications • Plain English summaries of findings and case studies • Stakeholder workshops and webinars communicating the research findings and case studies			

Project description

Project description

Short duration rainfall extremes cause flash flooding, particularly in urban environments where much of the ground is covered by impermeable surfaces. Our drainage infrastructure is designed to handle these rainfall extremes, but as these extremes become more intense, the design needs to change as well. Recent work to update the climate change considerations for the Australian Rainfall and Runoff guidance identified several knowledge gaps including the climate change impact on sub-daily rainfall extremes for diverse areas around Australia.

This project will improve our knowledge of climate change impacts on sub-daily rainfall extremes and deliver this knowledge in a way that can inform the next update to the Australian Rainfall and Runoff guidance. This project addresses the national priority “Build climate resilience in the built environment.”

For each target major Australian city the project will:

- Identify historical trends in rainfall extremes at short durations using meteorological stations and weather radar data.
- Evaluate the Regional Climate Model ability to simulate these events to understand the model’s limitations and improve it where possible.
- Project the future change in these events under different emission scenarios

The project will first develop and apply the methodology to a single city and then repeat it for other major cities as resources and time allow.

The model used will be the Weather Research and Forecasting (WRF) model. This project will be done in close coordination with ACS who will also use BARPA and CCAM to simulate these events. This ensures that any conclusions drawn are not applicable to only one modelling system, but are more likely to reflect expected changes in the real world.

This project is related to project CS5.6 Extreme rainfall in compound events. That project is focused on extreme rain in compound events at daily and longer time scales in observations and existing climate change projection datasets. While this project is focused on sub-daily time scales and will perform very high resolution, next generation, climate simulations to examine them. The projects will maintain communication and look for opportunities for synergy.

The research will inform the next update to the climate considerations in the Australian Rainfall and Runoff guidance and so will be used by engineers in the design of water sensitive structures.

Is this a cross-hub project?

No.

Does this project contribute to a cross-cutting initiative?

Yes – climate adaptation initiative

- The project will contribute to future updates to the Australian Rainfall and Runoff guidelines, helping to ensure that future structure designs are adapted to the changing climate.
- Co-development and co-delivery of synthesised findings through summary factsheets and workshop/webinar will target increasing stakeholder capacity, uptake and application of research into adaptation processes and thinking.

Indigenous consultation and engagement

The project meets the following revised Three Category approach:	**Category 1** Indigenous led ☐	**Category 2** Co-design ☐	**Category 3** Communicate ☒

This project is a category 3 project under the updated NESP 3 category approach.

This project is aligned to the hub's Indigenous partnerships strategy and adheres to the NESP Indigenous Partnership Principles. These principles will strengthen relationships but also foster positive Indigenous engagements. These engagements will allow for trust, transparency and respect to be strengthened over time. The adoption of these approaches will ensure maintenance of appropriate Indigenous engagement throughout the project's lifecycle, and that the project legacy is available to communities engaged with, and more widely as suitable. Project Indigenous engagement will be measured through the hub's monitoring and evaluation framework and process.

Every Indigenous community in Australia is different. Informed partnership processes reflect responsible and transparent engagement underpinned by Indigenous people having the right to their Indigenous Cultural and Intellectual Property (ICIP), and Free, Prior and Informed Consent (FPIC).

The incorporation of the updated NESP 3 category approach to Indigenous partnerships - Indigenous led, Co-Design and Communicate - during the engagements will optimise the project outcomes and outputs thus allowing for project success to be achieved.

The Climate Systems Hub in partnership with the National First Peoples Platform on Climate Change have called for collaboration with climate scientists. This request is for, but not limited to, current understanding and future projections of seasonal patterns that are impacting or anticipated to impact both natural and cultural indicators within Indigenous knowledge systems.

The project team will seek advice from the Platform to consider pathways through which to communicate the outcomes of this research which may include via organisations suggested by DCCEEW. We note that the Platform has existing links to the Indigenous Desert Alliance and SEED (who participated in the Gathering).

The scientific field work (outside scope of this project) conducted through the various communities will provide valuable data for Indigenous people, thus allowing for adaptation measures to be implemented in caring for Country. Incorporating the National First Peoples Platform on Climate Change in elements of the co-design process will support scientists in the development of specific case-studies.

Project milestones

Milestones	Due date	Responsible person
Milestone 1 – Inception meeting with ACS collaborators: meeting minutes circulated	28 February 2025	Jason Evans
Milestone 2 – Project workplan approved by the Climate Systems Hub Project Management Team	15 March 2025	Jason Evans
Milestone 3 – Stakeholder advisory group meeting: meeting minutes circulated	30 April 2025	Jason Evans
Milestone 4 - Stakeholder advisory group meeting: meeting minutes circulated	20 October 2025	Jason Evans
Milestone 5 – Stakeholder advisory group meeting: meeting minutes circulated	30 April 2026	Jason Evans
Milestone 6 - Stakeholder advisory group meeting: meeting minutes circulated	20 October 2026	Jason Evans
Milestone 7 - Data sets produced on future changes in short duration extreme precipitation under various emission scenarios.	1 November 2026	Jason Evans
Milestone 8 – Synthesis report approved by NESP CSH Project Management Team	15 November 2026	Jason Evans
Milestone 9 – Plain English summary of research findings and case studies for local and state government research users	30 November 2026	Jason Evans
Milestone 10 – Final project report produced and sent to Stakeholder advisory group	30 December 2026	Jason Evans

Data and information management

The project will take an approach to ensure all outputs meet the FAIR data principles – Findable, Accessible, Interoperable, and Reusable – in conjunction with the CARE principles for any Indigenous Cultural and Intellectual Property (ICIP) – Collective benefit, Authority to control, Responsibility, and Ethics. Together, these aim to ensure all data are easily shared and reused, but also used ethically. The project will adhere to principles of ICIP and acknowledge data sovereignty elements in all project outputs for any ICIP.

A data management plan will serve as a record of all datasets and other information used as inputs and outputs for the project, including any models and code/software. The plan will ensure consideration has been given to how the data associated with the project will be managed and that appropriate resources are devoted to data management.

The *NESP data and information guidelines* and the Climate Systems Hub Data Management Strategy detail the fundamental approach to data management and the many aspects projects need to consider, including dealing with ICIP. The Data Wrangler will provide any guidance needed by the Project Lead and the project's Data Custodians.

FAIR Data Principles

While it is acknowledged that projects will not know all the details at the outset, how and where project outputs will be made freely and openly available needs to be considered. Different types of data and information will require different approaches. The principles of the Data Management Strategy on how different data types will be managed are summarised in the following table, noting that not all data types are applicable to every project.

Project output	Data management and accessibility
All data/information products	• Research data and outputs will be well-documented according to accepted and trusted standards, including principles of ICIP. A key requirement for all research products generated by the hub research will be following metadata standards based on accepted best practice • Data will be made publicly available whenever legally, ethically and contractually possible, under an open licence policy except in particular cases, with particular. A record of these exceptions will be kept, and exceptions reported regularly to the Department • Data and other research output will be stored in repositories that are accessible to end-users and other researchers, with the choice of repository based on practicalities of the data and its likely use, and stored in such a way as to endure and remain FAIR well beyond the life of the project • The project will develop its own data management plan, with identified data custodians responsible for managing the data • The nature of research outputs, their formats and repositories, will be developed through a co-design

Project output	Data management and accessibility
	process involving stakeholders and end-users to ensure data meet their requirements and are fit-for-purpose, and will evolve through ongoing consultation • Research outputs and data will be accompanied by documentation providing guidance to users on how best to make use of the data • The hub will maintain a metadata catalogue of all research data, and all metadata will be published on other public metadata catalogues • Outputs such as websites will follow the Web Content Accessibility Guidelines (WCAG), and include an accessibility statement.
Scientific publications and reports	• Publications and reports will be made available through the CS hub website and/or appropriate peer-reviewed scientific journals.
Application ready data sets	• To be published in public repositories. • Data services made available to enable ingestion into end-user models and decision-support tools.
End-user products	• Published in appropriate medium such as print or a scientific journal. • Captured in metadata catalogues. • A copy will be stored on the hub website for public access.
Raw research data	• Stored on infrastructure where generated and where they can be shared, as appropriate under ICIP considerations, with other researchers.

Location of research

The table below describes the scale at which the project will be working, and the location(s) where the majority of the project research will be conducted.

Most activities will be desktop analysis conducted across various offices in Sydney and Hobart.

At which spatial scale is the project working	**National** ☒	**Regional** ☐	**Local** ☒
Location(s) – gazetted region /place name	Major Australian city regions – Sydney, Melbourne, Brisbane, Perth, Adelaide, Hobart, Darwin, Canberra		
Aboriginal or Torres Strait Islander nation or traditional place name(s)	TBD. Could include Gadigal,		

Project-specific risks

Risk	Potential impact on project	Likelihood (rare, unlikely, possible, likely, highly likely)	Consequence (minor, moderate, high, major, critical)	Risk rating (low, medium high, severe)	Treatment to reduce or manage risk
Insufficient compute time at NCI	*Slow progress*	*unlikely*	*moderate*	*low*	*Leverage institutional allocations to get more compute time*
Insufficient data storage at NCI	*Slow progress*	*possible*	*major*	*medium*	*Leverage institutional resources to get more data storage*
Change in research focus of ACS	*Results will rely only on one model rather than a suite of models*	*possible*	*moderate*	*medium*	*As a single model result the outcomes will be indicative rather than reliable.*
Staff turnover	*Unable to deliver all case studies.*	*possible*	*moderate*	*medium*	*Maintain a positive postdoc experience, support postdoc to remain.*

Project keywords

Extreme rainfall, sub-daily, flash flooding, major cities, climate projections

Project CS5.8 – Building for the future

Project type: • Hub research project	
Project status: • New project submitted for approval	
Cross-cutting initiative:	Yes Climate Adaptation initiative
Project start date: 01/01/2025	**Project end date**: 30/06/2026
Total project budget: $425,884 (GST exclusive)	**NESP funding:** (GST exclusive) 2025 $110,060 2026 $111,882 **Co-contributions (cash and in-kind):** (GST exclusive) 2025 $101,060 2026 $102,882
Project leader details:	Name: Ramona Dalla Pozza Organisation: UTAS Phone: Email: Ramona.dallapozza@utas.edu.au

Project summary

The Australian Government supports the establishment of standards, programs and other innovative measures to improve energy efficiency in commercial, residential and government buildings. The changing climate needs to be considered to help ensure Australia's buildings are resilient and energy efficient and to aid in the development of future adaptation and mitigation strategies and building design codes.

This project will bring together climate scientists and industry practitioners to establish a methodology, using climate projections, that can produce future average and extreme weather files. During the project, heat wave weather files for ten representative Australian locations will be developed to assist ABCB to assess heat stress impacts on new minimum building standards. An ongoing co-design and consultation process with stakeholders will help keep the task aligned with the project plan.

Pathway to impact

Outcomes
By developing a co-designed best practice approach to producing future climate files and climate zoning as a direct output of this project, the hub is enabling building designers to be able to adequately consider expected heat extremes and heatwaves in their building design, contributing to our desired impact on society (see below Figure 1). Through co-design with residential and commercial building policy staff in DCCEEW and experts in industry, it is intended that this project contributes to improved policy outcomes for NatHERS, NABERS, Trajectory for Low Energy Buildings, as well as influencing the 2028 update to the National Construction Codes (NCC) for residential buildings.

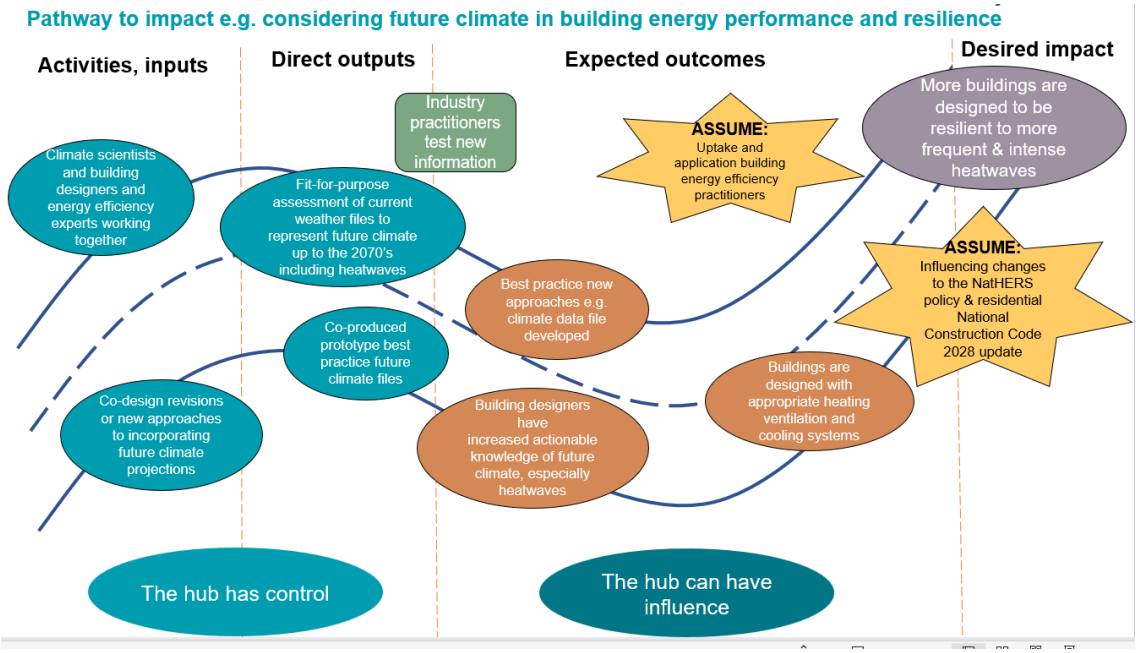


Figure 1: Conceptual diagram the pathway to impact from for this project from direct activities and outputs, to the expected outcomes and desired impact.

Research-user	Engagement and communication	Impact on management action	Outputs
Homes Ratings & Disclosure branch, Energy Performance and Security Division, DCCEEW	Initiators of the project and involved in the development and design of project and outputs. Co-design partners (William Tolis and Daniel Daly are part of the project team) Other members may be part of the Project Advisory Group,	This research will be used to inform the following policies: Nationwide House Energy Rating Scheme (NatHERS), Trajectory for Low Energy Buildings, future details within the Built Environment Sector Plan, the NatHERS Strategic Plan update, and	Milestone 6 - Developing weather data files with best practice approaches to represent future extreme heat (including heat wave) at ten representative climate locations including scoping the potential for

Research-user	Engagement and communication	Impact on management action	Outputs
	where findings and outputs to be communicated via regular meetings, presentations and project workshops.	regulatory changes specified within the 2028 National Construction Code update for residential buildings.	ongoing delivery at other locations. Case study applications to test the new approaches impact in using current (past) files vs future files. Milestone 4/7– Development of plain English summary of project findings for publication (informed by stakeholder workshop).
Industrial & Buildings Energy Performance and Security Division, DCCEEW	Initiators of the project and involved in the development and design of project and outputs. Co-design partners Dev Bhardwaj and Tim Lemesurier are part of the project team) Other members may be part of the Project Advisory Group, where findings and outputs to be communicated regular meetings, presentations and project workshops.	This research will be used to inform the following policies: National Australian Built Environment Rating System (NABERS), Trajectory for Low Energy Buildings	Milestone 6 - Developing weather data files with best practice approaches to represent future extreme heat (including heat wave) at ten representative climate locations including scoping the potential for ongoing delivery at other locations. Case study applications to test the new approaches impact in using current (past) files vs future files. Milestone 4/8– Development of plain English summary of project findings for publication (informed by stakeholder workshop).

Research-user	Engagement and communication	Impact on management action	Outputs
Australian Building Codes Board	Part of the Project Advisory Group, where findings and outputs to be communicated regular meetings, presentations and project workshops.	This research will influence the regulatory changes specified within the 2028 National Construction Code update for residential buildings.	Milestone 6 - Developing weather data files with best practice approaches to represent future extreme heat (including heat wave) at ten representative climate locations including scoping the potential for ongoing delivery at other locations to assist ABCB to assess heat stress impacts on minimum building standards . Milestone 4/8– Development of plain English summary of project findings for publication (informed by stakeholder workshop).
Department of Finance (WA)	Part of the Project Advisory Group, where findings and outputs to be communicated regular meetings, presentations and project workshops.	This research will influence the regulatory changes specified within the 2028 National Construction Code update for residential buildings.	Milestone 4/8– Development of plain English summary of project findings for publication (informed by stakeholder workshop).
Department of Energy, Environment and Climate Action (DEECA) (VIC)	Part of the Project Advisory Group, where findings and outputs to be communicated regular meetings, presentations and project workshops.	This research will influence the regulatory changes specified within the 2028 National Construction Code update for residential buildings.	Milestone 4/8– Development of plain English summary of project findings for publication (informed by stakeholder workshop).
I-Body Decarbonisation and	Interested stakeholder, outputs	This research will influence the	Milestone 4/8– Development of

Research-user	Engagement and communication	Impact on management action	Outputs
Climate Risk forum (Led by Infrastructure Australia and includes members State and Territory Infrastructure agencies)	to be communicated via email and semi-regular presentations.	regulatory changes specified within the 2028 National Construction Code update for residential buildings.	plain English summary of project findings for publication (informed by stakeholder workshop).

Additional outputs

- Stakeholder workshops, July and Nov 2025, April 2026 (Timing of workshops needs to align with ABCB processes and will be confirmed during the initial co-design phase).Publishing of plain English summary of user-informed literature review and fit-for-purpose assessment of existing methods.
- Publishing of plain English summary of co-designed case study applications to test the new approaches with industry practitioners, energy efficiency modellers and building designers.
- Development of plain English summary of project findings for publication on hub website
- Public webinar to present results of study.
- Peer-reviewed papers.

Project description

When buildings are required to be assessed for compliance with energy efficiency and/or carbon intensity performance provisions, in cases this involves completing a simulation of the expected energy use of the building using one of several software packages. These software packages require an hourly annual weather file, often a Typical Meteorological Year (TMY) file, derived from a historical sample of actual weather data collected over a span of more than 15 years. There is a voluntary option available using future climate projections for residential buildings (see link Predictive weather files for building energy modelling - Australian Housing Data (csiro.au) however these files have received critical feedback from across industry and the climate science community as they only capture average future temperatures (not extremes).

As our climate is changing, and as buildings designed today have an expected life-span of approximately 50-70 years, building designs need to consider the climate of the 2070s, including extremes such as heatwaves, to keep occupants comfortable and healthy. In addition, users have expressed the need for a review of the climate zone boundaries approach that divides Australia into regions of similar climatic conditions and expressed concern that current files used do not include other climate variables such as precipitation. Co-design meetings at the start of this project will refine the methodology and develop clear requirements to understand what is in the project scope.

The aim of this project is to review current methodology, consult widely and develop consistent weather files for use in both residential and commercial energy efficiency and resilience modelling that include a meaningful representation of future climate projections for heat extremes and heatwaves likely to be experienced up to the 2070s. The new files will be developed according to a best practice approach endorsed by the Australian climate science community, that has been co-designed, co-produced and piloted to ensure that it is fit-for-purpose for industry. The project will also scope the requirements of providing this piloted and user-tested approach as an ongoing service through a delivery agency such as the Australian Climate Service.

This project will build on previous work reviewing existing methods (for example, in operation and recommended) addressing limitations to meaningfully integrate future climate information. This will include a fit-for-purpose assessment of the current approach - typical meteorological year (TMY) and climate zones (for example, ABCB CZ 1-8 or NatHERS 69) versus alternative methods such as multi-year or scenario-based approaches. Revisions to the current TMY approach or new approaches would be tested with industry designers and modellers to assess their suitability and ensure useability and accessibility. The project will not deliver any new climate projections but rather focuses on developing/identifying suitable approaches and methodologies to analyse the data, and interpret the range of climate extremes at locally relevant scales projected for Australia up to the 2070s, relevant to building design considerations. This could include producing a range of plausible scenarios for testing including 2035s (immediate future), 2050s (mid-future), and 2070s (far future).

The work will be co-designed and co-produced with nominated staff from the commercial and residential buildings policy branches of DCCEEW as well as CSIRO, who will form part of the project team. They will link hub researchers to industry practitioners who need to use the information.

A broader Project Advisory Group will support this process to streamline engagement and correspondence between the key entities and individuals involved who may contribute to directing project outcomes. These stakeholders include DCCEEW and CSIRO personnel, as well as representatives from the Australian Building Codes Board (ABCB), as applicable. This group may also allow for communicating the co-ordination of multiple timeframes, resources and outcomes via a collective; recognising that related projects may be undertaken separately by some of these stakeholder entities concurrently with this project.

In addition, through DCCEEW's existing stakeholder committees and reference groups we will involve key state and territory stakeholders and industry bodies (for example, the IBPSA International Building Performance Simulation Association). Through the knowledge brokering network, other relevant state and territory government stakeholders who deliver local 'implementation' and incentivisation around the schemes (for example,, Victorian Energy Upgrades Programs for households) will be engaged. Through this co-design process, we will ensure that the best practice and/or nationally-agreed approach is compatible with and integrated into major national building design and ratings systems including the National Australian Built Environment Rating System (NABERS), the Nationwide House Energy Rating Scheme (NatHERS), and Trajectory for Low Energy Buildings. This work will also seek to influence the 2028 update to the National Construction Code (NCC) for residential buildings.

Project outputs

This project will develop fit-for-purpose future climate information and tools to support government and business to develop climate resilient and energy efficient buildings. Key outputs will include:

A user-informed literature review of existing methods (for example, in operation and recommended) addressing limitations to meaningfully integrate future climate information. This would include a fit-for-purpose assessment of existing methods for example, typical meteorological year (TMY) and climate zones (for example, ABCB CZ 1-8 or NatHERS 69) - versus alternative methods such as multi-year or scenario-based approaches.

Co-designed revisions to the current TMY approach or the development of new best practice approaches to develop weather data files to represent future extreme heat (including heat wave) at ten representative climate locations. This would include scoping the delivery of ongoing best practice climate data files (prototyped through this project) with an operational climate service (for example, the Australian Climate Service).

Co-designed case study applications (TBC) to test the new approaches with industry practitioners, energy efficiency modellers and design professionals (for example, architects, building designers). This may include a star-band impact analysis (NatHERS and NABERS) of the difference in using current (past) files vs future files, or an output of similar nature that links to the flow on implications or any changes.

The project engagement activities will be co-led with nominated staff from the commercial and residential buildings policy branches of DCCEEW bringing together climate scientists with industry practitioners. Activities may include focused workshops with broader industry

practitioners to understand user needs, and consultation with regional networks. The hub is strategically placed to bring the Australian climate science community together to develop this best practice approach to applying climate projections, as it includes climate scientists (both from CSIRO and the Bureau of Meteorology, and that are also involved in the Australian Climate Service), key universities, and the states and territories through the National Partnership for Climate Projections. Knowledge brokers embedded in state government agencies will enable engagement with a wide range of industry practitioners, government policy makers and peak bodies (including state and territory bodies, and national infrastructure bodies for example, Green Building Council of Australia, Infrastructure Sustainability Council of Australia, Architects Institute of Australia and Engineers Australia).

Is this a cross-hub project?

No.

Does this project contribute to a cross-cutting initiative?

Yes – Climate Adaptation Initiative

The project is working to improve climate-ready design guidelines improving the resilience of Australia's building stock.

It delivers to the following Initiative outcomes:

- Strong end-user capacity, uptake and application of evidence-based climate systems research and adaptation information (Synthesise, communicate, disseminate).
- Decision support tools are delivered that enable application of climate change adaptation on the ground (Planning and decision support).

Indigenous consultation and engagement

The project meets the following revised Three Category approach:	**Category 1** Indigenous led ☐	**Category 2** Co-design ☐	**Category 3** Communicate ☒

This project is a category 3 project under the updated NESP 3 category approach.

This project is aligned to the hub's Indigenous partnerships strategy and adheres to the NESP Indigenous Partnership Principles. These principles will strengthen relationships but also foster positive Indigenous engagements. These engagements will allow for trust, transparency and respect to be strengthened over time. The adoption of these approaches will ensure maintenance of appropriate Indigenous engagement throughout the project's lifecycle, and that the project legacy is available to communities engaged with, and more widely as suitable. Project Indigenous engagement will be measured through the hub's monitoring and evaluation framework and process.

Every Indigenous community in Australia is different. Informed partnership processes reflect responsible and transparent engagement underpinned by Indigenous people having the right to their Indigenous Cultural and Intellectual Property (ICIP), and Free, Prior and Informed Consent (FPIC).

The incorporation of the updated NESP 3 category approach to Indigenous partnerships - Indigenous led, Co-Design and Communicate - during the engagements will optimise the project outcomes and outputs thus allowing for project success to be achieved.

The Climate Systems Hub in partnership with the National First Peoples Platform on Climate Change have called for collaboration with climate scientists. This request is for, but not limited to, current understanding and future projections of seasonal patterns that are impacting or anticipated to impact both natural and cultural indicators within Indigenous knowledge systems.

The project team will seek advice from the Platform to consider pathways through which to communicate the outcomes of this research which may include via organisations suggested by DCCEEW. We note that the Platform has existing links to the Indigenous Desert Alliance and SEED (who participated in the Gathering).

The scientific field work (outside scope of this project) conducted through the various communities will provide valuable data for Indigenous people, thus allowing for adaptation measures to be implemented in caring for Country. Incorporating the National First Peoples Platform on Climate Change in elements of the co-design process will support scientists in the development of specific case-studies.

Project milestones

Milestones	Due date	Responsible person
Milestone 1 – Signing of contract between hub lead and research organisations	1 November 2024	Ramona Dalla Pozza
Milestone 2 – Project workplan approved by CS Hub Program Management Team	14 February 2025	Ramona Dalla Pozza
Milestone 3 –User-informed literature review and fit-for-purpose assessment of existing methods drafted for publication as a technical report.	30 March 2025	Ramona Dalla Pozza
Milestone 4 –Summary of findings drafted for publication (informed by stakeholder workshop).	30 April 2025	Ramona Dalla Pozza
Milestone 5 – Technical report detailing the analysis of the future climate projections in selected case study regions to determine how well existing methods (for example, TMY weather files) meaningfully represent a climate of ~2070s including heat extremes.	30 May 2025	Surendra Rauniyar, Dörte Jakob
Milestone 6 - Developing weather data files with best practice approaches to represent future extreme heat (including heat wave) at ten representative climate locations including scoping the potential for ongoing delivery at other locations	30 September 2025	Surendra Rauniyar, Dörte Jakob
Milestone 7 - Co-designed case study applications (TBC) to test the new approaches with industry practitioners and modellers	30 March 2026	Ramona Dalla Pozza
Milestone 8– Development of plain English summary of project findings for publication (informed by stakeholder workshop)	15 April 2026	Ramona Dalla Pozza
Milestone 9 – Public webinar to present results of study	30 May 2026	Ramona Dalla Pozza

Data and information management

The project will take an approach to ensure all outputs meet the FAIR data principles – Findable, Accessible, Interoperable, and Reusable – in conjunction with the CARE principles for any Indigenous Cultural and Intellectual Property (ICIP) – Collective benefit, Authority to control, Responsibility, and Ethics. Together, these aim to ensure all data are easily shared and reused, but also used ethically. The project will adhere to principles of ICIP and acknowledge data sovereignty elements in all project outputs for any ICIP.

A data management plan will serve as a record of all datasets and other information used as inputs and outputs for the project, including any models and code/software. The plan will ensure consideration has been given to how the data associated with the project will be managed and that appropriate resources are devoted to data management.

The *NESP data and information guidelines* and the Climate Systems Hub Data Management Strategy detail the fundamental approach to data management and the many aspects projects need to consider, including dealing with ICIP. The Data Wrangler will provide any guidance needed by the Project Lead and the project's Data Custodians.

FAIR Data Principles

While it is acknowledged that projects will not know all the details at the outset, how and where project outputs will be made freely and openly available needs to be considered. Different types of data and information will require different approaches. The principles of the Data Management Strategy on how different data types will be managed are summarised in the following table, noting that not all data types are applicable to every project.

Project output	Data management and accessibility
All data/information products	• Research data and outputs will be well-documented according to accepted and trusted standards, including principles of ICIP. A key requirement for all research products generated by the hub research will be following metadata standards based on accepted best practice • Data will be made publicly available whenever legally, ethically and contractually possible, under an open licence policy except in particular cases, with particular. A record of these exceptions will be kept, and exceptions reported regularly to the Department • Data and other research output will be stored in repositories that are accessible to end-users and other researchers, with the choice of repository based on practicalities of the data and its likely use, and stored in such a way as to endure and remain FAIR well beyond the life of the project • The project will develop its own data management plan, with identified data custodians responsible for managing the data • The nature of research outputs, their formats and repositories, will be developed through a co-design

Project output	Data management and accessibility
	process involving stakeholders and end-users to ensure data meet their requirements and are fit-for-purpose, and will evolve through ongoing consultation • Research outputs and data will be accompanied by documentation providing guidance to users on how best to make use of the data • The hub will maintain a metadata catalogue of all research data, and all metadata will be published on other public metadata catalogues • Outputs such as websites will follow the Web Content Accessibility Guidelines (WCAG), and include an accessibility statement.
Scientific publications and reports	• Publications and reports will be made available through the CS hub website and/or appropriate peer-reviewed scientific journals.
Application ready data sets	• To be published in public repositories. • Data services made available to enable ingestion into end-user models and decision-support tools.
End-user products	• Published in appropriate medium such as print or a scientific journal. • Captured in metadata catalogues. • A copy will be stored on the hub website for public access.
Raw research data	• Stored on infrastructure where generated and where they can be shared, as appropriate under ICIP considerations, with other researchers.

Location of research

The table below describes the scale at which the project will be working, and the location(s) where the majority of the project research will be conducted.

At which spatial scale is the project working	**National** ☒	**Regional** ☐	**Local** ☐
Location(s) – gazetted region /place name	Desktop studies, the majority of the desktop research will take place will be in Melbourne, and the research output will cover regions across Australia (TBC).		
Aboriginal or Torres Strait Islander nation or traditional place name(s)	Project members will work out of Naarm (Melbourne) at the BoM Office and CSIRO Clayton Office, and from home office on Wurundjeri Country.		

Project-specific risks

Risk	Potential impact on project	Likelihood (rare, unlikely, possible, likely, highly likely)	Consequence (minor, moderate, high, major, critical)	Risk rating (low, medium high, severe)	Treatment to reduce or manage risk
Staff changes or overallocation (especially for co-contributors) results in loss of expertise from the project.	Unable to deliver on aspects of the project milestones	Possible	High	Medium	Have more than one person with similar expertise on the project team.
The absence of clear policy guidelines on how we provide the information on contemporary and future climate for building design (for example, no equivalent Australian Rainfall and Runoff Guidelines)	Unable to reach an agreed approach that is fit-for-purpose for decision making	Possible	High	Medium	Drawing on the expertise of the project team and building time into the project for stakeholder co-design to understand how decisions are being made.
Conflicting needs/priorities from key stakeholders, could introduce scope creep on outputs.	Unable to deliver within current timeframe and resources.	Possible	High	Medium	Drawing on the expertise of the project team and building time into the project for stakeholder co-design to understand how decisions are being made and therefore what the most useful outputs would be.
The future climate	The tools are	Unlikely	Moderate	Medium	Be very clear what the

Risk	Potential impact on project	Likelihood (rare, unlikely, possible, likely, highly likely)	Consequence (minor, moderate, high, major, critical)	Risk rating (low, medium high, severe)	Treatment to reduce or manage risk
information and tools developed in this project as used for unintended applications.	considered not fit-for-purpose by certain stakeholders				intended purpose is for the tools and the stakeholders and specific use cases they were co-developed for.
Inadequate funding for testing of files using software for large commercial building applications	May reduce useability and application for commercial buildings	Likely	Moderate	Medium	Seek cost estimates and suggested process for testing of files on commercial building software. Identify potential funding sources.

Project keywords

future climate, heatwaves, building resilience, energy performance.

Project CS5.9 – Communicating coastal floods

Project type: • Hub research project	
Project status: • New project submitted for approval	
Cross-cutting initiative:	Yes Adaptation initiative
Project start date: 01/01/2025	**Project end date**: 31/12/2026
Total project budget: $160,666 (GST exclusive)	**NESP funding:** (GST exclusive) 2025 $41,610 2026 $42,756 **Co-contributions (cash and in-kind):** (GST exclusive) 2025 $37,632 2026 $38,668
Project leader details:	Name: Julian O'Grady, Helen Bloustein Organisation: CSIRO, DEECA Phone: +61 3 9239 4409 Email: julian.ogrady@csiro.au helen.bloustein@deeca.vic.gov.au

Project summary

Our research aims to enhance stakeholder understanding of the likelihood of future coastal flooding, aiding adaptation professionals and coastal managers in responding to sea level rise. Rare and catastrophic floods will become more frequent and more likely to occur in the future due to climate change, leading to chronic impacts over a period of time. That is why it is more important than ever stakeholders can access the science, understand what it means for their context and have options to apply the information to their situation. In this project we will work with stakeholders to understand this situational context and identify a small number of case studies to pursue.

Using a co-design approach for these case studies, we will improve science delivery by aligning sea level rise data with user preferences for engagement and delivery of data and information as new information emerges.

Pathway to impact

Outcomes
Impact will be achieved by engaging with active practitioners to co-develop products that will present coastal inundation or flood likelihood overlays in different formats for the study locations. This may include presenting likelihood in more easily interpretable styles such as the number of events over a given period, for example, identifying where there are three flood events over a 10-year period. Generally, these practitioners would be non-technical climate experts and those less familiar with sea level rise science and its implications, but who play a crucial role in formulating state and local government adaptation policies and approaches and implementing these decisions on the ground. Having access to information in various forms will enable them to determine responses to important questions such as: • What will the future sea level be under different future scenarios? • What is the likelihood of coastal flood from rare storm tide water level, and what will it be with future sea level rise? • How much more often will extreme sea level events occur with sea level rise? The project will build on the current NESP Canute extreme water level tool science and engagement to develop new flood layers/overlays products to communicate coastal flood likelihood in certain locations. Access to authoritative and easily consumed data and information on sea-level change and coastal sea-level extremes, can support planning and management of, infrastructure, social and cultural values, and ecosystems. Our research could also provide valuable insights for improving communication about the likelihood of other flood types, including riverine flooding, where complex terminology such as annual exceedance probabilities and average recurrence intervals are also used. The project will be developed for one or two study locations in Australia. In these locations, engagement will be undertaken to understand decision maker needs and assess the usefulness of the product for informing coastal adaptation responses to future sea level rise. The project will seek to build on sea level research led by Xuebin Zhang in the Climate Systems Hub and predecessor the Earth Systems and Climate Change Hub.

Research-user	Engagement and communication	Impact on management action	Outputs
Torres Straight Regional Authority	On country engagement to understand local coastal vulnerabilities and preferences for information. Findings to be shared with communities (including via Gur A Baradharaw Kod Torres Strait Sea and Land	Community guidance will inform: the appropriate channels for sharing findings; how Indigenous knowledge can expand the potential for knowledge sharing, reach and engagement with other communities.	Milestone 3/5 Research outputs including datasets, flood layers and synthesis reports. Community-driven engagement to co-design delivery approaches including

Research-user	Engagement and communication	Impact on management action	Outputs
	Council Torres Strait Islander and Aboriginal Corporation (GBK)) and Climate Resilience Centre for Torres Strait and the Northern Peninsula		maps to visually depict extreme water levels. Contribute to CS5.10 – Indigenous-led literature and products to inform national and international processes on climate action Indigenous engagement capacity building through tailored materials /presentations
First Nations Climate Adaptation Policy, National Adaptation Policy Office (NAPO), DCCEEW	Research engagement activities will be provided by email.	Enable activities to be tracked and coordinated	Milestone 3/5 Co-designed research outputs including datasets, flood layers and synthesis reports.
Australian Climate Service (ACS)	Research team meetings.	Improved communication of risk information on extreme and compound extreme water level hazards available in ACS portals and documentation	Milestone 3/5 Methods, documentation, case study validate, insight, and feedback of the modelling approach to real-world scenarios to support future national model development
State, territory and local government agencies. E.g DCCEEW NSW, DEECA Vic, Dept of Transport WA, Renewables, Climate and Future Industries Tas and Department of Environment, Science and Innovation, Qld	Engage in co-design through stakeholder workshops to identify key case studies and hazard metrics. Briefings of research progress and findings to gather further feedback and incorporate learnings into subsequent research iterations. Key partners identified to develop specific case studies of high local importance.	Research outputs will be able to be tailored by location and adopted by State/Territory and Local Gov decision makers to inform their extreme sea level rise awareness campaigns and cascade into adaptation messaging and actions.	Milestone 3/5 Co-designed research outputs including datasets, flood mapping layers and synthesis material, such as guidance materials and fact sheets, tested for usability and delivered on suitable platforms (for example, CoastAdapt, Canute).

Research-user	Engagement and communication	Impact on management action	Outputs
	Establish project engagement network to test approaches and share examples.		
Marine and Coasts Hub project 4.10 De-risking nature repair	Engage in co-design through stakeholder workshops to identify key case studies and hazard metrics. Briefings of research progress and findings to gather further feedback and incorporate learnings into subsequent research iterations. Key partners identified to develop specific case studies of high local importance. Establish project reference network to test approaches and share examples.	Research outputs including data and information will be made accessible to the Marine and Coast Hub to inform possible nature-based investment planning approaches for managing and scaling up marine and coastal restoration activities. Researchers will have access to this project's outputs and the ability to overlay robust climate data and information into their own data tools.	TBC - Research outputs including datasets, flood layers and synthesis material, such as guidance materials and fact sheets. The data and information would be tested for suitability alongside nature-based solution monitoring frameworks.
Additional outputs • Output of data and guidance material on platforms such as Canute 3, CoastAdapt or CS4.1 Adapt Land&Sea • Plain English communication products • Webinars and tailored presentations • Peer reviewed papers			

Project description

Project description

While flood likelihood terminology like “a 1% AEP flood” is both familiar and useful for expert engineers, it’s incomprehensible for most people wondering if they will be impacted by increased coastal flooding from sea level rise. Terminology such as a ‘100 year ARI’ flood may be more relatable to many people, however the likelihood of a 100 year event happening again can be easily underestimated in a changing climate and rising sea levels. One percent AEP and 100 year ARI terminology represent acute, one off, rare events and can be used to map potentially catastrophic high impact flooding. While this is useful in some planning situations, developing understanding and impetus to act across a broader range of decision makers is needed. What may raise awareness and concern, and influence organisations and communities to instigate adaptation measures is repeat flooding from less rare (for example, a 10-year ARI), moderate impact events, resulting in chronic impacts. Recent studies present chronic flood impacts using terminology around the likely number of high tide flood events over a given time period, for example, three flood days in a given year. User response to this type of information has shown some positive outcomes in communicating the risk of flooding or inundation.

This project will explore whether similar or other approaches to presenting the latest extreme sea level rise science and its impact likelihoods, resonate with decision makers. For example, when considering significant decisions, it is crucial to identify the future timeframe for predicting any potential impacts and risks on an investment. For family groups, this timeframe might correspond to the period required to raise a child. In financial investments, it could align with the duration of a mortgage. In the context of coastal wetlands, it includes the cycle of ecological development, functioning, and regrowth. These cross-disciplinary considerations are often intertwined, but not always synchronised. While circumstances may change and decisions reconsidered, a typical span of 30 years is a sensible timeframe for a cycle of evaluation of impact. As discussed early, the decision makers need appropriate information to clearly understand what the likelihood of impact is over this period (for example, a 1% AEP or 3 times in 30 years).

The chosen case studies will be undertaken to evaluate and understand if the presentation of likelihood terminology over this kind of timeframe is effective in informing decision-making. The proposed project will produce several key outputs and engagement opportunities. Building on the foundations laid in the current NESP cycle, we will continue to engage with First Nations communities, specifically seeking on-ground collaboration in the Torres Strait, as part of the ongoing IPCC AR7 Indigenous-led research paper initiatives. We will conduct targeted workshops with state government stakeholders, to tailor climate information that meets their specific administrative and strategic needs. Interested stakeholders will be derived from knowledge broker recommendations and from attendees at the NESP Canute workshops held in 2022 and 2023. Additionally, the project will co-develop enhanced future extreme sea level rise related climate data accessible through platforms such as CoastAdapt and the Canute portal. Outputs will also include creating inundation mapping layers for the selected case study engagement locations, along with synthesised guidance materials to aid in the interpretation of the new inundation maps. Research findings will be disseminated to the scientific community through conferences such as the Adaptation conference organised by NESP CSH or other NESP Hub channels.

This work should be considered a priority because national scale coastal risk studies underscore the increasing vulnerability of Australia's coastal regions to flooding due to climate change. The 2009 national assessment by the Department of Climate Change (DCC 2009) provides a foundational overview of climate change risks to Australia's coasts, highlighting the urgent need for adaptive strategies to mitigate these impacts. CoreLogic's (2022) report, "Coastal Risk Scores for Financial Risk Assessment," highlights the rising financial risks associated with coastal properties, emphasising the need for detailed risk assessments to guide investment and insurance decisions. Complementing these findings, Hutley et al. (2022) in the Climate Council's "Uninsurable Nation" report, identify Australia's most climate-vulnerable locations, stressing that many areas face increasing uninsurability due to heightened riverine flood risks due to higher coastal sea levels. A recent XDI report highlights coastal inundation as the major driver of climate risk to real estate investment trust property in Australia. And the 2024 AON report indicates almost half a million properties in Australia face a 1% risk of coastal flooding annually. Collectively, these studies paint a comprehensive picture of the escalating coastal flooding threats, calling for enhanced resilience planning and policy interventions to protect vulnerable communities and properties. In many cases, the methodology or quality underlying coastal flood hazard in these studies is either incomplete or unknown, sometimes representing a ‘black box’. This reinforces the need to further build confidence in stakeholder understanding and interpretation capability in this area, something this project will be well-placed to contribute towards.

Is this a cross-hub project?

No, but cross-Hub work is being explored. The CS Hub has had some exploratory discussions with Rebecca Morris and Alan Jordan from the Marine and Coastal Hub (Project 4.10 De-risking nature repair), and Brendan Macky and Patrick Norman from the Resilient Landscapes Hub (Project 3.19. Climate-resilient landscapes: an adaptation case study in NSW’s Northern Rivers region, Griffith University). These discussions are ongoing.

Does this project contribute to a cross-cutting initiative?

Yes – climate adaptation.

As we move into the future, we need to pre-empt coastal inundation impacts and **predict** when triggers of inundation may be reached to inform adaptation planning to avoid future impacts. The prediction tools we develop could help inform activities in the Marine and Coastal and Resilient Landscapes hub through co-design. Working with 2 case study locations, will help identify how to build strong end-user capacity, uptake and application of our findings delivered through decision support tools.

The project aims to contribute to the NESP climate Adaptation initiative by

1. Strong end-user capacity, uptake and application of evidence-based climate systems research and adaptation information (Synthesise, communicate, disseminate)

2. Decision support tools are delivered that enable application of climate change adaptation on the ground (Planning and decision support)

Indigenous consultation and engagement

The project meets the following revised Three Category approach:	**Category 1** Indigenous led ☐	**Category 2** Co-design ☒	**Category 3** Communicate ☐

This project is a category 2 project under the updated NESP 3 category approach.

This project will contribute to CS5.10: *Indigenous-led literature and products to inform national and international processes on climate action*, through co-design of themed case study work related to Sea Country in CS5.10, including contribution to Indigenous-led literature. The case study will have an Indigenous lead and a science lead as determined through the co-design process with CS5.10. Governance of the Indigenous engagement in this project will come through CS5.10 which is Indigenous-led.

The project will undertake localised case studies, which includes developing model data in the Torres Strait and seeks opportunities to communicate and align project research with Torres Strait partners.

This project is aligned to the hub's Indigenous partnerships strategy and adheres to the NESP Indigenous Partnership Principles. These principles will strengthen relationships but also foster positive Indigenous engagements. These engagements will allow for trust, transparency and respect to be strengthened over time. The adoption of these approaches will ensure maintenance of appropriate Indigenous engagement throughout the project's lifecycle, and that the project legacy is available to communities engaged with, and more widely as suitable. Project Indigenous engagement will be measured through the hub's monitoring and evaluation framework and process.

Every Indigenous community in Australia is different. Informed partnership processes reflect responsible and transparent engagement underpinned by Indigenous people having the right to their Indigenous Cultural and Intellectual Property (ICIP), and Free, Prior and Informed Consent (FPIC).

The incorporation of the updated NESP 3-category approach to Indigenous partnerships - Indigenous led, Co-Design and Communicate - during the engagements will optimise the project outcomes and outputs thus allowing for project success to be achieved.

The Climate Systems Hub in partnership with the National First Peoples Platform on Climate Change have called for collaboration with climate scientists. This request is for, but not limited to, current understanding and future projections of seasonal patterns that are impacting or anticipated to impact both natural and cultural indicators within Indigenous knowledge systems.

The scientific field work (outside scope of this project) conducted through the various communities will provide valuable data for Indigenous people, thus allowing for adaptation measures to be implemented in caring for Country. Incorporating the National First Peoples Platform on Climate Change in elements of the co-design process will support scientists in the development of specific case-studies.

This project will have ethics approval under CSIRO Social and Interdisciplinary Science Human Research Ethics Committee (CSSHREC 198/24 Climate Systems Hub – Indigenous-led literature and products to inform national and international processes on climate action).

Project milestones

Milestones	Due date	Responsible person
Milestone 1 – Project workplan approved by the NESP CSH program management team	15 March 2025	Julian O'Grady/Helen Bloustein
Milestone 2 – Engagement activities to meet stakeholders – introduce the proposed research direction, confirm participation levels of stakeholders, evaluate and identify potential case studies and the approach to communicate outputs. Document findings and share with participating stakeholders.	28 March 2025	Julian O'Grady/Helen Bloustein
Milestone 3 – First co-designed case study products (for example, datasets and fact sheets) to be presented via an interactive event (for example, meeting, conference, webinar, targeted stakeholder presentations)	30 November 2025	Julian O'Grady/ Helen Bloustein
Milestone 4 – Collate feedback to inform engagement of next case study iteration. Share summary with event participants.	28 February 2025	Julian O'Grady/ Helen Bloustein
Milestone 5 – written contribution to form part of CS5.10 case study work on coastal impacts	December 2025	Julian O'Grady/ Helen Bloustein
Milestone 6 – Other co-designed products (for example, datasets and fact sheets) to be presented via an interactive event (for example, meeting, conference, webinar) and presented on platforms such as CoastAdapt or Canute.	30 August 2026	Julian O'Grady/ Helen Bloustein
Milestone 7 – written contribution to form part of CS5.10 case study work on coastal impacts	September 2026	Julian O'Grady/ Helen Bloustein
Milestone 8 – Co-designed products summarising outcomes/findings published	30 December 2026	Julian O'Grady/ Helen Bloustein
Milestone 9 – Synthesis report approved by NESP CSH Project Management Team	15 November 2026	Julian O'Grady/ Helen Bloustein

Data and information management

The project will take an approach to ensure all outputs meet the FAIR data principles – Findable, Accessible, Interoperable, and Reusable – in conjunction with the CARE principles for any Indigenous Cultural and Intellectual Property (ICIP) – Collective benefit, Authority to control, Responsibility, and Ethics. Together, these aim to ensure all data are easily shared and reused, but also used ethically. The project will adhere to principles of ICIP and acknowledge data sovereignty elements in all project outputs for any ICIP.

A data management plan will serve as a record of all datasets and other information used as inputs and outputs for the project, including any models and code/software. The plan will ensure consideration has been given to how the data associated with the project will be managed and that appropriate resources are devoted to data management.

The *NESP data and information guidelines* and the Climate Systems Hub Data Management Strategy detail the fundamental approach to data management and the many aspects projects need to consider, including dealing with ICIP. The Data Wrangler will provide any guidance needed by the Project Lead and the project's Data Custodians.

FAIR Data Principles

While it is acknowledged that projects will not know all the details at the outset, how and where project outputs will be made freely and openly available needs to be considered. Different types of data and information will require different approaches. The principles of the Data Management Strategy on how different data types will be managed are summarised in the following table, noting that not all data types are applicable to every project.

Project output	Data management and accessibility
All data/information products	• Research data and outputs will be well-documented according to accepted and trusted standards, including principles of ICIP. A key requirement for all research products generated by the hub research will be following metadata standards based on accepted best practice • Data will be made publicly available whenever legally, ethically and contractually possible, under an open licence policy except in particular cases, with particular. A record of these exceptions will be kept, and exceptions reported regularly to the Department • Data and other research output will be stored in repositories that are accessible to end-users and other researchers, with the choice of repository based on practicalities of the data and its likely use, and stored in such a way as to endure and remain FAIR well beyond the life of the project • The project will develop its own data management plan, with identified data custodians responsible for managing the data

Project output	Data management and accessibility
	• The nature of research outputs, their formats and repositories, will be developed through a co-design process involving stakeholders and end-users to ensure data meet their requirements and are fit-for-purpose, and will evolve through ongoing consultation • Research outputs and data will be accompanied by documentation providing guidance to users on how best to make use of the data • The hub will maintain a metadata catalogue of all research data, and all metadata will be published on other public metadata catalogues • Outputs such as websites will follow the Web Content Accessibility Guidelines (WCAG), and include an accessibility statement.
Scientific publications and reports	• Publications and reports will be made available through the CS hub website and/or appropriate peer-reviewed scientific journals.
Application ready data sets	• To be published in public repositories. • Data services made available to enable ingestion into end-user models and decision-support tools.
End-user products	• Published in appropriate medium such as print or a scientific journal. • Captured in metadata catalogues. • A copy will be stored on the hub website for public access.
Raw research data	• Stored on infrastructure where generated and where they can be shared, as appropriate under ICIP considerations, with other researchers.

Location of research

The table below describes the scale at which the project will be working, and the location(s) where the majority of the project research will be conducted.

At which spatial scale is the project working	**National** ☐	**Regional** ☐	**Local** ☒
Location(s) – gazetted region /place name	Preferred priority locations, Masig Island (Torres Strait) and Western Port (Vic). To be determined via co-design. Potential secondary locations could include: WA or NSW – based on already identified stakeholder interest in the research		
Aboriginal or Torres Strait Islander nation or traditional place name(s)	Kalau Lagau Ya: Masig Boonwurrung: Warn Marin		

Project-specific risks

Risk	Potential impact on project	Likelihood (rare, unlikely, possible, likely, highly likely)	Consequence (minor, moderate, high, major, critical)	Risk rating (low, medium high, severe)	Treatment to reduce or manage risk
Case study timing doesn't align with stakeholder requirements	Case study has limited impact for stakeholders or content needs to be re-scoped	possible	moderate	medium	Continue to consider alternative case study locations and refine case study content through ongoing stakeholder engagement over the two year project.
Organisational appetite to make public datasets that identify the impacts to individual assets (for example, buildings)	Negative stakeholder feedback	unlikely	moderate	medium	Collaborate with wide range of stakeholders to moderate the reporting of impacts.

Project keywords

future climate, sea level rise, coastal flooding, coastal inundation, coastal management

CS5.10 – Indigenous-led literature and products to inform national and international processes on climate action

Project type: • Hub research project	
Project status: • New project submitted for approval	
Cross-cutting initiative:	Yes Climate Adaptation Initiative
Project start date: 01/01/2025	**Project end date**: 31/12/2026
Total project budget: $1,332,299 (GST exclusive)	**NESP funding:** (GST exclusive) 2025 $331,945 2026 $338,586 **Co-contributions (cash and in-kind):** (GST exclusive) 2025 $327,626 2026 $334,142
Project leader details:	Name: Damian Morgan-Bulled (Project Leader – Indigenous) Organisation: CSIRO Phone: 0429 022 003 Email: damian.bulled@csiro.au Name: Simon Marsland (Science Leader) Organisation: CSIRO Phone: 03 9239 4548 Email: simon.marsland@csiro.au *Dependent on travel grant from DCCEEW First Nations Engagement Funding:* Name: Mandy Hopkins (Project Leader – Strategy and Operations) Organisation: UTAS Phone: 0408 346 206 Email: mandy.hopkins@utas.edu.au

CS5.10 – Indigenous-led literature and products to inform national and international processes on climate action

Project summary

This project facilitates the bridging of diverse knowledge systems around climate science: Traditional Knowledge Systems and Western Science Systems. Such bridging builds capacity to develop new knowledge systems where these two sciences come together through Indigenous-led and co-designed climate change research. Outputs from this research can be considered in Intergovernmental Panel on Climate Change (IPCC) assessment reports. This collaboration will deliver face-to-face workshops on Country over several years, in which Indigenous Knowledge holders will work alongside western scientists to develop scientific papers on climate change. Communication products that share the research in formats that meet user needs are also envisaged, including to support communities' decision-making about enabling actions to manage the impacts of climate change.

Pathway to impact

Outcomes
The Australian Government Environment Department, through the National Environmental Science Program, has provided continuous funding to support Indigenous engagement in the climate change science space over the last decade. This project will show how continuity of funding and engagement can provide multiple pathways to impact. Of note: • The capacity of First Nations communities will be built to enable them to provide tangible contributions and the international level along with contributions to the UNFCCC's Local Community and Indigenous People's Platform. Future Indigenous-led engagements will draw upon the transferable, place-based, methodology developed and refined from this project including the principles of FPIC and ICIP. This project also supports action on the following recommendation from the 2021 First Nation Peoples Statement on Climate Change: • *"The right to manage Country. First Nations peoples must be involved in the national dialogue about climate change and be engaged on any decision that impacts us and our Country. We call for these rights to be respected and observed on an international, national, state and local level. Our knowledge must be included in climate management frameworks."* The project case studies will, as appropriate, include environmental impacts on flora and fauna in considerations of climate change impacts.

Research-user	Engagement and communication	Impact on management action	Outputs
National First Peoples Platform on Climate Change (NFPPCC)	Engaged in the development and design of project and outputs. The project has been and will continue to be Indigenous-led and co-designed, respecting the principles of Free Prior and Informed Consent (FPIC) and Indigenous Cultural and Intellectual Property (ICIP). Findings and outputs to be communicated via project	Research will inform First Nations components of National Climate Risk Assessments and the forthcoming National Adaptation Plan. Delivering on recommendations from the 2021 NFPGCC Statement on Climate Change 2021	Indigenous-led peer reviewed scholarly articles in support of the IPCC Seventh Assessment Report cycle.

Research-user	Engagement and communication	Impact on management action	Outputs
	workshops and presentations at NFPPCC meetings and related fora.		
First Nations communities participating in the project (to be determined through co-design)	These communities and their needs will be identified through the co-design process. An important aspect of this process is engagement through the National First Peoples Gathering on Climate Change 2024.	Indigenous Weather Knowledge calendars with climate change overlays provide a tool to consider the climatic changes to Country in their land management practices: for example shifting of seasons for cultural burning.	Indigenous Weather Knowledge calendars with climate change overlays possible tangible tool
National Adaptation Plan team DCCEEW	Have been discussing options with the NAP team about how the project might help with the NAP	Research will inform First Nations components of National Climate Risk Assessments and the forthcoming National Adaptation Plan.	Case studies could possibly be included in the report
Emissions Reduction Division, National Inventory Systems and International Reporting Branch, Inventory, Reporting and Engagement Section, Department of Climate Change, Energy, the Environment and Water	Needs have been identified through numerous meetings with DCCEEW culminating in an IPCC concept workshop in Nov ember 2023. Briefings of research progress and findings.	Supporting information for International engagements regarding First Nations Australians activities around climate change and adaptation initiatives. Improved coordination of First Nations involvement in National and International processes including IPCC, COP, NAPs, NCRA.	Indigenous-led peer reviewed scholarly articles in support of the IPCC Seventh Assessment Report cycle.
Office for First Nations International Engagement, Department of Foreign Affairs and Trade	Prior consultation and meetings to identify needs. Briefings of research progress and findings.	Supporting information for International engagements regarding First Nations Australians activities around	Providing advice to the Ambassador for First Nations People about Australia's activities being undertaken at the National level with First Nations

CS5.10 – Indigenous-led literature and products to inform national and international processes on climate action

Research-user	Engagement and communication	Impact on management action	Outputs
		climate change and adaptation initiatives. Improved coordination of First Nations involvement in National and International processes including IPCC, COP, NAPs NCRA.	Communities on Climate Change
Intergovernmental Panel on Climate Change (IPCC)	Communication of availability of Indigenous-led scholarly literature to relevant author teams.	Supporting information to target needs of IPCC in Indigenous space.	Indigenous-led peer reviewed scholarly articles in support of the IPCC Seventh Assessment Report cycle.
New Zealand Ministry for the Environment — Manatū Mō Te Taiao	Meetings have been held with the Ministry for the Environment and the Māori Chief Scientist to discuss collaboration possibilities with First Nations communities	Improved coordination of First Nations involvement in the National and International processes including IPCC, COP, NAPs NCRA.	Joint collaborative Indigenous-led peer reviewed scholarly articles in support of the IPCC Seventh Assessment Report cycle.
Additional outputs • Capacity building for First Peoples nationally and internationally • Special issue of *Journal of Southern Hemisphere Earth Systems Science* (JSHESS) for Indigenous-led co-designed literature on climate change and impacts • Other communication style documents as appropriate, but not outside the focus of the project for research papers			

Project description

Project description

This project will use an Indigenous-led co-designed process that includes the principles of Free, Prior, and Informed, Consent (FPIC) and Indigenous Cultural and Intellectual Property (ICIP) to provide more avenues for Indigenous Peoples' perspectives, knowledge and practices to be considered in Intergovernmental Panel on Climate Change (IPCC) reports and enhance Indigenous Peoples' participation in IPCC processes. The project team will work with First Nations Communities through Indigenous-led, co-designed case studies in a culturally safe manner to enhance the capacity within those Communities to be able to inform and contribute to IPCC processes. The case studies will produce peer-reviewed publications that will be available for consideration by the IPCC Seventh Assessment cycle.

The project will be undertaken through two thematic areas. In the next co-design workshop decisions will be made around the thematic areas, climate science and hazards agreed and where to undertake the case studies. At present the suggested local Communities will be Torres Strait, Yorta Yorta, Yauwaalaraay/Euahlayi, with further Communities being added by platform members and/or through the co-design process. The following is suggested Country areas and possible science/hazard foci. The next workshop will further develop the project plan, with further work and deliverables, envisaged for the National First Peoples Gathering on Climate Change on 14-18 October 2024 in Dubbo, New South Wales:

Sea Country (for example, coastal communities, coral atolls, Islands TBC by project team through co-design)

Research foci could include: marine heatwaves, coral bleaching, seagrass and kelp die-off, species migration, invasive species, cyclones, wind, extreme rainfall, storms including lightening, air quality, sea level rise, storm surge (including king tides), coastal inundation, sea level change (El Nino and La Nina variability).

Inland Country (for example, River Country, Desert County, Savannah Country, High Country, Tropical rainforest Country, Built Environments other TBC by project team through co-design)

Research foci could include: heatwaves, temperature, humidity, extreme water events, dry (drought), wet (flooding), storms, bushfire weather, wildfire (rapid change), cultural burning, healing, air quality.

Some of the problems that the project will help to address are as follows:

Development of Indigenous-led scientific literature to support the Intergovernmental Panel on Climate Change (IPCC) identified lack thereof.

Capacity building of First Nations communities in the climate change and climate adaptation spaces.

Responding to calls from the 2021 First Nations Peoples Statement on Climate Change

Other priorities will be determined through the co-design process

The primary priority of this project is capacity building to support First Peoples voices in responding to the challenges of climate change and climate adaptation. This project also underpins the DCCEEW response to the *IPCC Voices Report* through the co-production of Indigenous-led peer-reviewed literature.

- This project is strongly committed to co-design across the project lifecycle. A series of thematic meetings will be held on Country in locations suited to the relevant thematic areas and engaging Communities. Project scope will be negotiated through co-design.

The thematic areas under consideration were developed as part of the National First Peoples Gathering on Climate Change (Cairns 2021) through engagement of First Peoples and western scientists. This work builds on collaborations between Indigenous Peoples and climate scientists that began in 2021 at the NESP National First Peoples Gathering on Climate Change (see National-First-Peoples-Gathering-on-Climate-Change-Report_final.pdf (nespclimate.com.au)) and the Aboriginal and Torres Strait Islander Peoples' voices and engagement in the IPCC report (2023). At a co-design workshop held by the NESP CS Hub in November 2023, a shared vision from the participants was that the project could build on the 6 themes developed at the Gathering (2021), based on the parallel knowledge system science discussions: bushfire, extreme heat, extreme wet and dry, tropical cyclone, marine heatwaves, and sea level rise.

- This project will provide more avenues for Indigenous Peoples' perspectives, knowledge and practices to be considered in IPCC reports and enhance Indigenous Peoples' participation in IPCC processes. This project has strong linkages to CS Hub RP2025 projects and will draw on these projects' scientific strengths as appropriate.

- This project will provide supporting information for International engagements regarding First Nations Australians activities around climate change and adaptation initiatives. It also supports improved coordination of First Nations involvement in National and International processes including IPCC, COP, NAPs, NCRA.

Is this a cross-hub project?

No.

Does this project contribute to a cross-cutting initiative?

Yes. Climate Adaptation Initiative.

- The project will contribute to the Climate Adaptation Initiative by providing further Indigenous–led methods to engage First Nations communities place based activities that include FPIC and ICIP.

- It contributes to the following Climate Adaptation Initiative outcomes:
  - Adaptation focused research and outputs are produced across the NESP Hubs
  - Strong end-user capacity, uptake and application of evidence-based adaptation information. through the use of Traditional Knowledge

- Decision support tools are delivered that enable application of climate change adaptation on the ground, for example; how does cultural burning practices reduce the impact of wildfire and how can this be included as an adaptation action in western land management plans.
- Adaptation decision-makers and researchers are supported to share learnings and build relationships

- The project is currently envisioned as only within the CS Hub. However, through the co-design process opportunities may arise for cross-hub work.

Indigenous consultation and engagement

The project meets the following revised Three Category approach:	**Category 1** Indigenous led ☒	**Category 2** Co-design ☐	**Category 3** Communicate ☐

This project is a category 1 project under the NESP 3 category approach. The project is led by the Climate Systems Hub Indigenous Facilitator and receives advice through co-contributions from membership of the National First Peoples Platform on Climate Change (NFPPCC).

Every Indigenous community in Australia is different. Informed partnership processes reflect responsible and transparent engagement underpinned by Indigenous people having the right to their Indigenous Cultural and Intellectual Property (ICIP), and Free, Prior and Informed Consent (FPIC). Ethical research guidelines are met through signed consent forms and are co-shared and stored in agreed information systems, as are signed code of conduct forms by scientists.

As is the requirement for FPIC our conversations regarding participation and collaboration on this project began initially as a program item, prior to the 2021 Gathering, in Gimuy (Cairns) with follow-up of a Scoping consultation and engagement of a new project – IPCC contributions, 28 November 2023 held in Naarm (Melbourne). During this process we sought agreement from our First Nations colleagues to proceed with the project concept and approval to advance through the next steps of FPIC. Continuation of this project has taken place at the recently held National First Peoples Gathering on Climate Change in Dubbo where break out groups workshopped case studies.

These break out groups determined that the project will work with five Indigenous communities to deliver case studies based on themes that evolved for the 2021 Gathering. The (First Peoples' groups) Countries identified at the 2021 Gathering agreed to take these case studies forward into a project. In 2023 at the initial workshop to discuss the concept of the IPCC project our First Peoples colleagues agreed on the (First Peoples' groups) Countries that would be involved, those groups identified and agreeable were: -

1) Torres Strait Islands, Masig Island, theme sea-level-rise, Hilda Mosby to be the Indigenous lead, Julian O'Grady from NESP as the science lead,
2) Shark Bay & Tasmania, Southeast Coast, marine heatwaves, Biana McNeair and Learna Langworthy, Indigenous leads, Neil Holbrook science lead.
3) Narran lakes Northwest NSW & Barmah/Moira Lakes, Vic & NSW, big wet/big dry. Indigenous leads Damian Morgan Bulled, Sonia Cooper& Jason Wilson, science leads, Christine Chung & Dewi Kirono
4) National focus, bushfire & extreme heat. Indigenous leads Djarra Delaney & Indigenous Desert Alliance, Science lead Pep Canadell & Jason Evans also in the team were Jade Gould & Samarla Deshong

Break out groups at the 2024 Gathering were tasked with testing these themes and places with the participants. They were also tasked with providing feedback to the project team

leaders to take the case studies forward with the understanding that the Countries chosen are pilot studies and the methods can be transferable to any Country with the same climatic conditions. There were also discussions around the need to consider an extra case study on ICIP and another led by the Youth on Climate Action. Further discussion and endorsement will be required once on Country visits begin. This will also begin the self-determination discussions regarding the reciprocal and beneficial outcomes to Country and Community. Determining what they are for each case study and how the project will ensure delivery outcomes.

This project is an Indigenous led project with the hub Indigenous Facilitator as the Indigenous lead and overarching lead of the project; the Indigenous Partnerships Officer will provide strategic project management with a Science lead from NESP. The Governance of the project will be at two levels. Firstly, a strategic advisory group will consist of the NFPPCC members and will provide advice and guidance on FPIC & ICIP along with any other areas where their expertise is required. In addition the Hub Program management team will provide advice and guidance on the management of the project including scope & deliverables, incorporating DCCEEW to assist in providing advice on project deliverables. Secondly, an operational working group consisting of the overarching project lead team and the Indigenous and science leads from each case study will provide the input from on the ground.

The NFPPCC in partnership with the Climate Systems Hub and mandated through the past 3 Gatherings at Barmah (VIC), Cairns (QLD) and Dubbo (NSW) have called for collaboration with climate scientists, requesting but not limited to future projections of seasonal patterns that are currently impacting or anticipated to impact natural indicators within Indigenous knowledge systems. This project understands that adaptation measures have become a key focus for Indigenous people.

Communication tools and schedules include agreed and shared understanding of the partnership cycle from scoping, risks, design, research methodology, cultural ceremony obligations, field work and contingency measures - through to co-production of materials and co-authorship of reports.

Monitoring and evaluation will review the partnership cycle of Indigenous-led co-design.

Consultation with the NFPPCC will be maintained in their role as the advisory committee throughout the project lifecycle. This engagement supports the preparation and development of appropriate systems and procedures to guide the co-design of scoping, project design and implementation steps. Processes and participation in this project are informed by the Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS) ethical guidelines, and the United Nations Declaration on the Rights of Indigenous Peoples. Appropriate systems, information storage, capabilities and risk management are essential incremental steps leading to the engagement with scientists. Traditional Owners have stipulated the need for such a committee as the NFPPCC, ensuring protocols, processes, FPIC, co-design and co-authorship of reports and products are upheld.

This project will have ethics approval under CSIRO Social and Interdisciplinary Science Human Research Ethics Committee (CSSHREC 198/24 Climate Systems Hub – Indigenous-led literature and products to inform national and international processes on climate action).

CS5.10 – Indigenous-led literature and products to inform national and international processes on climate action

Project milestones

Given the strong emphasis on co-design with First Peoples communities these Milestones will be further reviewed and agreed as part of the co-design process through initial on Country and online meetings.

Milestones	Due date	Responsible person
Milestone 1 – Sign contract with DCCEEW Emissions Reduction Division, Inventory, Reporting and Engagement Section, IPCC Focal Point for additional $800,000 funding to support on-Country workshops	1 Feb 2025	Amelia Tandy
Milestone 2 –Ethics approval (CSSHREC 198/24 Climate Systems Hub – Indigenous-led literature and products to inform national and international processes on climate action	1 Feb 2025	Damian Morgan-Bulled/Simon Marsland/Amelia Tandy
Milestone 3 – Project Workplan developed to share with the hub Program Management Team	31 Mar 2025	Damian Morgan-Bulled/Mandy Hopkins
Milestone 4 – Development of documented processes for project engagement methodology including the reciprocal and beneficial aspects of the research and beginning the ICIP framework	31 Mar 2025	Damian Morgan-Bulled/Mandy Hopkins
Milestone 5 –Report on initial on Country themed co-design meetings to further develop Milestone 3 methods and Communities, Corporations or PBC's identified	30 Jun 2025	Damian Morgan-Bulled/Mandy Hopkins
Milestone 6 – Project refinement review for potential RP2026 resubmission	30 Aug 2025	Damian Morgan-Bulled/Mandy Hopkins/Simon Marsland
Milestone 7 – 2nd round of themed meetings held – draft review manuscripts for peer-reviewed submission	30 Dec 2025	Damian Morgan-Bulled/Mandy Hopkins
Milestone 8 – 3rd round of themed meetings held and draft themed manuscripts prepared for peer-reviewed submission	30 Jun 2026	Damian Morgan-Bulled/Mandy Hopkins/Simon Marsland
Milestone 9 – Themed manuscripts submitted to peer-reviewed journal	30 Sep 2026	Damian Morgan-Bulled/Mandy Hopkins/Simon Marsland
Milestone 10 – Final Project Report published and sent to research users	15 Dec 2026	Damian Morgan-Bulled/Mandy Hopkins

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Milestones	Due date	Responsible person
Milestone 11 - NFPGCC to deliver a draft First Nations synthesis product endorsed by the First Nation participants	March 2027	Damian Morgan-Bulled/Mandy Hopkins/ NFPPCC

Data and information management

The core data and information of the project will adhere to principles of Indigenous Cultural and Intellectual Property (ICIP) and acknowledge data sovereignty elements in all project outputs.

The project will develop a data management plan that details the approach that will be taken to ensure all outputs of the project meet the FAIR data principles – Findable, Accessible, Interoperable, and Reusable. It will serve as a record of all datasets and other information used as inputs and outputs for the project, including any models and code/software. The plan will ensure consideration has been given to how the data associated with the project will be managed and that appropriate resources are devoted to data management.

The *NESP data and information guidelines* and the Climate Systems Hub Data Management Strategy details the fundamental approach to data management and the many aspects projects need to take into account. The Data Wrangler will provide any guidance needed by the Project Lead and the project's Data Custodians. The data management plan is a living document, to be revised and updated as the project evolves, and outputs are identified through co-design process and generated by the project.

FAIR Data Principles

While it is acknowledged that projects may not know all the details at the outset, how and where all of the project outputs will be made freely and openly available needs to be considered. Different types of data and information will require different approaches. The principles of the Data Management Strategy on how different data types will be managed are summarised in the following table.

Project output	Data management and accessibility
All data/information products	• Research data and outputs will be well-documented according to accepted and trusted standards, including principles of ICIP. A key requirement for all research products generated by the hub research will be following metadata standards based on accepted best practice • Data will be made publicly available whenever legally, ethically and contractually possible, under an open licence policy except in particular cases, with particular. A record of these exceptions will be kept, and exceptions reported regularly to the Department • Data and other research output will be stored in repositories that are accessible to end-users and other researchers, with the choice of repository based on practicalities of the data and its likely use, and stored in such a way as to endure and remain FAIR well beyond the life of the project • The project will develop its own data management plan, with identified data custodians responsible for managing the data

Project output	Data management and accessibility
	• The nature of research outputs, their formats and repositories, will be developed through a co-design process involving stakeholders and end-users to ensure data meet their requirements and are fit-for-purpose, and will evolve through ongoing consultation • Research outputs and data will be accompanied by documentation providing guidance to users on how best to make use of the data • The hub will maintain a metadata catalogue of all research data, and all metadata will be published on other public metadata catalogues • Outputs such as websites will follow the Web Content Accessibility Guidelines (WCAG), and include an accessibility statement.
Scientific publications and reports	• Publications and reports will be made available through the CS hub website and/or appropriate peer-reviewed scientific journals.
Application ready data sets	• To be published in public repositories. • Data services made available to enable ingestion into end-user models and decision-support tools.
End-user products	• Published in appropriate medium such as print or a scientific journal. • Captured in metadata catalogues. • A copy will be stored on the hub website for public access.
Raw research data	• Stored on infrastructure where generated and where they can be shared, as appropriate under ICIP considerations, with other researchers.

Location of research

The table below describes the scale at which the project will be working, and the location(s) where the majority of the project research will be conducted.

At which spatial scale is the project working	**National** ☒	**Regional** ☐	**Local** ☐
Location(s) – gazetted region /place name	**To be determined through co-design.**		
Aboriginal or Torres Strait Islander nation or traditional place name(s)	**To be determined through the co-design process.**		

Project-specific risks

Risk	Potential impact on project	Likelihood (rare, unlikely, possible, likely, highly likely)	Consequence (minor, moderate, high, major, critical)	Risk rating (low, medium high, severe)	Treatment to reduce or manage risk
Interruption to travel for on Country participants	Lower attendance than planned; viability of workshop	Possible	Moderate	Medium	None
Budget insufficient for full activity ambition	Viability of project	Possible	High	High	Seek additional budget if an underspend becomes apparent.
Lack of availability of staff	Research staff have no allocation to produce co-design activities	Highly – likely	High	High	Find research staff to work on project that have culturally appropriate training and understanding of working with First Nations
Weather on Country	Some of the activities on Country will need to be adjusted if there is inclement weather	Likely	Moderate	Medium	Will be managed ensuring there are plans in place for evacuation in case of fire or undercover activities in case rain
Health, safety & wellbeing	Participants suffer injury, Viability of workshops, relationship with project team negaitvely impacted	Unlikely	Moderate M	Low	Contact medical services to see if they can be available on Country Talk through cultural protocols at opening and nominate people to

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Risk	Potential impact on project	Likelihood (rare, unlikely, possible, likely, highly likely)	Consequence (minor, moderate, high, major, critical)	Risk rating (low, medium high, severe)	Treatment to reduce or manage risk
					discuss concerns with Have Aboriginal Medical Services team on hand for our offsite visits Ensure cultural protocols are explained and understood Fill out CSIRO OHS&E requirements
Project Leader being spread too thin due to demands from hub and other Indigenous initiatives (for example NCRA and NAP).	Not completed on time or to standard. Personal impact on Project Leader.	Possible	High	High	Regularly review workload for hub Indigenous Facilitator; ensure appropriate support from hub and other initiatives, roles and responsibilities of Indigenous Facilitator established in other hub work.
Funding from the National Inventory Systems and International Reporting Branch of DCCEEW for travel costs doesn't eventuate.	Unable to hold on Country meetings.	Rare	Critical	Low	Funding has been confirmed. Contracting has commenced with all parties and anticipate contract to be signed by Christmas..
Unable to secure	Lose engagement	Unlikely	Critical	Low	Contracting arrangements

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Risk	Potential impact on project	Likelihood (rare, unlikely, possible, likely, highly likely)	Consequence (minor, moderate, high, major, critical)	Risk rating (low, medium high, severe)	Treatment to reduce or manage risk
employment for Mandy Hopkins on project.	with First Nations collaborators				are being put in place with UTAS.

Project keywords

Traditional Owners, Indigenous partnerships, Indigenous knowledge systems, climate change and adaptation, Caring for Country

Project CS4.1 – Adaptation planning approach for protected places

Project type: • Hub research project	
Project status:: • Existing project seeking amendment	
Cross-cutting initiative:	Yes Climate Adaptation Initiative Protected Places Initiative Threatened Species
Project start date: 01/06/2024	**Project end date**: 30/12/2026
Total project budget: $ 1,329,600(GST exclusive)	**NESP funding:** $ (GST exclusive) 2024 $58,742 2025 $346,008 2026 $315,827 **Co-contributions (cash and in-kind):** $ (GST exclusive) 2024 $50,822 2025 $292,848 2026 $265,353
Project leader details:	**Project leader:** Name: Sarah Boulter Organisation: University of Tasmania Phone: 0459 785 529 Email: sarah.boulter@utas.edu.au **Co-leads:** Name: Nicholas Macgregor Organisation: Parks Australia Email: Nicholas.macgregor@dcceew.gov.au Name: Jess Melbourne-Thomas Organisation: CSIRO Email: Jess.Melbourne-Thomas@csiro.au
Project summary Continuing to build Australia's ability to manage protected areas such as World Heritage Areas and National Parks for the future is critical in adapting to climate change. In this project we will work with two of Australia's iconic protected places – Kakadu National Park, and the Queensland section the Gondwana rainforest World Heritage Area. The aim is to support adaptation planning for each property by applying and testing the Australian Government's toolkit World Heritage Adaptation Planning. To inform management in the	

face of climate change, this project will deliver detailed research and planning to assess the vulnerability of each property's many values. It will explore different approaches to adaptation planning and decision making to protected places. The two place-based efforts will be co-lead with property managers and Traditional Owners as appropriate.

Pathway to impact

Outcomes
The central outcome of this research is improved management of Kakadu National Park and Gondwana Rainforests (Qld Section) World Heritage area to strengthen their capability to improve their World Heritage outlook, through having a detailed new adaptation strategy that has been co-developed with stakeholders. Beyond the case studies, the project will also improve tools and knowledge for addressing climate change in protected areas and in conservation management more generally.

Research-user	Engagement and communication	Impact on management action	Outputs
Parks Australia	Parks Australia staff will be closely involved throughout the project as co-investigators.	Results will directly inform management of Kakadu National Park. Specifically, managers will have a detailed understanding of the vulnerability of important attributes underpinning park values over space and time; a clear picture of appropriate management pathways including the likely timing of different actions, decision points, thresholds, and triggers; a detailed framework for monitoring impacts and adaptation and evaluating success; and a clear understanding of costs. Together, this knowledge will enable appropriate management to be targeted in the highest priority places at appropriate times.	Outputs will include: Updated and co-developed vulnerability assessment and risk analysis for Kakadu Adaptation plan with practical management options and a sequence of actions
Kakadu Traditional Owners	There will be ongoing engagement and co-design with TOs and other Indigenous	Binninj/ Mungguy will be empowered to provide their perspectives and knowledge to inform adaptation planning	Updated and co-developed vulnerability assessment and risk analysis for Kakadu

Research-user	Engagement and communication	Impact on management action	Outputs
	people led by Parks Australia	and management options They will co-develop new information and priorities to incorporate into management of their land	Adaptation plan with practical management options and a sequence of actions
DCCEEW – Office of the Threatened Species Commissioner	Updates will be provided at regular intervals	Results will support conservation of species in a priority place of the *Threatened species action plan 2022–2032*	Adaptation actions for threatened species and ecosystems in Kakadu and Gondwana WHA
DCCEEW – [World Heritage]	Updates will be provided at regular intervals	Improved understanding of approaches to managing World Heritage areas under climate change	Implementation guide and supporting case studies demonstrating adaptation planning approach for protected areas that builds on WHA toolkit
DCCEEW – [Ramsar]	Updates will be provided at regular intervals Inclusion in facilitated workshops as appropriate	Improved understanding of approaches to managing Ramsar areas under climate change	Implementation guide and supporting case studies demonstrating adaptation planning approach for protected areas that builds on WHA toolkit
Northern Territory Government	Inclusion in facilitated workshops as appropriate	Improved understanding of approaches to managing protected places in northern Australia under climate change	Updated and co-developed vulnerability assessment and risk analysis for Kakadu Adaptation plan with practical management options and a sequence of actions
Department of Environment and Science (Qld)	DES staff are leading the development of the adaptation plan for Gondwana Rainforests (Qld section) World Heritage Area.The CS Hub project team will be closely involved throughout the project	Development of a Climate Change Adaptation Plan Integrate climate adaptation findings into park management activities for the Gondwana Rainforests of Australia World	Co-developed adaptation plan for Gondwana Rainforests World Heritage Area (Queensland section)

Research-user	Engagement and communication	Impact on management action	Outputs
	as co-facilitators of, and advisors to their process.	Heritage Area (Qld Section) Determine priority management actions for protecting the areas Outstanding Universal Values (OUV) and other unique values, under the threat of climate change	
Gondwana Rainforests World Heritage Advisory Committee (Qld section)	Updates will be provided at regular intervals Inclusion in facilitated workshops as appropriate	Development of a Climate Change Adaptation Plan Determine priority management actions for protecting the areas Outstanding Universal Values (OUV) and other unique values, under the threat of climate change	Co-developed adaptation plan for Gondwana Rainforests World Heritage Area (Queensland section)
First Nations people of the Gondwana Rainforests (Qld section): Yugambeh, Yuggera Ugarapul and Githabul Peoples	There will be ongoing engagement and co-design with TOs and other Indigenous people facilitated by DES We will liaise with an existing project looking at traditional values	A platform to provide their perspectives and knowledge to inform adaptation planning and management options for their Country	Understanding of potential climate impacts on cultural values Co-developed adaptation plan for Gondwana Rainforests World Heritage Area (Queensland section)
Additional outputs List project-generated outputs that aren't specific to identified research-user: • Published analysis of approaches to adaptation planning in protected places • Long-form case studies contributed to on-line platform (CS4.2).			

Project description

Project description

Approaches to managing protected areas is at a critical juncture. Existing values and underpinning attributes that define the protected status of an area may change or be lost under climate change. Yet their role in preserving biodiversity and ecological function, even as species within them potentially shift and change with the climate, is more important than ever to landscape function. Management approaches must take account of the dynamic, and threat multiplying, impact of climate change. Continuing to build our capacity to manage protected areas for the future is critical in adapting to climate change.

In 2022, the Australia Government published the Climate Change Toolkit for World Heritage Properties in Australia. The toolkit was designed to support adaptation planning in protected places. It was accompanied by an updated vulnerability assessment for all Australia's World Heritage properties. There is now a need for individual properties to apply the toolkit, build on the outcomes of the vulnerability assessment, and begin implementing management responses. There is also an opportunity to test the practical implementation of the approach to different properties.

This project will partner with managers for 2 protected area properties – Kakadu and Gondwana (Qld section) - embarking on adaptation planning projects. The objective is to test and apply the toolkit, further developing property-specific approaches, researching and compiling supporting information, as well as guiding implementation of an adaptation planning approach. Ultimately each property will have an adaptation strategy as a result. The Climate Systems Hub will use the project to develop implementation case studies and further guidance for other protected places.

The properties

Kakadu

Kakadu National Park is Australia's largest terrestrial national park, a Ramsar site and a World Heritage and Natural Heritage site. Its landscapes include rocky escarpment and plateau scrubland, extensive lowland woodland – the largest area of savanna within a protected area in the world – pockets of monsoon rainforest, and very extensive and varied aquatic ecosystems, including several large rivers and their floodplains, wetlands, estuaries and tidal mudflats. These landscapes support extremely high biodiversity including many threatened or endemic species and a threatened ecological community. Equally important are the park's values relating to culture and history. It holds a collection of rock art notable for the number of art sites, for the range of artistic styles and for the detail of the work. The park also contains cultural and historic sites that provide a record of tens of thousands of years of human occupation. And it provides a home to Binninj/Mungguy people and the opportunity to maintain their culture and pass it on to future generations. It's value to Australia is immense.

The impacts of climate change could be particularly acute in Kakadu. The park's vast landscapes are already prone to high natural seasonal variation in environmental conditions. Climate change could intensify the park's already very strong seasonal weather pattern, affecting the timing and intensity of floods and fires, seasonal rainfall, and floodplain dynamics. These could lead to changes in the character of coastal and wetland areas causing major changes to floodplain dynamics, and fire regimes, and consequently to

ecosystems, populations of native and invasive non-native species, and associated cultural values. Such impacts are an additional and interacting stress on top of other pressures such as feral species, and the general challenges of managing a complex and dynamic environment. The risk is loss of cultural sites and weakened maintenance of living culture, changes to ecosystems and loss of species, and disruption of tourism benefits. The significance of climate change was underlined in the most recent IUCN outlook report for the park (IUCN 2020/21), in which the threat of climatic changes was assessed as 'Very High'.

Risks to the Kakadu's values because of climate change need to be understood and carefully managed to help steer management of the park through the changes to come, and to continue to play a vital role in conserving biodiversity and culture in the Top End.

We will partner with Parks Australia to support implementing an adaptation planning approach and development of a new adaptation strategy for the park. The project team will work with the Kakadu Research and Management Advisory Committee and Kakadu Indigenous Research Committee to help facilitate discussions with appropriate experts and stakeholders as the project progresses.

Gondwana (Queensland section)

The Gondwana Rainforests of Australia is a serial World Heritage property containing 40 separate reserves within north-east New South Wales and south-east Queensland. Covering more than 366,000 hectares, the rainforests comprise warm temperate, cool temperate, subtropical and dry rainforests similar to those that covered the ancient supercontinent Gondwana. The rainforests are biodiversity hot-spots and are home to many rare and threatened plants and animals.

The 2019-2020 'Black summer' bushfires impacted large areas of the Gondwana Rainforests of Australia World Heritage Area, and concern was raised in both the State of Conservation UNESCO reporting for this property (2021) and Queensland's State of the Environment Reporting (2020). Unprecedented bushfires and other large-scale disturbance events are a stark indication that climate change and its impacts is already upon us.

The key finding from the Gondwana State of Environment Report (2020) was that 'Climate change presents one of the greatest emerging challenges for the protection of Gondwana Rainforests World Heritage Values' (DES 2020). The IUCN Conservation Outlook (2020) reported that climate change was a high threat to the property and the overall outlook deteriorated from the 2017 and 2014 reporting, from 'good with some concerns' to 'significant concern' in the latest cycle (IUCN 2020). These two recent reports demonstrate the urgency to better understand the nature of climate risks and identify opportunities to develop adaptation which must be embedded into management mechanisms and actions as soon as possible.

The Queensland Department of Environment and Science (DES) is leading an adaptation planning project for the Gondwana World Heritage Area (Qld). The Climate Systems Hub will support their process and help facilitate the development of an adaptation plan. Our contribution to this case study will be a lighter tough than Kakadu and involve guidance on approach, workshop support, input data/information and support in draft adaptation plan.

Approach

Our approach follows 6 steps (Table 1). Each step is anticipated to include desk-based research, guidance on the approach and facilitated workshops at different stages. Each partnership will attract different levels of support, and this is outlined in the table below.

Each project will commence with detailed planning with partners and key stakeholders. This commencement step will include:

- establishing cultural governance arrangements
- roles and responsibilities
- a detailed timeline
- information needs.

This will be recorded in a short project plan for each property at the start of the project.

Table 1. The indicative six steps to co-developing adaptation plans and the role of the project for each property

Step	Activities	Project CS4.1 role	
		Kakadu	**Gondwana**
1. Update vulnerability assessment and complete risk assessment	Collate values and underlying attributes for properties including cultural values Assess vulnerability (known sensitivity and adaptive capacity) Apply information about hazards and exposure to identify potential risks to attributes Develop consequence and likelihood measures to rate risk Consequence values include understanding potential persistence or change of values and risks to management goals	Work with Parks to collate existing work, knowledge, and documents to build list of values Assemble spatially explicit information of vulnerability (for example, species mapping/lists), hazards (for example, known response/impact to climate factors of species and ecosystems), and exposure (for example, climate information) Co-facilitate workshop/s to test values, vulnerability and consequence scale Analyse persistence or change Facilitate risk rating and prioritisation	Assist as needed in development of cultural governance and project scope Understand information needs to support identification of climate change impacts, vulnerabilities and opportunities for adaptation Contribute spatially explicit information of vulnerability, hazards, and exposure Co-facilitate workshop/s to test values, vulnerability and consequence scale

2. Identify potential adaptation actions	Identify a range of options in response to risk analysis.	Work with Parks to draw on previous planning and research in Kakadu, stakeholder opinion and published literature to assemble options	Co-facilitate workshop/s to identify adaptation options
3. Evaluate options	Assess the feasibility of each option including using cost models. Identify interdependencies between, and potential for bundling actions, as well as any incompatibilities. Prioritise options.	Assess options using a range of approaches for example the values-knowledge-rules framework of Goddard et al. (2016) and/or the five criteria of social, technical, financial, temporal, and political feasibility (Gillespie et al. 2020) Develop and apply approaches for modelling the cost of adaptation drawing on the national-level approaches developed by Yong et al. (2023) and the regional application of those approaches in the Norfolk Island Region Threatened Species Recovery Plan developed by Yong and Parks Australia (unpublished).	Provide guidance to DES project officer on approaches to assess options
4. Construct adaptation pathways	Consider how priority actions could be sequenced Understand thresholds at which actions might need to be initiated, reviewed, or changed	Co-facilitate workshop/s to prioritise and sequence actions	Co-facilitate workshop/s to prioritise and sequence actions

	Multiple pathways are likely to be considered Develop sequence of actions into visual maps		
5. Develop framework for monitoring and evaluation	Develop monitoring and evaluation framework to be compatible with existing approaches	Review existing property monitoring and evaluation approaches Review literature for information on monitoring and evaluation approaches Co-facilitate workshop to develop framework	Provide advice on development of monitoring and evaluation framework
6. Adaptation strategy or plan	Bring together agreed outcomes into an adaptation plan or strategy	Co-write final document, focusing on maximum practical value for conservation managers and decision makers.	Contribute to final document to help incorporate prioritised risks and vulnerabilities into relevant park management actions

Is this a cross-hub project?

Yes. There is scope to work with researchers from Resilient Landscapes, Marine and Coastal Hubs. We are engaging with the Sustainable Communities and Waste Hub to better understand if they might also play a role.

Does this project contribute to a cross-cutting initiative?

Yes, this project delivers to the Initiatives as described below.

Threatened and Migratory Species and Threatened Ecological Communities Initiative – Kakadu is part of a priority place under the *Threatened species action plan 2022–2032*. It delivers to the Initiative outcome:

> Policy, investment and on-ground action to halt the loss of and recover Australia's threatened and migratory species and threatened ecological communities is better informed by scientific and Indigenous knowledges

It does this through understanding the vulnerability of threatened species and ecosystems, and developing management approaches to reduce risks from climate change.

Protected Places Management Initiative - The project works to support and improve management of protected places under a future climate. It delivers to the Initiative outcomes 1 and 2:

Outcome 1: Support the management of Australia's protected places by building capacity of Indigenous communities and organisations to determine, lead and disseminate science to support protected place management.

Outcome 2: Improving the governance of Australia's protected areas by identifying effective interventions and approaches to management and highlighting opportunities to develop complementary approaches between programs and across land sea/nexus

The project will work with Traditional Owners and management teams to build their capacity to understand the place-based implications of climate change, equip them with tools to identify on-going management needs and help shape appropriate management approaches. At a broader scale, we will use these case studies to build improved knowledge and support for all protected places to consider climate risks.

Climate Adaptation Initiative - The project delivers to the 4 outcomes of this Initiative:

- Climate change adaptation focused research and outputs are produced across the NESP Hubs
- Strong end-user capacity, uptake and application of evidence-based climate systems research and adaptation information
- Decision support tools are delivered that enable application of climate change adaptation on the ground
- Adaptation decision-makers, adaptation researchers and climate scientists are supported to share learnings and build relationships.

The project is focused on building capacity of land managers to undertake climate-ready adaptive management through the development of tools and approaches that are transferable and accessible. The case studies will provide exemplars of lessons learned for knowledge sharing and transfer.

Transferability and scalability

Vulnerability assessment and adaptation planning in the context of a changing climate are an essential part of protected area management. As an extremely large national park owned by and jointly managed with Aboriginal Traditional Owners, containing a variety of landscapes and a rich and complex set of natural and cultural values, and with Ramsar, World Heritage and National Heritage designations, Kakadu National Park provides a case study that can be used to develop approaches and obtain results that will be transferable across Australia and around the world. Similarly, the Gondwana Rainforests (Qld section) World Heritage Area represents another significant natural area, but with very different ecosystems and geological features. It also has a different management arrangement and Native Title determinations yet to be made. The two properties, along with our past work with the K'gari World Heritage Area (CS2.3) offer an opportunity to analyse the approaches, challenges and enablers of the adaptation planning process and provide national guidance to other protected places.

The project is currently within this hub only and is led by the Climate Systems Hub. The role and contribution by each hub to the project at this stage is as follows:

- We will work with Professor Michael Douglas and *Bininj/Mungguy* Traditional Owners currently working to understand research priorities and Kakadu research protocols and look to draw on past and present research knowledge from the Resilient Landscapes Hub to identify values, vulnerabilities and spatially explicit information.

    - We will look to engage Dr Rachel Groom leading project 3.19 for the Marine and Coastal Hub, developing a marine research strategy for Kakadu. We will also work more broadly with the hub to help identify values, vulnerabilities and spatially explicit information for Kakadu.

Indigenous consultation and engagement

Which updated Three-category approach the project meets	**Communicate (3)** ☐	**Co-design (2)** ☒	**Indigenous led (1)** ☐

-

- Kakadu is an Aboriginal owned and jointly managed park, home to Binninj/Mungguy people. Partnership with Traditional Owners and other members of local communities will be central to the project.

- Gondwana Rainforest WHA (Queensland section) includes five properties managed principally by principally by the Queensland Parks and Wildlife Service (as part of the Queensland Department of Environment and Science (DES)) in partnership with First Nations peoples. The Climate Systems Hub's Indigenous Partnerships Strategy incorporates six principles. Below we outline how we will follow these in this project as appropriate:

Principle	**Project approach/es**
Indigenous partnerships based on respect and mutual benefit	Follow co-design principles that allow for shared power Coordinated co-design approach through KNP's existing processes of engagement and relationships
Acknowledgement of the right to Indigenous Cultural and Intellectual Property (ICIP).	Identify existing ICIP and any storage or access arrangements for project Offer co-authorship opportunities
Adherence to an approach of co-created research	Development of project plan for each property that includes agreement on cultural governance and engagement approach
Indigenous-led governance will be facilitated through participation of the Climate Systems Hub Indigenous Facilitator in the activities of the NESP Indigenous Facilitation Network (IFN).	N/A
Building successful Indigenous partnerships that are relationships focussed	Respect and leverage existing relationships between partners and Traditional Owners Provide adequate investment and support to allow Traditional Partner engagement in project
incorporate individual approaches into all Indigenous partnerships that are flexible, adaptive, and respectful of the availability and capacity of Traditional Owners	Agree project plan for each property that considers cultural governance, engagement, ICIP and FPIC Engage with existing governance structures (for example, Kakadu National Park Board)

- The project is currently classified under the updated 3-category approach as tier 1: communicate. We wish to enable shared power in our co-design approach but will need to further build on those existing relationships held by Parks Australia and DES to understand

the wishes and role of Traditional Owners in participating in this project. It is possible we may achieve tier 2: co-design for parts of the project as we progress.

This project is aligned to the hub's Indigenous partnerships strategy and adheres to the NESP Indigenous Partnership Principles. These principles will strengthen relationships but also foster positive Indigenous engagements. These engagements will allow for trust, transparency and respect to be strengthened over time. The adoption of these approaches will ensure maintenance of appropriate Indigenous engagement throughout the project's lifecycle, and that the project legacy is available to communities engaged with, and more widely as suitable. Project Indigenous engagement will be measured through the hub's monitoring and evaluation framework and process.

Every Indigenous community in Australia is different. Informed partnership processes reflect responsible and transparent engagement underpinned by Indigenous people having the right to their Indigenous Cultural and Intellectual Property (ICIP), and Free, Prior and Informed Consent (FPIC).

The incorporation of the updated NESP 3 category approach to Indigenous partnerships - Indigenous led, Co-Design and Communicate - during the engagements will optimise the project outcomes and outputs thus allowing for project success to be achieved.

The Climate Systems Hub in partnership with the National First Peoples Platform on Climate Change have called for collaboration with climate scientists. This request is for, but not limited to, current understanding and future projections of seasonal patterns that are impacting or anticipated to impact both natural and cultural indicators within Indigenous knowledge systems.

- The scientific field work (outside scope of this project) conducted through the various communities will provide valuable data for Indigenous people, thus allowing for adaptation measures to be implemented in caring for Country. Incorporating the National First Peoples Platform on Climate Change in elements of the co-design process will support scientists in the development of specific case-studies.

Project milestones

Milestones	Due date	Responsible person
Milestone 1 – Signing of contract between hub lead and research organisations	1 Oct 2024	Sarah Boulter
Milestone 2 – Establish any governance arrangements, cultural governance arrangements, partnerships and draft a detailed project plan for each case study. First quarterly progress report submitted	15 Dec 2024	Sarah Boulter, Nicholas MacGregor, Angela Siggery
Milestone 3 – ICIP agreement and protocols for FPIC negotiated with Traditional Owners as needed	15 Jan 2025	Marian Sheppard
Milestone 4 – Kick-off meeting for Kakadu case study held. Values table completed for Kakadu	15 Jan 2025	Sarah Boulter, Nicholas MacGregor
Milestone 4 – First vulnerability workshop for Gondwana completed	28 Feb 2025	Sarah Boulter, Ellen Weber
Milestone 5 – Second workshop for Gondwana complete.	15 Mar 2025	Marian Sheppard, Sarah Boulter
Milestone 6 – Hazard information collated and made available for Kakadu	30 Apr 2025	Vanessa Round, Marian Sheppard
Milestone 7 – Adaptation plan for Gondwana complete	15 Jun 2025	Sarah Boulter, Ellen Weber
Milestone 8 – First draft vulnerability assessment for Kakadu complete	15 Jun 2025	Sarah Boulter, Nicholas MacGregor
Milestone 9 – Options workshop completed and list of options compiled for Kakadu	30 Nov 2025	Sarah Boulter, Nicholas MacGregor
Milestone 10 – Evaluate options and construct pathways for Kakadu	30 Mar 2026	Jess Melbourne-Thomas,
Milestone 11 – Develop monitoring and evaluation approach for Kakadu	30 Jun 2026	Sarah Boulter, Nicholas MacGregor
Milestone 12 – Draft adaptation plan complete for Kakadu	30 Aug 2026	Sarah Boulter, Nicholas MacGregor
Milestone 13 – Implementation guide and case studies for protected places completed	30 Nov 2026	Sarah Boulter

Data and information management

The project will take an approach to ensure all outputs meet the FAIR data principles – Findable, Accessible, Interoperable, and Reusable – in conjunction with the CARE principles for any Indigenous Cultural and Intellectual Property (ICIP) – Collective benefit, Authority to control, Responsibility, and Ethics. Together, these aim to ensure all data are easily shared and reused, but also used ethically. The project will adhere to principles of ICIP and acknowledge data sovereignty elements in all project outputs for any ICIP.

A data management plan will serve as a record of all datasets and other information used as inputs and outputs for the project, including any models and code/software. The plan will ensure consideration has been given to how the data associated with the project will be managed and that appropriate resources are devoted to data management.

The *NESP data and information guidelines* and the Climate Systems Hub Data Management Strategy detail the fundamental approach to data management and the many aspects projects need to consider, including dealing with ICIP. The Data Wrangler will provide any guidance needed by the Project Lead and the project's Data Custodians.

FAIR Data Principles

While it is acknowledged that projects will not know all the details at the outset, how and where project outputs will be made freely and openly available needs to be considered. Different types of data and information will require different approaches. The principles of the Data Management Strategy on how different data types will be managed are summarised in the following table, noting that not all data types are applicable to every project.

Project output	Data management and accessibility
All data/information products	• Research data and outputs will be well-documented according to accepted and trusted standards, including principles of ICIP. A key requirement for all research products generated by the hub research will be following metadata standards based on accepted best practice • Data will be made publicly available whenever legally, ethically and contractually possible, under an open licence policy except in particular cases, with particular. A record of these exceptions will be kept, and exceptions reported regularly to the Department • Data and other research output will be stored in repositories that are accessible to end-users and other researchers, with the choice of repository based on practicalities of the data and its likely use, and stored in such a way as to endure and remain FAIR well beyond the life of the project • The project will develop its own data management plan, with identified data custodians responsible for managing the data • The nature of research outputs, their formats and repositories, will be developed through a co-design

Project output	Data management and accessibility
	process involving stakeholders and end-users to ensure data meet their requirements and are fit-for-purpose, and will evolve through ongoing consultation • Research outputs and data will be accompanied by documentation providing guidance to users on how best to make use of the data • The hub will maintain a metadata catalogue of all research data, and all metadata will be published on other public metadata catalogues • Outputs such as websites will follow the Web Content Accessibility Guidelines (WCAG), and include an accessibility statement.
Scientific publications and reports	• Publications and reports will be made available through the CS Hub website and/or appropriate peer-reviewed scientific journals.
Application ready data sets	• To be published in public repositories. • Data services made available to enable ingestion into end-user models and decision-support tools.
End-user products	• Published in appropriate medium such as print or a scientific journal. • Captured in metadata catalogues. • A copy will be stored on the hub website for public access.
Raw research data	• Stored on infrastructure where generated and where they can be shared, as appropriate under ICIP considerations, with other researchers.

Location of research

The table below describes the scale at which the project will be working, and the location/s where the majority of the project research will be conducted.

At which spatial scale is the project working	**National** ☐	**Regional** ☒	**Local** ☐
Location(s) – gazetted region /place name	Kakadu National Park Gondwana Rainforests of Australia World Heritage Area (Qld Section) Darwin Canberra Melbourne Hobart Brisbane		
Aboriginal or Torres Strait Islander nation or traditional place name(s)			

Project-specific risks

Risk	Potential impact on project	Likelihood (rare, unlikely, possible, likely, highly likely)	Consequence (minor, moderate, high, major, critical)	Risk rating (low, medium high, severe)	Treatment to reduce or manage risk
Interruption to travel for on Country participants	Lower attendance than planned; viability of workshop	Possible	Moderate	Medium	Will work with Parks Australia and Resilient Landscape Hub to plan workshops, to minimise risk as much as possible.
Budget insufficient for activity ambition	Viability of project	Possible	High	High	Funding has been included for workshops based on advice from Parks Australia and RL Hub.
Lack of availability of staff (one staff member left partner agency and another went on long leave)	Research staff have no allocation to produce co-design activities	High – already occurred	High	High	New research staff have been identified to work on project that have culturally appropriate training and understanding of working with First Nations. Project team is seeking lost capability from elsewhere.
Weather on Country	Some of the activities on Country will need to be adjusted if	Likely	Moderate	Medium	Will be managed ensuring there are plans in place for evacuation in

Risk	Potential impact on project	Likelihood (rare, unlikely, possible, likely, highly likely)	Consequence (minor, moderate, high, major, critical)	Risk rating (low, medium high, severe)	Treatment to reduce or manage risk
	there is inclement weather				case of fire or undercover activities in case rain
Lack of existing relationship between CS Hub and Park managers.	Insufficient time to build trust and	Possible	Moderate	High	Partnering with Parks Australia, RL Hub and QLD DES will enable CS Hub to build on existing relationships, instead of starting fresh.

Project keywords

Protected places management, climate adaptation, biodiversity, rainforest, wetland

Project CS4.3 – ‘Adapt Land and Sea’ - a cross hub biodiversity adaptation knowledge platform

Project type: Co-funded cross-hub research project	
Project status: Existing project seeking amendment	
Cross-cutting initiative:	Yes Climate adaptation initiative
Project start date: 01/01/2024	**Project end date**: 31/12/2026
Total project budget: $1,763,500(GST exclusive)	**NESP funding:** $ (GST exclusive) • Climate Systems • 2024 $205,060 • 2025 $366,192 • 2026 $360,300 • Resilient Landscapes $250,000 **Co-contributions (cash and in-kind):** $ (GST exclusive) • Climate Systems • 2024 $201,501 • 2025 $323,651 • 2026 $306,796
Project leader details:	Name: Jenny Styger Organisation: University of Tasmania Phone: 0427 123 871 Email: jennifer.styger@utas.edu.au

Project summary

This project continues the Climate Systems Hub’s program of providing curated climate information and data from hub projects and other sources to support stakeholders’ decision-making and adaptation needs. Presently, very little information exists to assist managers of biodiversity adapt to climate change. At the same time, NESP projects are producing research, data and outputs that can be of assistance to land and sea managers dealing with climate change.

- An online adaptation decision support and knowledge platform will assist biodiversity managers as well as provide a platform for all four NESP Hubs to house outputs relevant to climate adaptation for biodiversity. Through information synthesis, careful curation, co-

design and collaboration with NESP projects, project 4.3 will build a climate adaptation knowledge platform for biodiversity.

Pathway to impact

Outcomes
• The central outcome of this project is improved ability for biodiversity managers to strengthen their capability to adapt to climate change. The project offers a platform to disseminate and operationalise relevant NESP2 content produced across various projects. • Co-design will be a central feature in the development of the platform. A user-needs analysis will ensure awareness amongst key stakeholders, providing opportunity for end-users to shape content, leading to an end user-focused outcome that results in an increase in the number of biodiversity managers considering climate risk and adaptation options.

Research-user	**Engagement and communication**	**Impact on management action**	**Outputs**
Conservation, biodiversity, protected places and land managers	Co-design, scoping and needs analysis for delivery of synthesised and curated biodiversity adaptation platform. Engagement with end-users in guiding development of conservation adaptation knowledge platform.	Access to synthesised guidance on approaches to adaptation in conservation management and evolving community of practice.	Biodiversity adaptation knowledge platform with step-by-step guidance on adaptation planning
DCCEEW: National Adaptation Policy Office, Parks Australia, Wetlands Section, World and National Heritage Branch	Co-design of outputs with stakeholders and relevant hub projects, particularly CS4.1 and CS 2.7	Detailed robust information is currently lacking, impeding climate adaptation planning Co-designed information and data products will assist more robust decision-making and on-ground management actions	Biodiversity adaptation knowledge platform with step-by-step guidance on adaptation planning
Catchment Management Authorities/ NRM bodies/ Conservation NGOs	Co-design of outputs with stakeholders and relevant CS Hub projects, particularly CS2.7	Co-designed information and data products will assist more robust decision-making and on-ground management actions	Biodiversity adaptation knowledge platform with step-by-step guidance on adaptation planning Case studies of adaptation options
All stakeholders	Identification of topics through ongoing co-design activities among stakeholders.	Co-designed information and data products will assist more robust decision-making and on-ground management actions	Biodiversity adaptation knowledge platform with step-by-step guidance on adaptation planning

			Information sheets and case studies
First Nations peoples	Work with the hub’s Indigenous Facilitator and project CS4.1 team to identify opportunities to collaborate.	Build confidence in Indigenous communities to understand climate risks and undertake adaptation planning. Improve access to information for First Nations peoples	Biodiversity adaptation knowledge platform
Additional outputs • Publication of research reports and submission of peer reviewed academic journal articles • Presentations at scientific conferences, workshops and events for public engagement			

Project description

Project description

1. Key challenge to be addressed

Climate change is going to profoundly alter the natural world, resulting in loss of species and ecosystems, shifts in their current distribution and the creation of novel environments. Biodiversity managers are no longer able to rely on business as usual and must consider options for adapting to a new climate.

Currently very little support exists to provide guidance on climate adaptation options for biodiversity managers. At the same time, many projects across all four NESP Hubs are producing research outputs and datasets that are relevant to this problem.

To assist in climate adaptation, biodiversity managers need robust climate change information and datasets that are trusted, readily understood and appropriate to their needs. They also need advice and guidance on when and how to appropriately use climate information, and when not to use it.

This project will develop a cross-hub adaptation knowledge platform for biodiversity managers that brings together and curates options, guidance and research outcomes for biodiversity climate adaptation from across all four NESP Hubs and other relevant Australian research.

2. Approach

A three-phase approach has been adopted for this project. **Phase one** is the initiation phase and involves gathering background information and engaging with content producers to inform platform content. **Phase two** is the build phase and involves the specifics of the platform development including a user-needs analysis and writing content. **Phase three** is the launch, test, and dissemination phase.

Phase 1 - initiate

As part of the initiation phase, a desk-top review will be conducted to develop a state of play report that outlines current adaptation support tools already available for biodiversity managers, summarises conservation governance arrangements, identifies gaps and opportunities and presents a generic adaptation planning framework.

At this stage of the project, networks will be forged with biodiversity managers across Australia and potential case studies highlighting biodiversity adaptation will be collected.

Phase 2 – build

As part of the build phase, a user-needs analysis will be undertaken to best shape platform content. The user-needs analysis will be both a series of face-to-face workshops held in major centres and a written survey to reach more widely.

A web development plan will be developed, outlining site hosting arrangements, plans for site longevity, a site map and sketch of site content.

Phase 3 – launch and test

Phase 3 will see the site launched, ideally with a beta version at the Climate Adaptation conference in 2025. A communications plan will be developed to most successfully promote

the site. Following the launch of the beta version, detailed user-testing and feedback surveys will be conducted to assist in improving site content and functionality.

3. **Research links**

This project will foster direct links between many NESP projects as it provides a repository for research outcomes.

Drawing from the work of CS2.1 *Enabling best practice climate adaption,* this project will incorporate findings to improve biodiversity adaptation outcomes. Working closely with project CS4.2 *Synthesis, communication, and data: Tailored information for stakeholders* and hub Knowledge Brokers, synthesized and curated climate information will form part of the content of ConservationAdapt.

Project CS2.7 *Climate-effective management for threatened species and protected places* is developing a database of adaptation options for threatened species and ConservationAdapt provides an ideal platform to house this database online with cross-hub outcomes and the climate adaptation initiative. Regional climate information produced by project CS2.5 *Regional climate change guidance for local action* can contribute to relevant regional platform content.

Several projects from the Resilient Landscapes Hub are producing content relevant for featuring on ConservationAdapt. This includes a new project with Bush Heritage Australia on conservation innovation, adaptation planning for the Northern Rivers region, species impacts of heat stress, wet season burning in Kakadu and the identification of fire refugia in the Blue Mountains and Wet Tropics.

Additional research links will be developed with other hubs and external researchers and biodiversity managers as the project proceeds.

4. **Application of research to inform on-ground decision makers**

The principal output will be the ConservationAdapt web platform. As per the hub Data management strategy, the ConservationAdapt platform will be hosted on a freely accessible, high-profile site that is not dependent on NESP2 funding.

ConservationAdapt will present tailored information outputs from NESP researchers and the wider Australian research community to on-ground biodiversity decision makers, and present step-by-step guidance on adaptation planning written in plain English. ConservationAdapt will include a range of products that assist managers and policy makers with climate adaptation for biodiversity conservation. We will work with users and experts to identify content needs. Likely content will include:

- A generic adaptation framework
- Decision support approaches
- Case studies
- Information sheets and links to other relevant information sources
- Curated climate data visualisation
- Database of adaptation strategies for biodiversity conservation.

Is this a cross-hub project?

- The Climate systems Hub will lead the scoping and development of this cross-hub conservation adaptation knowledge platform.

- All hubs have committed support to the project through contribution to a working group, sharing information and materials and contributing to knowledge brokering.
- It is expected all hubs will participate in the Working Group, develop and write content and as appropriate contribute data for visualisation components.

Does this project contribute to a cross-cutting initiative?

This project delivers to all four outcomes of the climate adaptation initiative:

- Climate change adaptation focused research and outputs are produced across the NESP Hubs
- Strong end-user capacity, uptake and application of evidence-based climate systems research and adaptation information
- Decision support tools are delivered that enable application of climate change adaptation on the ground
- Adaptation decision-makers, adaptation researchers and climate scientists are supported to share learnings and build relationships.

It delivers to the Threatened and Migratory Species and Threatened Ecological Communities Initiative outcome:

- Policy, investment and on-ground action to halt the loss of and recover Australia’s threatened and migratory species and threatened ecological communities is better informed by scientific and Indigenous knowledges.

It does this through delivering accessible information to support management approaches that reduce risks from climate change.

It delivers to the Protected Places Management Initiative outcome 2:

- Improving the governance of Australia’s protected areas by identifying effective interventions and approaches to management and highlighting opportunities to develop complementary approaches between programs and across land sea/nexus.

The project will be carried out and led by the Climate Systems Hub.

Indigenous consultation and engagement

Which updated Three-category approach the project meets	**Communicate (3)** ☒	**Co-design (2)** ☐	**Indigenous led (1)** ☐

- This project is a category 3 project under the updated NESP 3 category approach. Direct collaboration and co-design of outputs will be facilitated through the Indigenous Facilitator and project CS4.1.

This project is aligned to the hub’s Indigenous partnerships strategy and adheres to the NESP Indigenous Partnership Principles. These principles will strengthen relationships but also foster positive Indigenous engagements. These engagements will allow for trust, transparency and respect to be strengthened over time. The adoption of these approaches will ensure maintenance of appropriate Indigenous engagement throughout the project’s lifecycle, and that the project legacy is available to communities engaged with, and more widely as suitable. Project Indigenous engagement will be measured through the hub’s monitoring and evaluation framework and process.

Every Indigenous community in Australia is different. Informed partnership processes reflect responsible and transparent engagement underpinned by Indigenous people having the right to their Indigenous Cultural and Intellectual Property (ICIP), and Free, Prior and Informed Consent (FPIC).

The incorporation of the updated NESP 3 category approach to Indigenous partnerships - Indigenous led, Co-Design and Communicate - during the engagements will optimise the project outcomes and outputs thus allowing for project success to be achieved.

The Climate Systems Hub in partnership with the National First Peoples Platform on Climate Change have called for collaboration with climate scientists. This request is for, but not limited to, current understanding and future projections of seasonal patterns that are impacting or anticipated to impact both natural and cultural indicators within Indigenous knowledge systems.

The scientific field work (outside scope of this project) conducted through the various communities will provide valuable data for Indigenous people, thus allowing for adaptation measures to be implemented in caring for Country. Incorporating the National First Peoples Platform on Climate Change in elements of the co-design process will support scientists in the development of specific case-studies.

Project milestones

Milestones	Due date	Responsible person
Milestone 1 – Signing of contract between hub lead and research organisations	1 February 2024	Simon Marsland
Milestone 2 – Establish any governance arrangements, cultural governance arrangements, partnerships and finalise a detailed project plan.	30 March 2024	Jenny Styger, Sarah Boulter
Milestone 4 – Submission of quarterly project progress reports	30 Mar, 30 Jun, 30 Sep each year	Jenny Styger
Milestone 5 – Working group meets at least three times per year	Each year	Jenny Styger
Milestone 6 – User needs workshops and survey	30 June 2024	Jenny Styger, Knowledge Brokers, TBC
Milestone 8 – Web development plan finalised	31 October 2024	Jenny Styger, TBC
Milestone 9 – Finalise hosting and site build arrangements	31 October 2024	Jenny Styger, Sarah Boulter
Milestone 10 – Finalise initial written content for platform	31 March 2025	Jenny Styger, TBC
Milestone 7 – Gather case studies and other content	31 March 2025	Jenny Styger, TBC
Milestone 11 – Finalise communications plan for promotion	1 March 2025	Jenny Styger, TBC
Milestone 12 – Launch beta version of site	To coincide with Climate Adaptation conference, approx July 2025	Jenny Styger, Sarah Boulter
Milestone 13 – Collect and collate end-user feedback, make site improvements	30 March 2026	Jenny Styger
Milestone 14 – Final launch	2026	Jenny Styger, Sarah Boulter

Data and information management

The project will take an approach to ensure all outputs meet the FAIR data principles – Findable, Accessible, Interoperable, and Reusable – in conjunction with the CARE principles for any Indigenous Cultural and Intellectual Property (ICIP) – Collective benefit, Authority to control, Responsibility, and Ethics. Together, these aim to ensure all data are easily shared and reused, but also used ethically. The project will adhere to principles of ICIP and acknowledge data sovereignty elements in all project outputs for any ICIP.

A data management plan will serve as a record of all datasets and other information used as inputs and outputs for the project, including any models and code/software. The plan will ensure consideration has been given to how the data associated with the project will be managed and that appropriate resources are devoted to data management.

The *NESP data and information guidelines* and the Climate Systems Hub Data Management Strategy detail the fundamental approach to data management and the many aspects projects need to consider, including dealing with ICIP. The Data Wrangler will provide any guidance needed by the Project Lead and the project’s Data Custodians.

FAIR Data Principles

While it is acknowledged that projects will not know all the details at the outset, how and where project outputs will be made freely and openly available needs to be considered. Different types of data and information will require different approaches. The principles of the Data Management Strategy on how different data types will be managed are summarised in the following table, noting that not all data types are applicable to every project.

Project output	Data management and accessibility
All data/information products	• Research data and outputs will be well-documented according to accepted and trusted standards, including principles of ICIP. A key requirement for all research products generated by the hub research will be following metadata standards based on accepted best practice • Data will be made publicly available whenever legally, ethically and contractually possible, under an open licence policy except in particular cases, with particular. A record of these exceptions will be kept, and exceptions reported regularly to the Department • Data and other research output will be stored in repositories that are accessible to end-users and other researchers, with the choice of repository based on practicalities of the data and its likely use, and stored in such a way as to endure and remain FAIR well beyond the life of the project • The project will develop its own data management plan, with identified data custodians responsible for managing the data

Project output	Data management and accessibility
	• The nature of research outputs, their formats and repositories, will be developed through a co-design process involving stakeholders and end-users to ensure data meet their requirements and are fit-for-purpose, and will evolve through ongoing consultation • Research outputs and data will be accompanied by documentation providing guidance to users on how best to make use of the data • The hub will maintain a metadata catalogue of all research data, and all metadata will be published on other public metadata catalogues • Outputs such as websites will follow the Web Content Accessibility Guidelines (WCAG), and include an accessibility statement.
Scientific publications and reports	• Publications and reports will be made available through the CS Hub website and/or appropriate peer-reviewed scientific journals.
Application ready data sets	• To be published in public repositories. • Data services made available to enable ingestion into end-user models and decision-support tools.
End-user products	• Published in appropriate medium such as print or a scientific journal. • Captured in metadata catalogues. • A copy will be stored on the hub website for public access.
Raw research data	• Stored on infrastructure where generated and where they can be shared, as appropriate under ICIP considerations, with other researchers.

Location of research

The table below describes the scale at which the project will be working, and the location/s where the majority of the project research will be conducted.

At which spatial scale is the project working	**National** ☒	**Regional** ☒	**Local** ☒
Location(s) – gazetted region /place name	Australia wide. End-users will be engaged from across Australia. Most activities will be desktop analysis conducted across various offices including Canberra and Hobart..		
Aboriginal or Torres Strait Islander nation or traditional place name(s)	Current project members work on Ngunnawal country and Muwinina country, but the location of future work will be determined by engagement with cross-hub projects.		

Project-specific risks

Please refer to Research Plan Attachment D – Risk for specific risks associated with this project.

Risk	Potential impact on project	Likelihood (rare, unlikely, possible, likely, highly likely)	Consequence (minor, moderate, high, major, critical)	Risk rating (low, medium high, severe)	Treatment to reduce or manage risk
Difficulties obtaining and sustaining buy-in from other cross Hubs.	Diminishes the relevance as a cross-hub project. Limits the scope and potential of the eventual output.	*Likely*	*Moderate*	*Medium*	Engage Hub leaders and SPS via a project steering committee to build supoprt for project and keep Hubs engage
Failure to find appropriate site hosting arrangements.	Cannot support the eventual project output.	Possible	Major	High	Project staff remain open-minded to all opportunities. Begin discussions early.
Difficulties finding appropriate resources (staff/web developer/graphic designer)	Cannot support the eventual project output.	*Unlikely*	*Major*	*High*	Reach out to cross hub members for assistance Reach out to ACS as this program are developing protals
Lack of end-user engagement in the project	Limited co-design diminishes utility and take-up of the product.	*Unlikely*	*High*	*Medium*	Work with Knowledge Broker/s to assist on this matter.

Project keywords

Provide 5 keywords to describe the project.

Biodiversity, climate adaptation, guidance, information curation, platform.