

National Environmental Science Program

Sustainable Communities and Waste Hub
research plan 2025 (variation)–
Attachment B project plans- IP4



Contents

Preface – List of changes to IP Research Plans	iii
Project IP4.05 – Improved Air Quality, Forecasting and Assessment	2
Pathway to impact.....	4
Project description	8
Indigenous consultation and engagement.....	24
Project milestones	25
Data and information management.....	28
Location of research	29
Project keywords.....	30

Project IP4.05 – Improved Air Quality, Forecasting and Assessment

Project type: Hub research project	
Project status: Existing project seeking amendment and new project submitted for approval	
Cross-cutting initiative:	No
Project start date: 01/07/2022 For IP4.05.05- 01/07/2025 (New project)	Project end date: 30/12/2026
Project leader details:	<p>IP4 co-leads:</p> <p>Name: Amanda Wheeler Organisation: CSIRO Environment</p> <p>Name: Prof Fay Johnston Organisation: University of Tasmania</p> <p>IP4.02.01</p> <p>Name: Erin Dunne Organisation: CSIRO Environment & Name: Amanda Wheeler Organisation: CSIRO Environment</p> <p>IP4.02.02</p> <p>Name: Dr Kathryn Emmerson Organisation: CSIRO Environment</p> <p>IP4.02.03</p> <p>Name: Prof Fay Johnston Organisation: University of Tasmania</p> <p>IP4.02.04</p> <p>Name: A Prof Donna Green Organisation: UNSW</p>

	IP4.05.05 Name: Amanda Wheeler Organisation: CSIRO Environment
Cross-hub contact details: (If applicable)	Name: Amelia Tandy (IP4.02.01) Organisation: Climate Systems Hub Name: Marcus Thatcher (IP4.02.02) Organisation: Climate Systems Hub

Pathway to impact

Outcomes

This multi-year project proposes to build upon activities from RP2022 and those yet to be undertaken in IP4.

The outputs from IP4.02.01 – ‘Let’s Yarn About Smoke’, a foundational project, are intended to be a roadmap forward for cooperation and engagement in a broad scope of Indigenous identified research priorities, stakeholders and potential opportunities. Activities undertaken will contribute to better management of the impacts of smoke from planned and unplanned fires on Aboriginal and Torres Strait Islander people and the broader Australian community.

We do anticipate that outcomes will generate key findings to support public guidance, policy development and roadmaps to improve Australian air quality and reduce population exposures.

The following proposed activities and outputs represent potential opportunities within existing activities that IP4 researchers are presently engaged.

The following are anticipated outcomes for RP2023 - 2026 activities:

Informing policy and frameworks

IP4.02.03 will develop methodologies that can be implemented by local governments to reduce homeowners’ reliance upon wood heaters for home heating. It will also inform policies to support the phase out of wood heaters.

IP4.02.04 will contribute to the improved guidance on the use of HEPA filters for air quality in public spaces, guidelines on the selection and use of low-cost sensor networks for the management of local air quality problems and a roadmap for interventions to reduce exposure on high air pollution days. The evaluation of safer air centres where the public can seek refuge during poor air quality episodes will generate a policy brief, a communication kit for local government and local health districts, and a cost-benefit analysis.

IP4.02.02 will provide a lens on how altered we can expect air quality to be under future emission scenarios in Australia. The research outcomes will be used by government agencies for managing future changes to air quality and health.

IP4.05.05 will support the development of the methodology for a review of the Australian ambient air quality standards. The review methodology will be developed in consultation with relevant policy and regulatory officials from the state and territory and Commonwealth environment and health agencies.

Community benefits

IP4.02.04 will deliver plain English guidance for the use of HEPA cleaners and outcomes of the comparison testing and intervention studies, the public and stakeholders will be able to make more informed decisions on purchasing cleaners to reduce their exposure to air pollution.

With the additional support of an (Early -Mid career researcher (EMCR) CSIRO-based researcher we will develop a guidance document for local governments on the selection methodology of public buildings for use during poor air quality episodes.

Economic Benefits

IP04.02.03 will incorporate Discrete Choice Experiments to gather information on what drives individual decision making on wood heater use. These can be used to understand potential economic choices.

Environmental Benefits

The environmental value of project IP4.02.03 will be two-fold. Through the implementation of wood heater interventions and the assessment of their impact, this project aims to assess which interventions result in not only increased human health outcomes but also environmental health. The result of successful interventions should see an increase in ambient air quality, with a reduction in the pollutants being emitted from wood heaters – not only from the combustion of standard wood but from people burning other fuel sources, such as rubbish and treated wood. In addition to this, reducing the number of people who use wood heaters will reduce the environmental costs of sourcing wood to use as fuel. Currently it is estimated in Tasmania one third of wood burned in residential wood heaters is sourced from a ‘sustainable’ producer, with the majority being illegally taken from bushland. Dead wood plays a major role in the ecosystem of the Australian bush and its removal has ramifications far beyond releasing its stored carbon into the atmosphere.

Changes in ambient air quality will be measured in this project using EPA monitoring stations and low-cost air quality sensors.

Partnerships & Collaboration

IP4.02.01 will identify current and planned air quality activities through consultation and discussion with relevant partners. This lead to a roadmap that can be used to progress future smoke-related research activities. Partnerships with Healthy Environment and Lives Network (HEAL), Charles Darwin University and Asthma Australia were explored throughout RP2023 and are now in place. A sub-project with Charles Darwin University has been identified and funded by MRFF with activities are taking place in RP2024-26. Funding from CSIRO Indigenous research office is supporting an Indigenous research fellow and an Indigenous research associate to conduct yarning circles with communities in NSW, NT and WA to establish how communications around smoke exposure during landscape burns can be effectively shared.

IP4.02.03 will engage a broad range of stakeholders, including the LGA's responsible for air quality complaints related to wood heater emissions and Asthma Australia who are funding the woodstove changeout intervention. This will ensure that suitable educational material can be developed to support actions.

The IP4.02.03 and IP4.02.04 projects will also support the development of early / mid-career researchers who will have the opportunity to undertake and manage research activities with the support and guidance of the team. This will create future leaders in this research space. Additional funding has been applied for and provided to support both projects. This has enhanced the collaborations with Asthma Australia and other research organisations.

The expected longer-term outcomes of the projects include:

The ultimate outcome of this research over the course of the NESP program will be the reduction of exposure of Australian communities to poor air quality in future. This outcome contributes to Goals 3 and Goal 11 of the UN Sustainable Development Goals by reducing mean annual levels of particulate matter in cities and reducing mortality rates attributed to household and ambient air pollution.

The research will provide the tools and knowledge that will empower all scales of government to undertake a co-ordinated approach to interventions that will reduce exposure to air pollution and save lives. Outputs from this project that will contribute to this outcome will enable government to plan for the impacts of a warming climate on future air quality and to maximise the co-benefits of reducing emissions and improving air quality.

Research-user	Engagement and communication	Impact on management action	Outputs
<p>Department of Climate Change, Energy, Environment and Water (DCCEEW) (Environment Protection Branch, NESP Program)</p> <p>Community groups and national networks as well as industry partners, including Asthma Australia and Sustainability Tasmania.</p> <p>Burnet Institute</p>	<p>The needs of researchers and research-users will be identified through conversations and consultation during RP2022/23.</p> <p>Continual engagement is embedded in the workplan which will include workshops and regular virtual meetings.</p> <p>Research findings and project updates will be provided at quarterly meetings with the Department.</p> <p>IP4 project leads will meet quarterly with the Hub Knowledge Broker to identify opportunities for communications and knowledge translation. IP4 meets every other Monday, the Knowledge Broker will be invited to attend quarterly.</p>	<p>The research outcomes will:</p> <ul style="list-style-type: none"> Be used to assist the 2027 State of the Environment report to include an Indigenous co-author for the Air Quality Chapter. Work towards the NESP goal of finding ways to strengthen Indigenous knowledge, build strong partnerships and explore ways we might share and weave Indigenous and non-Indigenous knowledge that can be applied to improve the health of our environment and urban and regional communities. (IP4.02.02) inform the direction of future emissions and planning policy. (IP4.02.03) will test and compare different management options developed in 	<p>IP4.02.01 –</p> <p>A roadmap forward for further conversations and if appropriate, the development of project ideas to carry out in further years of this project.</p> <p>IP4.02.02 -</p> <p>Journal paper on 2050 air quality outcomes from anthropogenic emissions.</p> <p>Journal paper on 2050 air quality outcomes from biogenic emissions.</p> <p>Discussion paper reflecting on the model outcomes to assist policy decisions.</p> <p>Presentation of emission scenarios for the year 2050 and their impact on urban air quality at workshops and conferences.</p> <p>Factsheets summarising main project outcomes in plain English.</p> <p>IP4.02.03 –</p>

Research-user	Engagement and communication	Impact on management action	Outputs
		<p>collaboration with stakeholders.</p> <ul style="list-style-type: none"> This will have a direct pathway to influencing management – both through the process of establishing the research interventions and through the results that come from their evaluation. (IP4.02.04) Outcomes of the interventions using HEPA filtration will be vital to guide decisions relating the rapid retrofitting of public buildings as well as for new building regulations to reduce the ingress of air pollutants. The low-cost sensor network assessment will be used to evaluate the efficacy of interventions to reduce exposures to air pollutants. Improved air quality in classrooms and greater student awareness of the health and environmental impacts of pollution. Strengthened understanding and respect for Indigenous land management practices, including cultural burning. Practical experience for students in environmental monitoring, critical thinking, and collaborative decision-making. (IP4.05.05) the development of a review methodology will ensure that Australian ambient air quality standards are the best available for the protection of human health and the environment. 	<p>RP2023</p> <p>Appropriate monitoring network established and data integration systems in place.</p> <p>Pre-intervention data captured and assessed.</p> <p>Production of factsheets aimed at non-scientific readers.</p> <p>RP2024 & RP2025</p> <p>Interim data and evaluation reports on implementation trial results and progress of EMCR.</p> <p>RP2026</p> <p>Comprehensive evaluation report, including national and regional scale cost-benefit modelling, and recommendations for wood heater policy and strategy.</p> <p>Resource packages and other translation outputs produced as agreed with partners.</p> <p>Peer-reviewed manuscript on the benefits and challenges of the different interventions led by the EMCR.</p> <p>IP4.02.04</p> <p>Discussion paper including the results of the lab test on comparative HEPA filters available in Australia. Online tool to facilitate choice of low-cost sensors and HEPA filters for research-users</p> <p>Education materials about how best to use HEPA filters in different settings and how to respond to increased indoor air pollution identified by low-cost monitors.</p> <p>How and when to use LCS/ HEPA in concert with existing HVAC systems to improve air quality in public spaces.</p> <p>Significant effort will be made to translate research findings into plain English and communicated through</p>

Research-user	Engagement and communication	Impact on management action	Outputs
			<p>social media (infographics/fact sheets) as well as traditional peer reviewed papers and workshops/presentations.</p> <p>Enhanced STEM engagement through authentic data gathering and problem-based learning.</p> <p>A scalable, evidence-based model for improving indoor air quality in other Victorian schools and systems.</p> <p>Peer-reviewed manuscript on the findings related to the evaluation of public buildings as safer air havens led by the EMCR.</p> <p>IP4.05.05</p> <p>A methodology will be provided for the review of the Australian ambient air quality standards.</p>
Additional outputs N/A			

Project description

Project summary

Research in IP4 explores how air quality in Australia, while generally good, continues to cause significant health impacts from bushfire smoke, planned burns, wood-heaters, and local industrial pollution. Australia faces great challenges with a changing climate. Questions have been identified around how a changing climate will impact air pollution. A range of stakeholder engagement activities identified four air quality priorities that form the basis of four multiyear research projects:

- 1) engagement with Indigenous communities around smoke exposures and management of planned burns
- 2) modelling experiments based on a range of climate scenarios
- 3) evaluation of interventions to reduce population exposures to wood heater smoke and
- 4) effective use of low-cost sensors to quantify changes in air quality resulting from air quality interventions to create safer air quality havens.

A fifth project has been identified by DCCEE to develop the methodology to review Australian ambient air quality standards. This will be in consultation with relevant state and territory agencies. It will take into account any new data science and practice.

Project description

During RP2021, researchers in IP4 worked with stakeholders and partners to co-design a series of impactful research projects under the 'improved air quality, forecasting and assessment' research theme. These stakeholders and partners included the Department of Climate Change, Energy, the Environment and Water, (the Department) and other research-users such as state environment departments, local government, NGOs, Indigenous groups and other NESP hubs. This engagement included virtual meetings, a survey (completed by 80 participants), an interactive workshop involving 45 participants, and presentations to national bodies including the Healthy Environment and Lives Network (HEAL), the Australia New Zealand Aerosol Symposium and the Climate Adaptation cross-cutting program of the Climate Systems NESP Hub.

In addition, two standalone documents were generated in RP2021. These were a synthesis review of 'Public health messaging during smoke events' and a 'Survey of current guidance for low-cost sensor air quality monitors' both of which have been used to inform the Sustainable Communities and Waste (SCaW) Hub IP4 stream moving forward.

RP2022 and 2023 activities commenced but are not completed yet. Most projects are conducting further engagement with stakeholders to better target research activities. IP4.02.01 have commenced conversations with relevant stakeholders, have hosted a Key Thinkers Forum, and continue to engage with researchers. A roadmap of relevant Indigenous research activities has been created and we have been able to leverage other projects that are engaging with Indigenous communities around air quality. RP4 saw the commencement of a new partnership with Charles Darwin University researcher Dr Supriya Mathew who has been funded by the MRFF Indigenous Health grant round. This project includes Dr Wheeler (CSIRO), Professor Fay Johnston and Dr Penelope Jones (UTAS) as chief investigators to

assist with air quality monitoring in remote Indigenous communities in the NT. Additional funding has been granted to Dr Wheeler (CSIRO) by CSIRO's Indigenous Research Office to develop a communications framework on smoke messaging for Indigenous communities. Funding includes three states and will be completed by June 2026. This will be conducted in collaboration with the Djurali Centre and University of Sydney Indigenous researchers. IP4.02.02 will evaluate a range of climate change scenarios and potential emission reduction policies to determine which ones will be carried forward for full modelling. IP4.02.03 has engaged with stakeholders to develop a roadmap of novel interventions / actions that are now being trialled to reduce wood heater emissions. IP4.02.04 has evaluated the efficacy of a range of HEPA cleaners, how they can best be used and has generated a guidance document on their use to improve air quality in public spaces. The report developed in RP2021 on low-cost sensors has been used to generate a guidance document on their use in the management of local air quality problems. The project has now moved into the evaluation phase of using public buildings as safer air havens during poor air quality episodes. The Burnet Institute project 'Pathways to Clean Indoor Air' based in Victoria is evaluating indoor air quality in schools, offices and public buildings. This offers a collaborative opportunity to extend the methodology developed for IP4.02.04 by CI Green.

The addition of another project in RP2025/26 has been initiated by the Department to set out a methodology for the review of Australian ambient air quality standards. This will include targeted consultation with relevant state and territory agencies.

IP4.02.01 Lets Yarn about Smoke

This project is an amendment to extend Project IP4.02.01 – Let's talk about smoke, for 36 months into RP2025/6. We have renamed the project to be 'Let's Yarn about Smoke'. We have reassessed the time required to carry out the deep listening and conversations required to undertake the project with communities and recognise that it cannot be constrained to 12 months. The work planned for RP2022 and RP2023 has progressed well with several opportunities resulting. This includes the identification and inclusion of Indigenous researchers to design and lead aspects of the associated projects.

Aboriginal and Torres Strait Islander people are likely to experience greater exposures to smoke and such exposures are known to exacerbate poor health and wellbeing in those with already high burdens of risk factors and disease. Accessible, culturally appropriate tools and resources are required to help reduce Aboriginal and Torres Strait Islander peoples' exposure to harmful smoke. Furthermore, Indigenous fire management is playing an increasing role in fuel reduction and carbon farming initiatives. Co-designed air quality research, resources and tools are required to assist Indigenous communities in the planning and management of smoke exposures to achieve the desired environmental, economic and socio-cultural outcomes.

The problem

In RP2021, an IP4 co-design workshop found that planned and unplanned fire smoke was among the most important areas of concern for many stakeholder groups, however Aboriginal and Torres Strait Islander stakeholders were not explicitly consulted as part of this process. The disproportionate impact of bushfire smoke on Aboriginal peoples' health and the relative absence of First Nations voices in natural hazard risk management have been highlighted in recent reviews prepared for the Lowitja Institute and Centre for Aboriginal

Economic Policy Research [3][8]. The SCaW Hub recognises and values the experiences, perspectives and cultures of Indigenous Australians. The National Environment Science program provides an opportunity for redress and empowerment of Aboriginal and Torres Strait Islander communities to strengthen their adaptive capacity to mitigate and manage air quality impacts in a changing climate..

From a purely western health science perspective smoke is a known cause of adverse health outcomes. To date, air quality research, management, and communication initiatives on the impact of smoke has largely focused on the negative health impacts on urban populations. Conversely, Aboriginal and Torres Strait Islander perspectives and experiences of smoke are unique. There are complex interactions between historical, social, cultural, and environmental factors which influence Indigenous peoples' attitude to smoke. Accessible, culturally appropriate tools and resources are required to help reduce Aboriginal and Torres Strait Islander peoples' exposure to harmful smoke.

Aboriginal and Torres Strait Islander people are likely to experience greater exposures to smoke than the non-Indigenous population as a result of higher rates of smoking [1]; the use of open fires for cooking and heating [2]; higher representation in remote and regional areas that are more frequently impacted by smoke from planned burns and bushfires [3,4] and their important and growing role in land and fire management [3]; and carbon abatement [5]. Exposure to smoke results in comparatively worse health and wellbeing outcomes among Aboriginal and Torres Strait Islander peoples with already high burdens of risk factors and disease.

Indigenous fire management is playing an increasing role in fuel reduction and carbon farming initiatives. In Northern Australia, savanna burning projects have contributed 10% of the total national avoided emissions reported in the Emissions Reduction Fund to date, mostly through projects on Aboriginal land. The Aboriginal carbon industry generates an estimated \$20 million per year in carbon credits and has provided nearly \$100 million in total revenue. Indigenous savanna burning carbon credits attract a premium due to their significant economic, social, and cultural co-benefits for the Indigenous communities engaged in these projects [5]. However, as with any form of planned burning there is a potential to cause significant impacts on local and regional air quality [6]. For instance, a recent study has indicated that smoke from fires on Aboriginal land may be contributing to a deterioration of dry season air quality in Darwin [7] and it is likely savanna burning projects are a significant source of smoke from these areas.

Our response

While there is growing recognition of the value of Indigenous-led land and fire management, and community health initiatives, there has been very little involvement of Aboriginal and Torres Strait Islander peoples in air quality research and management activities in Australia. The SCaW Hub provides a timely opportunity for Aboriginal and Torres Strait Islanders' needs and priorities to be better represented in the Australian air quality research and management landscape. By bringing together practitioners from air quality, Indigenous health, and fire and land management domains with government and community stakeholders, this project aims to:

- learn from, and where possible, support existing Indigenous-led actions towards improving air quality and health; and

- identify opportunities to co-design air quality research, resources and tools that address Indigenous identified priorities for managing the impact of landscape smoke on the health of communities.

The goal of this multi-year project will be to build and maintain new partnerships among Indigenous researchers and communities and the air quality research community to develop:

- greater Indigenous engagement and leadership of activities in IP4
- a network of stakeholders with an interest in air quality, smoke and health
- a shared understanding of different attitudes to smoke from ecosystem burning, and perceptions of the impact of smoke on the health of Country and communities
- opportunities to learn from, and where possible, enhance existing Indigenous led actions towards improving air quality and health
- opportunities for new activities that address Indigenous identified research priorities
- enhanced capability and capacity in the non-Indigenous air quality research community to appropriately engage with Indigenous peoples in mutually beneficial relationships.

Methodology

Years 1, 2 and 3 (RP2022 - RP2024) have focused on building partnerships that support sharing knowledge about smoke. The IP4 team have:

1. Reviewed the existing research landscape and liaised with the SCAW Indigenous Advisory Committee, the Healthy Environment and Lives (HEAL) Network and the NESP Climate Systems Indigenous Reference Group to develop these connections and identify Indigenous researcher /teams/ organisations to lead/co-lead the project.
2. Supported Indigenous leadership/co-leadership through contributing to co-design of a broad scope of Indigenous identified research priorities and frameworks for knowledge sharing. RP2024-26 now includes two externally funded research projects. A CSIRO Indigenous Research grant to evaluate the use of the Air Quality Forecasting model (AQFx) in the development of a smoke messaging communications framework. This is being conducted in collaboration with the Djurali Centre and the University of Sydney. The aim of the study is to:

- a. co-design a communications framework that will support Indigenous communities during extreme smoke events

The second project is the recently announced Medical Research Future Fund (MRFF) 2022 Indigenous Health project grant ID - 2025273. Dr Wheeler (CSIRO), Professor Fay Johnston and Dr Penelope Jones (UTAS) have been included as Chief Investigators to support air quality monitoring for Yolngu residents and Miwatj Health staff in East Arnhem, NT. The aim of the study is to develop strategies to prevent multi-morbidity by:

- b. Improving environmental health awareness by crowdsourcing ground-based air quality, temperature, and humidity data in three east Arnhem communities through fixed and wearable sensor monitoring.
- c. Exploring lived experiences of Yolngu regarding the health impacts of extreme environmental exposures and potential measures that can be put in place to reduce health impacts.

- d. Test cultural suitability and applicability of the AirRater app to track and manage health symptoms related to extreme humid heat and poor air quality.

Both projects will leverage existing yarning circles to understand community concerns related to who in community is at risk from extreme smoke episodes and how would the community prefer to receive smoke forecasts / warnings.

3. Developed and continue to support opportunities to connect project leaders with stakeholders through meetings, workshops and hub communications and networks. The Key Thinkers Forum was hosted in March 2023 (RP2022) and has identified a range of priorities. Follow up forums are being considered.
4. With guidance from the SCaW Indigenous Advisory Group a plan has been implemented for appropriate training programs for the IP4 Team to undertake.
5. Governance, community participation and Indigenous knowledge underpin our co-design approach. We aim to produce actionable knowledge, methods, tools and data for transitions towards circular economies and more sustainable communities.

Linkages

Several SCaW Hub partner organisations and researchers are also among the 100 investigators and 30 institutions involved in the National Health and Medical Research Council (NHMRC) funded HEAL Network, whose broad aim is to “bridge the gap between knowledge and action” to address the impact of environmental change on health (<https://heal2021.com.au/>). An opportunity for the SCaW Hub to support a current HEAL project with Asthma Australia’s National Research Program has been leveraged. The aim of the Asthma Australia project is to translate current scientific evidence and findings from consumer group engagement into a suite of advice materials tailored for use by people of Aboriginal, and Arabic backgrounds, health professionals and policy makers to take practical actions to reduce exposure to air pollution. The focus of the proposed project has included communities in NSW and ACT that were impacted by the 2019/20 bushfires. Given the clear alignment between objectives of IP4, HEAL and Asthma Australia initiatives, collaboration in this project has provided a clear opportunity to value add on effort and resources, and improve co-ordination at the national level, discussions will be ongoing throughout RP2024-26 to explore additional research activities and outreach.

Is this a cross-hub project?

Possibly - linkages with the NESP Climate Systems Hub are likely to evolve over the course of RP2022-RP2026.

Does this project contribute to a cross-cutting initiative?

No

IP4.02.02 How will a changing climate and emissions reduction measures impact sources of air pollution and secondary pollutant formation?

The project is a modelling study that will provide a lens on how altered we can expect air quality to be under future emission scenarios in Australia. It will be guided by RP2022 literature review results investigating a range of climate change scenarios and emission reduction policies. This project extends the work in RP2022 and RP2023 to expand the scope of the initial application. It will leverage modelling capability in the Climate Systems

Hub and will potentially contribute to cross hub Initiative activities. The research outcomes will be used by government agencies for managing future changes to air quality and health.

The problem

Australia is committed to emission reduction measures that will help combat future climate change. These measures will impact the sources, types and strengths of anthropogenic emissions to the air and thus change the levels of air pollution and secondary pollutant formation in our cities. A warmer climate will also impact the strength of natural emissions and change the levels of chemical processing that occurs in the atmosphere. Whilst we expect reducing emissions to lead to less air pollution, the impact of increasing temperatures and drought on natural emissions and chemical processing could increase air pollution.

This project is a priority because it will provide a lens on which measures will have the greatest impact on air quality in 2050, giving us time to adapt and/or find solutions. The RP2021 stakeholder workshop recommended that there needed to be a range of model scenarios and their potential economic benefits conducted as these are key to targeting appropriate activities.

Our response

This multiyear project that commenced in RP2022 seeks to address the key research question: How will a changing climate and proposed emissions reduction measures impact sources of air pollution and secondary pollutant formation?

The goal of this project will be to complete the activities necessary to design and implement a set of future modelling experiments based on a range of climate scenarios.

Methodology

The literature review that commenced in RP2022 is guiding activities for RP2023-25. It informed the need for, and design of, a series of modelling experiments to address the research question being asked in RP2023. The literature search included a focus on how greenhouse gas emission mitigation also has an air quality benefit. Update for 2024: the literature review and discussions with the Climate Systems Hub expanded the scope of the modelling study, due to biases within each Global Climate Model (GCM) and the need to model a 'representative' future.

We will use a Chemical Transport Model (CTM) to run simulations under a range of future climate scenarios, provided by the Climate Systems Hub. These will be compared to a baseline run which will tell us the level of changes we might expect by 2050.

The model inputs and process needed to assess air quality in a future climate will be generated by IP4 and include:

1. Decide on a model baseline run.
2. Produce downscaled meteorology from a range of predicted climate futures.
3. Run simulations based on expected emission inventories for 2050.

1. Decide on a baseline run:

All changes in air quality need to be compared to a baseline set of conditions across an 'average' year. Our initial plan was to include a long-term average in criteria air pollutants spanning at least 15 years will be calculated. We have experience and can create this

dataset using observations from fixed term air quality monitoring stations, in combination with the spatially varying concentrations output from the chemical transport model.

Update 2024: Conversations with members of the Climate Systems Hub have:

- pointed out that my intention to use observations as the base case was flawed. The biases in each of the GCMs means that performing comparisons with a base simulation that did not contain these biases was not a fair comparison. The solution is to run additional 'base' simulations using the 'historical' archive from each of the GCMs. This will add another four model runs to the list.
- increased the length of each model simulation from 1 year to 5 years. The 'base' simulations are now 5 year runs from 2013-2017, and the future climate runs are now 2048-2052. Originally the runs were to be for 2015 and 2050 only.

The model simulation time has increased by a factor of 5 and will make for a more robust analysis of air quality outcomes for 2050, which was accepted by stakeholders. However, the additional simulation time means that each task proposed originally will take longer than specified.

2. Produce downscaled meteorology:

Within the CSIRO drought resilience program, we built the system for providing the CTM with downscaled meteorology from stored outputs from the decadal prediction project. The model was run in forecast mode with 6 ensemble members up until June 2023. It predicted the current wetter conditions brought about by La Nina in the south-eastern states.

Using the experience gained from that program, we will use the Conformal Cubic Atmospheric Model (CCAM) to provide the projected 2050 meteorology for the modelling. This work is being done within the Climate Systems Hub with whom we are collaborating as a cross-hub exercise. Prediction of the future is challenging; an ensemble of climate outcomes is more likely to provide a reasonable estimate. Ensemble projections will be chosen that accurately project historical data, as they are 'more likely' to represent future climate scenarios more efficiently. Overall, the ensemble average is expected to perform better than individual model runs. To best represent the mean spread, our experience recommends that more ensemble projections are better than less, and the number of ensemble projections will be determined as part of this project.

We will investigate the impacts of how short periods of extreme heatwaves will impact on air quality. These heatwave periods will be identified by the Climate Systems Hub and downscaled accordingly for use in the CTM.

3. Emission inventories:

Australia has a target for a 43% reduction on 2005 greenhouse gas emissions by 2030 to reduce the impacts of climate change. This reduction will also provide benefits for air quality. We will produce a range of simulations for the year 2050 which include cleaner emissions from transport, industry and domestic appliances, prioritised based on RP2022 and RP2023 outcomes. Examples of scenarios that could be investigated include:

- No petrol/diesel fuelled motor vehicles
- No domestic solid fuel / wood heaters

- No coal fired power station emissions
- No nitrogen oxides from commercial domestic operations
- Increased by-products from production of hydrogen, e.g. ammonia.
- Increased biogenic emissions from urban greening activities.

We could also look at some of the unintended by-products of cleaner technologies – i.e., the ammonia used in the production of hydrogen fuel – and the potential increase in biogenic emissions from vegetation in a warmer world.

This work will build on, and utilise, our expertise gained from when we developed the CTM to provide the capability to separate out the different emission types in the model. Initial work looked at the impacts of global warming on biogenic emissions from *Eucalyptus* and how this led to an increase of up to 20 ppb ozone (a secondary pollutant) in Sydney during a 2050 simulated summer [9].

Update 2024: Each scenario investigated will take approx. 70 days to run, process and analyse, due to the 5X increase in model simulations. With an FTE of 20% (40 days) per year, this limits the scenarios that can be run. We will decide which of the anthropogenic emissions scenarios are the most important for this project in consultation with our stakeholders. We will also run an ‘impacts of climate change only’ experiment to separate the impacts from climate change from the emission reduction strategies, as recommended by the literature review completed for RP2022.

4. Develop an urban street canyon simulation:

In view of the 5X increase in the number of years modelled for each future scenario in this project, development of the street canyon model will be dropped. This was discussed with stakeholders and it was agreed that there are limited applications within Australia related to street canyons so it would not be that informative to continue with this model.

Linkages

The research cuts across a number of themes within SCaW. IP1.02.01 looking at nature connection, including urban greening aspects will directly inform the extent of urban vegetation in the biogenic model simulation. Cities such as Sydney are aiming for 30-40% vegetation coverage and are predominantly favouring native species which could emit more volatile organic compounds. However, there is a trade-off between choosing drought tolerant plants able to survive heatwaves in future and their emission potential. We aim to explore this trade-off in the model and see what the impacts on urban air quality could be.

Is this a cross-hub project? Yes

The Climate Systems Hub are generating the Conformal Cubic Atmospheric Model (CCAM) to provide the projected 2050 meteorology for the modelling being proposed.

This project is a multi-year project that directly addresses the question “how will a changing climate and emissions reduction measures impact sources of air pollution and secondary pollutant formation”. This question lays in the remit of the Climate Adaptation Initiative and the project will involve significant collaboration with researchers in the Climate Systems Hub.

Does this project contribute to a cross-cutting initiative? No.

Project IP4.02.03 – Wood heaters: developing and testing novel solutions to a persistent problem

The problem

Wood heaters are one of the most important sources of anthropogenic air pollution in Australia. The listed estimates for deaths attributable to wood heater smoke by state, and the associated health costs, are derived from the CSIRO national air pollution model (AQFx), using the most recent wood heater inventory data available (table). The economic costs to Australia are estimated at \$3.3 billion each year, thus forming a large proportion of the annual \$6.2 billion attributable to air pollution from all anthropogenic sources combined, including wood heaters. It is the single most important source of anthropogenic particulate pollution in both Sydney and Melbourne, Australia's two largest cities.

State/Territory	Estimated deaths (mid scenario)	Percentage of daily PM_{2.5} attributable to WHS	Cost in \$millions
New South Wales	385	20.8%	1,730
Victoria	167	11.6%	749
South Australia	74	16.5%	334
Queensland	63	7.2%	285
Western Australia	24	4.0%	107
Tasmania	21	19.2%	95
Australian Capital Territory	8	11.1%	36
Northern Territory	0	0.1%	0
TOTAL	743		\$3,336

(Source. CAR seed funding grant 2022. Publication in preparation).

Despite being the most important single source of particulate air pollution, a national approach does not exist for mitigating the environmental and health impacts, regulation of wood heaters, or enforcement of environmental regulations. Mitigation of health impacts falls across multiple agencies across local, state and national levels of government. Investment in this issue offers the opportunity for highly cost-effective improvements in environmental, health and economic outcomes. The most effective interventions evaluated have been local area initiatives that reduce wood heater numbers such as the initiatives implemented in Launceston from 2000 using funding from the National Heritage Fund. While local councils recognise the problem, resource limitations are the primary reason cited for lack of progress in the area. However, if national investment is provided for initiatives throughout Australia, it is crucial that the investment is targeted towards practical and effective interventions. This

project aims to identify which interventions will provide the best return on investment for national policy and investment in mitigation strategies.

In RP2021, an IP4 co-design workshop found that wood heater smoke was a priority concern for many stakeholder groups. This multi-year project responds to the high level of interest identified via the NESP survey and co-design workshop in RP2021. The IP4 team understands that there are a range of challenges related to reducing wood heater emissions. These include barriers to healthy and cost-effective heating choices for homeowners and safer heater operation, practical difficulties with managing chimney emissions and limitations to current Australian heater manufacturing standards and their enforcement.

Our response

This amended multi-year program (IP3.02.03) aims to implement and evaluate novel solutions to wood heater emissions to (a) directly inform policy and (b) support the scaling up of successful interventions.

The program proposed for RP2023-RP2026 builds on co-design work currently underway with government, industry and community partners to identify intervention options.

The outcomes will provide practical guidance and solutions for decision makers across Australia. It is highly relevant to research-users, being identified as a high priority by stakeholders in the IP4 Air Quality RP2021 workshop.

IP4.02.03 project seeks to address key evidence and capability gaps by supporting and evaluating novel wood heater interventions. In RP2022, six regions were identified that experience wood smoke pollution, and that have air quality monitoring in place. Three regions will trial interventions, and three will act as controls. Current NESP partners have already been approached.

We have met with the Environmental Protection Agency Tasmania, Asthma Australia, ACT Health and researchers from Curtin University and Australian National University, amongst other stakeholders, and held a workshop in November 2022 to share ideas and refine plans for wood heater interventions. In addition, in RP2022 we conducted Discrete Choice Experiments (DCE) to gather information on what drives individual decision making on wood heater use. Based on the workshop, stakeholder meetings and the DCE, we have identified three interventions to be trialled from RP2023 onwards. The project is a multi-year project to ensure interventions can be rigorously evaluated, including with respect to health benefits and economic costs, over multiple seasons and in multiple contexts nationally. Partners will identify suitable locations where wood heater emissions are a known problem. Pre and post intervention evaluations will be conducted to ensure that impacts are quantified. All interventions will be suitable for local governments to manage going forward.

Based on the workshop findings and the DCE, we will work with partners in our identified regions to develop a roadmap of interventions to be implemented and evaluated via the multi-year research plan.

Methodology

IP4.02.03 is a multi-year plan, spanning RP2022 to RP2026 that seeks to:

1. Implement the roadmap developed via RP2022. Key steps will include:
 - a. Establish or augment existing air quality monitoring in the six target regions to ensure air quality data are captured at sufficient resolution.

- b. Support our partners / stakeholders to roll-out the interventions with appropriate data collection mechanisms in place.
 - c. Gather air quality and other relevant data (e.g., health symptom data, public and stakeholder perceptions/experiences) over wood heater smoke seasons.
- 2. Evaluate the effectiveness of the interventions with respect to:
 - a. Wood smoke exposure reduction
 - b. Health impacts
 - c. Economic impacts.

The provision of the EMCR funding means that there will be two PhD candidates and an EMCR research fellow to evaluate three of the interventions. Funding applications to support these interventions has been challenging hence the need to utilise the additional EMCR funds. Interventions include the evaluation of a wood heater changeout in Armidale, NSW, a behaviour change evaluation in Mount Barker, SA and a community-based behaviour change in Snug, TAS. These have been selected based on in-kind contributions from stakeholders and their willingness to participate.

- 3. Model the health and economic impacts of the interventions at regional and national scales.
- 4. Based on our results, produce a comprehensive assessment of the interventions trialled, together with a guidance package for local and state governments to support best practice wood heater policy, regulation and management. In addition, we will produce other outputs (e.g. resource packs, social media products etc) as determined via ongoing conversations with our partners.

The interventions to be trialled have been determined via the RP2022 consultation. Evidence-based options that will be included are:

- Subsidies for replacing wood heaters with reverse cycle air conditioner units

Currently, the Australian Capital Territory (ACT), NSW and Victorian governments offer subsidies to replace household wood heaters. Previously, rebates of up to \$1,250 were available to replace wood heaters with reverse cycle air conditioning. However, uptake of this scheme was low, with the payment failing to act as an incentive to change, and instead acting as a reward for those who could already afford to make the switch.

We will leverage the new trial program being undertaken in NSW. Partial costs of replacing a wood heater with a reverse cycle air conditioner in 25 residences in Armidale, NSW are being covered by the NSW Government. Additional funds are being provided by Asthma Australia. This aims to reduce the financial burden that has restricted many households from being able to make the change.

Replacing wood heaters with reverse cycle air conditioning also tackles the growing issue of cooling during the summer months, increasing the human health benefits of such initiatives.

- Creative arts schemes and education campaigns

While it has been shown that education campaigns are not effective drivers of long-term change in relation to wood smoke emissions, innovative schemes running alongside the

above interventions may increase their uptake and increase the level of community engagement. For example, social media posts, competitions, segments on sustainability programs may reach members of the community who are able to implement change but are not aware of the extent of the problem of wood smoke pollution. Behaviour change interventions are underway in Mt Barker, SA and will commence in Snug, TAS. Activities include focus groups, world cafes and air quality education programs. The EMCR funding will ensure that these initiatives can progress.

Overall, this research will allow local governments across Australia to gain an insight into cost-effective and practical interventions that are available when attempting to reduce wood heater smoke pollution. The most suitable option will depend on the local social, economic and environmental considerations, and so guidance will be context specific. By evaluating a range of interventions, it will provide local governments and policy makers a few options at different cost categories to use going forward.

Linkages

No linkages with other IPs.

Is this a cross-hub project?

No

Does this project contribute to a cross-cutting initiative?

No.

Project IP4.02.04 – Evaluation of interventions to reduce air pollution in safe havens and use of Low-Cost Sensors to identify areas of concern

The problem

The last few years has seen several air pollution episodes that have triggered the call for interventions to reduce exposure to air pollution. The RP2021 stakeholder workshop identified this as one of the key priorities to be addressed. This was identified by stakeholders and the Department as an area of priority given the paucity of research existing in this space. Examples that were highlighted included design/designation of community clean air shelters and widespread roll out of HEPA (High-Efficiency Particulate Air) filter systems. Many of these interventions are currently being implemented with limited understanding of best practice for their use. This is especially important for vulnerable people such as those in aged care, schools or health settings.

We have also seen the rise of several low-cost sensor (LCS) tools and networks to measure air pollutants in a largely *ad hoc* fashion. Overseas experience has demonstrated that when implemented and integrated with reference station data, these low-cost data networks have the capacity to provide finer grained insight into local air pollution levels. There is the opportunity to use these systems and networks to provide a cost-effective opportunity to assess the effectiveness of any air pollution mitigation interventions, such as HEPA filtrations and building changes.

This research is of huge importance due to the recent public awareness of the negative impacts of air pollution on human health, but the general lack of awareness about how best to monitor and measure local air pollution, and how to reduce it indoors if it is present. Ensuring the project is driven by stakeholder concerns, the needs, concerns, and deliverables will meet the national priorities of applied research that delivers useful guidance for a range of stakeholders.

Our response

IP4.02.04 is a multi-year project focused on working with stakeholders such as ACT Health (see IP4.02.03), Victoria EPA, Department of Health Victoria and NSW DCCEEW to apply the knowledge identified in RP2022 to intervention case studies. This has included further comparative evaluation of HEPA filters themselves (in a laboratory setting) to their use in real world interventions studies, in for example, clean air shelters to reduce risk from air pollution, with a focus on vulnerable populations.

This project aims to provide up to date guidance on the choice and use of LCS and HEPA filters in the Australian context. Part of this project has included working with manufacturers to develop plain English education material and programs to ensure research-users understand the capacities and limitations of these technologies. The outcome of this multi-year project would be that research-users are more informed and able to make better choices over the selection and use of LCS and HEPA and, consequently, reduce the impacts of air pollution on health.

This project builds on the identified needs raised during RP2021 and RP2022 co-design workshop discussions and review of low-cost sensor availability and useability.

The previous consultations have guided intervention work including the appropriate use of HEPA filters and related hardware use in public spaces, schools and other buildings that could serve as safer air refuges / environments. The intention is to identify how best to use HEPA filters to reduce the health impacts associated with bushfire smoke and traffic emissions. With the additional funding from the EMCR budget we will conduct an evaluation of the barriers to using these safer air refuges. This will provide local governments with additional supporting data when selecting and evaluating a range of public buildings to use during poor air quality events.

IP4.02.04 seeks to address the following questions:

- How best to provide safer air spaces during times of high air pollution events.
- How to address the national priorities of the NESP by providing applied research that is translated into tangible guidance for stakeholders to improve environmental conditions.

Methodology

The research will be delivered via:

- literature reviews of current international best practice for the choice and use of LCS and HEPA;
- a laboratory test comparison of hardware currently available on the Australian market;
- intervention studies to explore how effective these technologies are in the Australian context; and

- production of plain English selection, guidance and use materials developed with the manufacturers, relevant stakeholders from local, state and federal government as well as non-government organisations.

There are limited guidance documents available internationally on how to select and manage public buildings for use as safer havens during poor air quality events. Health Canada have created a document that we are evaluating and using to develop Australian relevant guidance. Suggested interventions include changing the building ventilation and / or installing HEPA filters. The use of low-cost sensors is recommended to evaluate the efficacy of such interventions.

The team will co-design a range of interventions with stakeholders to ensure that the outcomes are relevant to their needs and can be broadly applicable for a range of building designs.

We need to identify how and where to provide safer air spaces for high air pollution days. IP4.02.04 will provide insights into how and where to do this via intervention studies which will be broadly replicable nationwide. The project lead, Professor Donna Green, has been approached by the Burnet Institute who are conducting a project 'Pathway to Clean Air' in Victorian schools and public buildings. They would like to collaborate, and utilise, the school-based activities developed under IP4.02.04. The research will be conducted via desktop assessments and *in situ* intervention experiments in existing buildings via a case study approach. In January 2025, the NHMRC targeted call for climate-related research funding was announced. Dr Wheeler was CIB on a project to evaluate the use of public buildings as resilience centres for use during poor air quality episodes and heat waves. We will leverage the IP4.02.04 and the EMCR funding to support the project. The specific objectives of the project are to:

- (1) Evaluate the effectiveness of community resilience centres in reducing exposure to and associated health impacts from extreme heat and smoke (PM_{2.5}) in at-risk populations groups, such as people living with chronic illness or diverse physical, mental or cognitive abilities, the elderly, Indigenous people, and people from culturally and linguistically diverse (CALD) groups.
- (2) Identify key generalisable building, location, accessibility, ventilation and other characteristics of community resilience centres that can better protect the public from heatwaves and bushfire smoke.
- (3) Understand public perceptions of such centres, including barriers to, and enablers for, their effective implementation and use, and develop targeted messages and advice for relevant population groups.
- (4) Develop recommendations and guidelines for local governments and public health authorities seeking to identify and implement community resilience centres for key Australian population groups in vulnerable situations.

The CSIRO-based EMCR will support this phase of the research. It will be informed by the earlier pilot intervention work conducted in RP2022 with HEPA cleaners and LCS in schools. This will work in concert with IP4.02.03 looking at wood smoke pollution (crossing over for PM_{2.5}) so we hope we may be able to share some resources and findings. This research will inform decision-making and on-ground action in relation to where we can best provide clear guidance for vulnerable communities about where to go during high air pollution events.

Is this a cross-hub project?

No.

Does this project contribute to a cross-cutting initiative?

No.

Project IP4.05.05 – Methodology for review of ambient air quality standards in Australia

The problem

The Department have requested that CSIRO experts – Drs Wheeler, Keywood and Emmerson develop the methodology to review Australian ambient air quality standards.

Our response

Commencing in July 2025 until September 2026 (RP5/6) we will engage with the Department to develop a review methodology in consultation with targeted policy and regulatory officials from the state and territory and Commonwealth environment and health agencies.

Methodology

Through the IP4.05.05 project we will:

- Review current scientific literature to identify any significant updates to evidence.
- Review any relevant current international standards/currently proposed standards, including WHO 2021 guidelines.
- Recommend a detailed methodology and identify data sources for analysis of historical data.
- Recommend a detailed methodology and identify data sources for projections of future pollution based on ambient monitoring trends, inventories, population and climate projections, and atmospheric dispersion modelling, with consideration of issues like double counting of pollutants and potential interactions between pollutants.
- Review previously developed concentration-response functions and health impact assessment methodologies (for both mortality and morbidity) and make recommendations regarding any required updates or further work needed.
- Make recommendations regarding the review method through stakeholder workshops. This will help ensure the states and territories are involved in the development of the review methodology, which will hopefully ensure that they are supportive and will make use of the methodology for any subsequent state-led reviews.
- Make recommendations on whether the review of pollutants should be conducted together or separately based on the findings of the points above, with details of any risks and/or benefits.
- Make any other recommendations regarding updates needed of the information base supporting previous reviews (e.g. Health risk assessment; Economic analysis; Investigation of exposure-reduction frameworks; Health impacts valuation).

- Make any other recommendations regarding structuring and resourcing of review work.

The final report will be published, with a four-week targeted consultation period provided for any stakeholder feedback. Key stakeholders will also be invited to attend a workshop/showcase, which we will facilitate.

We will consider and respond to stakeholder feedback on technical matters, including relating to the review methodology.

Following targeted consultation, we will make recommendations on the final methodology.

Is this a cross-hub project?

No.

Does this project contribute to a cross-cutting initiative?

No.

Indigenous consultation and engagement

Indigenous consultation and engagement form the crux of project IP4.02.01, with an aim to involve Indigenous researchers/knowledge holders at all stages and provide a platform for Indigenous-led dialogues. The IP4 team have much to learn in this space and continue to be guided by consultation with the SCaW Indigenous Advisory Committee, the NESP Indigenous Facilitation Network, the Senior Indigenous Facilitator and the SCaW Indigenous Partnerships Strategy.

This project aims to map-out, through conversations, any Indigenous identified priorities for managing the impact of landscape smoke on the health of communities. These conversations will be carried out according to the SCaW Indigenous Partnerships Strategy goals. In particular:

- Respect and Mutual Benefit – as noted in the SCaW Indigenous Partnerships Strategy, relationships are built over time and with on-going communication. We envisage this project will be the start of these ongoing conversations over the course of the Hub lifetime. In these conversations we will ensure that knowledge held by Indigenous collaborators is valued and protected through the partnership by ensuring all legal obligations are understood before discussions commence. All SCaW air quality researchers involved in this project will be encouraged to read True Tracks (Jenkins 2021)[®] and when available, undertake True Track[®] training.
- Right to Indigenous cultural and intellectual property – in addition to the above, the project will involve Ethics approval, primarily through CSIRO.
- Co-created research – this project represents the second year of an ongoing project to co-design research activities with Indigenous researchers and stakeholders around air quality. All air quality researchers involved in this project will be encouraged to read Our knowledge our way in caring for Country[®] and undertake 'Your Mob' training.

It is recognised that there was low participation of Indigenous researchers in the RP2021 process of IP4. This led us to propose the question, how can we increase engagement of Indigenous researchers and stakeholders in air quality discussions and research? As such, IP4.02.02 / 02.03 / 02.04 projects sit in the **Category 3: Communicate**. The outcomes from all projects will utilise the relationships developed through IP4.02.01 which will continue to engage and interact with relevant Indigenous researchers and organisations through regular workshops (twice yearly) and through established newsletters circulated by the HEAL network. The project also now includes the MRFF project being led by Charles Darwin University. Linda Ford (CDU) is a Chief Investigator along with SCaW researchers Dr Wheeler (CSIRO) and Professor Johnston (UTas) and others. This sub-project will occur in RP2023/2024 and will sit in the **Category 2: Co-design**.

IP4 will include capacity-building for all researchers, training and co-authorship. Indigenous cultural and intellectual property (ICIP) and traditional knowledge will be managed according to the Indigenous Strategy and will be incorporated into the project design.

Which Three-category approach the project meets:

Sub project	Category 1 Indigenous led	Category 2 Co-design	Category 3 Communicate
IP4.02.01			

	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
IP4.02.02 / IP4.02.03 / IP402.04 / IP4.05.05	Category 1 Indigenous led <input type="checkbox"/>	Category 2 Co-design <input type="checkbox"/>	Category 3 Communicate <input checked="" type="checkbox"/>

Project milestones

Milestones	Due date	Responsible person
Signing of contract between Hub lead and research organisations	1 February 2023	Amanda Wheeler
IP4.02.01		
Milestone 4 – IP4.02.01 Progress report for RP2022 (amendment to proposal)	1 March 2023	Erin Dunne
Milestone 1 - Progress report for RP2023	1 March 2024	Erin Dunne
Milestone 2 - A document detailing a Roadmap forward for further conversations and if appropriate, the development of project ideas to carry out in further years of this project. Summaries of any meetings and workshops throughout RP2023 will be provided.	15 May 2024	Erin Dunne
Milestone 3 – Progress report on the MRFF funded air quality and health study in East Arnhem, NT Summaries of any meetings and workshops throughout RP2024-25 will be provided	15 May 2025	Amanda Wheeler
Summaries of any meetings and workshops throughout RP2025-26 will be provided	15 May 2026	Amanda Wheeler
Final report of all activities and recommendations identified	15 December 2026	Amanda Wheeler

Milestones	Due date	Responsible person
IP4.02.02		
Milestone 0. Presentation and discussion of Literature Review	15 July 2023	Kathryn Emmerson
Milestone 1. Gathering model input data	15 October 2023	Kathryn Emmerson
Milestone 2. Decide on baseline conditions and acquire CCAM data	15 December 2023	Kathryn Emmerson
Milestone 3. Acquire CCAM downscaled data ensemble package for 2050	15 March 2024	Kathryn Emmerson
Milestone 4. Progress report for RP2023	15 March 2024	Kathryn Emmerson
Base case (2013-2017) runs		
Milestone 5. Run 4 x 5 year base case models	30 June 2024	Kathryn Emmerson
2048-2052 future climate runs		
Milestone 6. Decide on 2 most important anthropogenic emissions scenarios to run, in consultation with stakeholders.	31 August 2024	Kathryn Emmerson
Commence running 8 x 5 year models for each scenario.	1 September 2024	Kathryn Emmerson
Milestone 7. Progress report for RP2024	15 March 2025	Kathryn Emmerson
Milestone 8. Progress report for RP2025	15 March 2026	Kathryn Emmerson
Milestone 9. Final report and draft discussion paper on model findings	15 December 2026	Kathryn Emmerson
IP4.02.03		
Milestone 1 – Six regions and councils across Australia identified	1 April 2023	Fay Johnston and Project Officer
Milestone 2 – Data collection needs established	1 July 2023	Fay Johnston and Project Officer
Milestone 3 – Adequate air quality monitoring infrastructure in place	1 July 2023	Fay Johnston and Project Officer
Milestone 4 – Pre-intervention data captured	From 1 April 2023 to 31 December 2023	Fay Johnston and Project Officer

Milestones	Due date	Responsible person
Milestone 5 – Interventions deployed and evaluated in Armidale, NSW, Mt Barker, SA and Snug, TAS	1 September 2025	Fay Johnston, EMCR and Project Officer
Milestone 6 – Health and economic cost-benefit analysis completed	31 December 2026	Fay Johnston, EMCR and Project Officer
Milestone 7 – Comprehensive assessment reports and related translational outputs delivered	31 December 2026	Fay Johnston, EMCR and Project Officer
IP4.02.04		
Milestone 1 – LCS decision tool report	1 March 2023	Donna Green and researcher
Milestone 2 – HEPA comparison and intervention study report	1 November 2023	Donna Green and researcher
Milestone 3 – HEPA decision tool report and plain English guidance pieces report	1 November 2024	Donna Green and researcher
Milestone 4 – LCS/HVAC/HEPA options for safer air refuges report, including EMCR activities related to the evaluation of the additional resilience centres	1 November 2025	Donna Green and researcher. CSIRO EMCR
Milestone 5 – Workshop conducted for stakeholders to provide feedback	1 November 2026	Donna Green and researcher
Milestone 6 –Final compiled report integrating all separate results and provision of policy recommendations, including EMCR activities related to the additional resilience centres	15 December 2026	Donna Green and researcher. CSIRO EMCR
IP4.05.05		
Milestone 1 – Final report for targeted consultation	15 June 2026	Amanda Wheeler and researchers
Milestone 2 – Response to consultation comments	30 September 2026	Amanda Wheeler and researchers

Data and information management

The co-design process will identify detailed knowledge products to be delivered through RP2023 and beyond. Detailed data and information management plans will be developed for each of these. It is expected that any knowledge products generated through the co-design phase will be made publicly available through the Hub website, and in accordance with the Hub Data Management Strategy and subject to ethics approvals and any relevant Indigenous Cultural and Intellectual Property (ICIP) arrangements. The Data Wrangler will play a key role in coordinating and facilitating this data management and sharing through the provision of expert advice.

Project output	Data management and accessibility
Publications and Reports	Reports will include Indigenous Knowledge so the management and accessibility of the report will be subject to the conditions of the Ethics approvals and ICIP arrangements entered. Where possible we will endeavour to make the reports publicly available via the SCaW website or other suitable platforms.
Data sets	The IP4 team will work with the Hub Data Wrangler to ensure that all the requirements of the SCaW Hub Data Management strategy are met. All data produced by this NESP co funded project will be subject to FAIR and CARE principles and Ethics) principles and any specific Indigenous Cultural and Intellectual Property (ICIP) arrangements developed with the communities involved. We will handle the data that emerges from these discussions according to Article 31 of the United Nations Declaration on the Rights of Indigenous Peoples.
Workshop output	<p>Data will be stored in the Hub data repository upon finalisation of the databases. Project leads will be responsible for ensuring this is conducted in a timely manner.</p> <p>All data sets will be accompanied by high-quality metadata records, will be assigned persistent identifiers and will be subject to rigorous quality assurance and quality control checks.</p> <p>Slides and a summary of any workshops to be shared with attendees and made available through the SCaW website.</p>

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
	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Location(s) – gazetted region /place name	<p>IP4.02.01 This research will initially occur virtually, engaging on a national scale. As the projects progress, we may focus discussions within relevant states. We may have a better idea of locations once RP2022 is completed. Project management will occur from Aspendale, Victoria</p> <p>East Arnhem, NT, NSW and WA</p> <p>IP4.02.02 Aspendale Victoria</p> <p>IP4.02.03 The desktop component of this research will primarily be carried out in Hobart Tasmania. Locations for field trials are being determined via ongoing consultation in RP2022. However, approximately 6 locations/regions will be involved, potentially including City of Launceston, Snug, Margate, Blackmans Bay, City of Ballarat, City of Yarra, Mt Barker, SA and the ACT.</p> <p>IP4.02.04 Much of this research will initially occur virtually, engaging on a national scale. As the projects progress, we may focus discussions within relevant states.</p> <p>UNSW Sydney - Gadigal on Eora Country for the desktop research, with the research output impact at a national level.</p> <p>Victoria – Bunurong Country and Wurundjeri Country for additional schools in Melbourne.</p>		
Aboriginal or Torres Strait Islander nation or traditional place name(s)	<p>IP4.02.01 Bunurong Country Nhulunbuy, Gunyarrara and Yirrkala</p> <p>IP4.02.02 Bunurong Country</p> <p>IP4.02.03 The desktop component will be carried out primarily in nipaluna, lutruwita. The traditional owners and custodians of the land on which the City of Ballarat is built are the Wadawurrung People and the Dja Dja Wurrung People. The area now known as the City of Yarra stands on the traditional lands of the Wurundjeri people. The ACT is Ngannawal country.</p> <p>IP4.02.04 Gadigal on Eora Country Bunurong Country and Wurundjeri Country</p> <p>IP4.05.05 Bunurong Country</p>		

Project keywords

Air quality, Smoke, Indigenous knowledge, Emissions, Interventions, Wood heaters

References

- [1] Australian Bureau of Statistics (2021) 'Aboriginal and Torres Strait Islander People: Census 2021', Available: <https://www.abs.gov.au/articles/australia-aboriginal-and-torres-strait-islander-population-summary>, accessed 17 August 2022.
- [2] Amanda J. Leach, Christine Wigger, Jemima Beissbarth, Donna Woltring, Ross Andrews, Mark D. Chatfield, Heidi Smith-Vaughan, Peter S. Morris (2016) "General health, otitis media, nasopharyngeal carriage and middle ear microbiology in Northern Territory Aboriginal children vaccinated during consecutive periods of 10-valent or 13-valent pneumococcal conjugate vaccines", *International Journal of Pediatric Otorhinolaryngology*, 86, 224 -232, <https://doi.org/10.1016/j.ijporl.2016.05.011>.
- [3] Williamson, B., F. Markham, and J.K. Weir, Aboriginal peoples and the response to the 2019-2020 bushfires. 2020. ANU Centre for Aboriginal Economic Policy Research
- [4] Australian Bureau of Statistics (2019) 'National Aboriginal and Torres Strait Islander Health Survey 2018-19', Available: <https://www.abs.gov.au/statistics/people/aboriginal-and-torres-strait-islander-peoples/national-aboriginal-and-torres-strait-islander-health-survey/latest-release#smoking>, accessed 17 August 2022.
- [5] Cowley, R., Savanna Fire Forum Snapshot, 2021, Available: <https://industry.nt.gov.au/publications/primary-industry-publications/newsletters/regional-newsletters/rural-review/nt-rural-review-august-2021/savanna-fire-forum-2021-snapshot>. Accessed 17 August 2022.
- [6] Haikerwal, A.; Reisen, F.; Sim, M.R.; Abramson, M.J.; Meyer, C.P.; Johnston, F.H.; Dennekamp, M. Impact of smoke from prescribed burning: Is it a public health concern? *J. Air Waste Manag. Assoc.* 2015, 65, 592–598.
- [7] Jones, P.J., Furlaud, J.M., Williamson, G.J. et al. Smoke pollution must be part of the savanna fire management equation: A case study from Darwin, Australia. *Ambio* (2022). <https://doi.org/10.1007/s13280-022-01745-9>
- [8] HEAL Network and CRE-STRIDE, Climate Change and Aboriginal and Torres Strait Islander Health, Discussion Paper, Lowitja Institute , Melbourne, DOI: 10.48455/bthg-aj15
- [9] Emmerson, K. M., Possell, M., Aspinwall, M. J., Pfautsch, S., and Tjoelker, M. G.: Temperature response measurements from eucalypts give insight into the impact of Australian isoprene emissions on air quality in 2050, *Atmos. Chem. Phys.*, 20, 6193–6206, <https://doi.org/10.5194/acp-20-6193-2020>, 2020.