Northern Australia Environmental Resources Hub

National Environmental Science Programme

Northern Australia Environmental Resources Hub Final Report

Australian Government

National Environmental Science Program

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Front cover: Darwin mangrove mudflats. Photo: Patch Clapp.

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National Environmental Science Program

1 January 2015 – 30 June 2021

Hub name: Northern Australia Environmental Resources

Hub leadership organisation: University of Western Australia (UWA)

Head agreement host organisation: Charles Darwin University

Key contact: Professor Michael Douglas (UWA)

Contact telephone number: 0408 467 000

Contact email address: michael.douglas@uwa.edu.au

Other consortium partners/subcontractors/research organisations:

- University of Western Australia (UWA)
- Charles Darwin University (CDU)
- James Cook University (JCU)
- Griffith University (GU)
- Commonwealth Scientific and Industrial Research Organisation (CSIRO)
- North Australian Indigenous Land and Sea Management Alliance (NAILSMA)
- Northern Territory Department of Environment, Parks and Water Security (NT DEPWS)
- Queensland Department of Environment and Science (Qld DES)
- Western Australian Department of Biodiversity, Conservation and Attractions (WA DBCA)

Hub Leader certification

As Hub Leader, I certify that I have taken adequate steps to reasonably assure myself that

- each required report component is attached
- the contents of each component of the report is complete and accurate in all material respects
- funds have been used for the purpose for which they were provided and all funding conditions have been met, recipient and other contributions have been received, and appropriate oversight has been maintained of hub projects, their progress, performance and budgets during the reporting period
- all relevant risks to project delivery have been notified to the department in this and previous reports and that appropriate steps are being taken to manage those risks
- the hub and its sub-contractors have current workers compensation and public liability insurances, as required under the Funding Agreement
- any unallocated funds have been identified for refund to the department

Signed: 

Hub Leader Name: Professor Michael Douglas

Date: 8 November 2021

Hub Steering Committee Chair certification

As steering committee chair, I certify that any issues of concern or matters raised during steering committee meetings where the draft progress report was discussed have been adequately resolved, amended or incorporated into the final report submitted to the Department.

Signed: 

Hub Steering Committee Chair Name: John Childs

Date: 8 November 2021

Letter from the Hub Leader

I am pleased to present this final report for the NESP Northern Australia Environmental Resources Hub (NAERH). The finalisation of this hub concludes more than 15 years of research focused on northern Australia across three major Commonwealth funding programs – the National Environmental Science Program (NESP), the National Environmental Research Program (NERP) and the Commonwealth Environment Research Facilities (CERF). This long-term investment has enabled the region to focus on a wide range of research-user needs across priority geographic regions, including for water planning, Indigenous land and sea management, agricultural development, fire, threatened species, climate change, and invasive plants and animals. This investment has elevated the research capacity of institutions across northern Australia. It has importantly broadened the pool of expertise and enhanced the capability of researchers to work in remote locations and cross-cultural contexts to address key environmental challenges.

Transdisciplinary, user-driven research

The hub was designed and run to foster transdisciplinary research across the program. Transdisciplinary research approaches bring scientists from multiple disciplines together with research users to address both science questions and socially relevant problems. Transdisciplinary research also involves the collaboration between researchers from different disciplines and engages with research users throughout the research process, enabling mutual learning between all participants. The approach is expected to improve the likelihood of research adoption by users; and our hub provides ample evidence of research impact to support this. We have used the Fitzroy River catchment in Western Australia as a showcase region to trial and evaluate this research approach and lessons from this and our other projects have informed the approach of the recently commenced NESP Resilient Landscapes Hub.

The entire NAERH research program was co-designed with the Department of Agriculture, Water and the Environment (DAWE) and other research users rather than being driven by researchers, through open calls for project ideas. This demonstrated our deep understanding of co-design and transdisciplinary research principles and, critically, our extensive experience in applying them to run a successful NESP hub. We demonstrated how a user-driven approach could deliver a cohesive program of research to achieve the highest possible impact for DAWE and a wide range of other research users.

Demonstrations of our impact for DAWE, state/territory agencies and Indigenous land managers include: provision of new national data on threatened species distributions and threats for the Environmental Research Information Network (ERIN); advice and tools delivered and used by Parks Australia and Traditional Owners for weed management in Kakadu National Park; delivery of guidelines on inclusive water planning now being used by the Western Australian Government and Traditional Owners; and information on the benefits of Indigenous land management used to design policy by the National Indigenous Australians Agency.

The hub has operated within a broader context of government planning for northern Australia that largely stemmed from the Australian Government's 2015 *Our North, Our Future: White Paper on Developing Northern Australia*, which sought to lay the foundations for economic growth for northern Australia. From this arose the Northern Australia Infrastructure Facility (NAIF) that is providing financial assistance for northern infrastructure projects and the Cooperative Research Centre for Developing Northern Australia (CRCNA) that is funding industry-led research to develop new technologies, products and services in the north. Carbon farming and gas development have also undergone major economic expansions and at the state and territory level, water and catchment planning have been a driving policy agenda over the past 15 years.

It is always a challenge for research to provide timely and appropriate advice for government, policy-makers and land managers. The research that the hub has produced has had immediate influence on some part of the planning process (e.g. the WA Government's 'Managing water in the Fitzroy River catchment: Discussion paper for stakeholder consultation') and it will continue to have an impact for some time after the conclusion of the program. The hub's research provides general principles for water planning processes and the evaluation of future development scenarios; conceptual models and frameworks of Indigenous relationships and governance of water, as well as the impacts of water resource development; specific recommendations on water requirements for riparian and aquatic biota across a range of river types; and improved understanding of the cumulative ecological and economic impacts of water-resource development on estuarine and coastal systems.

During NESP, we initiated two new developments to enhance our user-driven research approach. Research plans were required to incorporate explicit *Pathway to Impact* tables that clearly identified target audiences for research outputs and how they were going to be reached. We also required project leaders and principal research users to enter into formal *Research User Agreements*. The Research User Agreement committed the project leader to deliver specified outputs in an agreed timeline and format, with the principal research user committing to making use of the outputs for specific policy, planning or on-ground management objectives.

Indigenous collaboration and engagement

The hub extended an impressive record of Indigenous engagement in large research programs in northern Australia as demonstrated by NERP and CERF (Tropical Research and Coastal Knowledge). We have worked with Traditional Owner partners at a number of scales (pan-northern Australia, regional and local) reflecting the diversity in Indigenous roles and functions. Traditional Owner partners were variously involved in setting the research priorities and direction, undertaking research, and implementing two-way knowledge sharing to ensure that research goals reflected the priorities of Indigenous land and sea managers.

Our researchers have established significant and enduring Indigenous research partnerships across northern Australia, built on trust and delivery of right-way science that respects Indigenous knowledge, culture and values. This has been demonstrated through large research collaborations where we have set new standards for Indigenous participation as indicated by highly complimentary reviews undertaken by Wensing et al 2020.

The nespnorthern.edu.au web portal gives many examples of our proven ability to develop Indigenous stakeholder networks and facilitate Indigenous participation in relevant research activities. Examples include the establishment and support for the Mitchell River Traditional Custodians Advisory Group (CERF & NESP), the Kakadu Indigenous Research Committee (NESP), as well as support for the Martuwarra Fitzroy River Council (NESP) and research partnerships with the North Australian Indigenous Land and Sea Management Alliance (NAILSMA) and with Wagiman Traditional Owners (Daly River, Northern Territory (NT)) that have endured for 15 years. Approximately half of our projects under this phase of NESP included direct Indigenous collaboration.

Catchment and regional research focus

The research program was organised around a number of issues-driven, catchment and regional case studies, selected to ensure coverage of all the issues in the scope of the hub, and to ensure that we operated across contrasting land uses and land tenures. Potential case studies were selected with research users giving explicit consideration of external timelines for delivery of research outcomes and the timing of environmental decision-making. This process enabled the hub to deliver timely answers to questions and solutions to problems to assist environmental decision-making. The Gulf region of Qld, Kakadu National

Park and the Fitzroy catchment of WA were our major regions of focus, with Cape York and the Daly River (NT) being others significant areas of interest.

Ongoing collaborations and long-term relationships between researchers and research users has ensured that research is provided in appropriate formats for decision-making. For example, we have provided timely advice for water planning in the NT, Western Australia (WA) and Queensland (Qld) through modelling to evaluate different water-use scenarios and provided maps of threatened species and threatening processes land managers across northern Australia.

Communications and knowledge management

The hub's communication and knowledge brokering approach was centred around user-driven, co-designed research, built on fostering a culture of trust-based partnerships. Identifying critical barriers, key decision-makers/influencers and timeframes for information needs was essential for this.

The hub website is a dynamic and up-to-date repository of resources, success stories, news, videos, diagrams/symbols, and publications such as factsheets, project updates, reports, booklets, posters and hub newsletters. The website is easily searchable and users are able to access resources through project webpages, researcher profiles, research themes and type of resource. The website also contains resources and information from previous research programs including NERP and CERF, making it a rich resource and an invaluable legacy product.

The development of a library of quality, multimedia content (video footage, photographs, prose, graphical symbols, presentations, maps) facilitate the reuse and repurposing of key messages for different audiences. These resources will also ensure a legacy of the program that is useful for many years to come.

We have looked for opportunities to synthesis outputs from a range of projects to compile more compelling and useful products and findings accessible to decision-makers, communities and other research users during and beyond the life of the program. We also looked for opportunities to leverage our hub's outputs, particularly through our event management, where we established a preference to sponsor conferences and workshops run by other organisations, where our research could be showcased to wider and more diverse audiences. We also prioritised supporting Indigenous partners to attend and present on the hub's collaborative research.

This hub delivered a step-change from earlier programs in being able to project our successes to a wide audience, and our communications and knowledge brokering team was able to capitalise on emerging trends and technologies that enabled this. Social media, combined with our ability to efficiently and inexpensively produce sophisticated videos, created many impressive results in communicating project outputs. The symbols library featuring iconic northern Australian images continues to grow in popularity and use among a diverse range of users from the environment, education and public health sectors.

Data management

Our data management model was essentially decentralised with each partner responsible for storage and accessibility, while meeting agreed standards and posting links to our website. Given the rapidly changing external digital environment, this approach was probably the most efficient and avoided wasted expenditure on building new platforms or systems that could fall into redundancy. We strongly supported and participated in the Commonwealth-led development of the NESP *Data Management and Accessibility Guidelines*, with support from all of the hubs.

Governance

Our Hub Steering Committee (HSC) provided strong support over the life of the hub and had a low turnover of members. This gave us consistency in direction and certainty in approach. The hub's decision to include only research users (rather than research providers) on the HSC was key to ensuring that decisions were made in the best interest of achieving broader environmental outcomes rather than to meet the priorities of researchers and their institutions. I believe the hub governance demonstrated best practice and this model has carried forward into the new NESP Resilient Landscapes Hub with little change.

Our meeting frequency at twice per year was appropriate and it was unfortunate that we were unable to hold additional field trips in the last 18 months, as we had planned to showcase a variety of hub outputs. We held one very successful trip to far north Qld and the Gulf in 2019 where the engagement with local and regional NRM managers was well received.

The Research Executive Committee met regularly as required depending on hub research planning and reporting workloads. This committee included representatives from our research partners (including state and territory governments) and provided essential support to the program by monitoring and reviewing research project design and delivery, providing advice to the HSC on project progress, financial management and strategic direction of the program, and facilitating collaborative arrangements among hub partners.

Administration

Charles Darwin University (CDU) provided a professional level of administrative and financial reporting support for the hub, supported by the hub's Executive Officer.

There were four variations to the hub Head Agreement between the Commonwealth and CDU over the life of the program – 2015 to provide greater budget flexibility, 2017 to give greater flexibility around financial auditing/reporting/treatment of pre-existing activity material/monitoring and evaluation planning/data management guidelines, 2019 to provide for an additional Interim Final Report in October 2020, and late 2020 for Covid-19 that extended the final delivery date for project outputs by 6 months from December 2020 to June 2021.

Finance

The hub's budget and finances were under-expended by $140,263 at the end of the program extension period of 30 September 2021. These funds equate to the amount of activity-generated income earned over the life of the program and will be returned to the Commonwealth in accordance with Clause 5.8 of Funding Head Agreement.

Conclusion

In conclusion, it has been a privilege to lead the Northern Australia Environmental Resources Hub over the past 6.5 years, and support the 100+ researchers and staff who have contributed to this impressive program.

Michael Douglas

Hub Leader

Research

Achievement of hub outcomes

From the Kimberley in WA to Kakadu in the Northern Territory and across to Cape York in far north Queensland, the hub has undertaken research that supports the sustainable development of Australia's unique northern environments. The hub's research has delivered new knowledge, tools and partnerships to inform practical solutions, particularly as northern Australia responds to its future development agenda.

The hub's outcomes are described in Clause 1.3 of Schedule 2 of the Funding Agreement, and also described in the research priorities provided by DAWE at the commencement of the program, and subsequently revised and amended in 2017 (Appendix A).

The hub partnered with governments, communities and industry to undertake research that supported sustainable development and improved the capacity to manage and monitor Australia's unique northern environments. The Hub's research informed practical solutions to the region's major environmental challenges and delivered new knowledge, tools and partnerships for a sustainable northern Australia. Major outcomes included:

- ***Managing and monitoring terrestrial and aquatic ecosystems and biodiversity.*** All of the Hub's projects contributed new knowledge to improve the management of terrestrial and aquatic ecosystems. From Cape York to the Kimberley, the Hub's research supported the management of threatening processes such as para grass, feral pigs and stinking passionflower in wetland and riparian ecosystem environments, and feral cats, fire and gamba grass in savanna ecosystems. The Hub's projects improved monitoring through the use of emerging technologies such as eDNA, including for threatened species detection (Gouldian finch) and introduced species such as cane toads. The Hub also combined Indigenous and scientific knowledge to set monitoring indicators of healthy wetland and savanna country in Kakadu National Park.
- ***Catchment and coastal land and water planning for urban, agricultural, and infrastructure development.*** Our catchment-based projects, such as in WA's Fitzroy River basin supported water-resource assessment and water planning, and included a new participatory, multi-objective catchment planning process by which stakeholders could collaboratively construct and assess the outcomes of alternative development and management scenarios (including identifying co-benefits and trade-offs between objectives). In the Gulf of Carpentaria, river flows are an essential part of the lifecycle of numerous important fishery species, particularly prawns and barramundi. Our research built on long-term partnerships with these fisheries to improve our understanding of the possible impacts of water extraction from Gulf rivers. This research supported good fisheries management and also highlighted the water needs of the region's aquatic biodiversity to ensure that water planners can make informed decisions about future water development in the region. River flows in the Gulf of Carpentaria are also critical for ensuring that food is available for migratory shorebirds on their long annual migrations between Australia and the far northern hemisphere. Our research revealed how important the animals living in the mudflats and sandflats are as a food source for sustaining shorebirds in the Gulf of Carpentaria. This research is supporting Australia's commitments to protecting migratory shorebirds and their habitats and informing upstream water development in these catchments.
- ***Landscape-scale studies covering savanna, rainforest and aquatic ecosystems and biodiversity.*** Our project on identifying high-priority areas in northern Australia for threat abatement and species recovery sourced data, expertise and methods to identify how to best fill gaps in knowledge of the spatial distributions of threatened ecosystems and species, and of their interactions with threatening processes. A 'road map' was created to develop a best-practice approach to modelling and mapping threatened

species, and threat distributions were developed to guide management actions across northern Australia to promote recovery of biodiversity.

- ***New knowledge to support land and water planning for urban, agricultural, and infrastructure development.*** Our project on savanna carbon sequestration found that significant carbon is stored in dead standing trees across the north, LiDAR technology can be used to accurately measure trees and wood at the landscape scale, and methods to calculate carbon credits for land management projects can be updated to account for this carbon. Improving methods used to calculate carbon credits for savanna burning projects can further incentivise emissions reductions and carbon storage, supporting many Indigenous-owned carbon businesses.
- ***Improving and supporting Indigenous land management including Indigenous Protected Areas.*** The hub supported Indigenous natural resource management and the development of sustainable business opportunities that benefit Indigenous people and are economically profitable. Indigenous-led guidelines are giving Indigenous peoples a voice about what is best practice in working with their knowledge in collaborative partnerships, and these guidelines are being taken up across Australia. Research has demonstrated that – in addition to their environmental benefits – Indigenous land and sea management programs are a pathway to Indigenous economic independence and regional development, as well as providing significant wellbeing outcomes. An Indigenous-led project in Kakadu National Park successfully mixed responsible artificial intelligence, modern science and traditional knowledge to solve complex environmental management problems.
- ***Delivering across a range of disciplines to underpin management effectiveness in Kakadu National Park.*** In Kakadu, our focus was on research that addressed threats such as fire, weeds and feral cats, both across the landscape and in riparian and floodplain areas. We also worked closely with the park's Traditional Owners to identify and undertake action-research partnerships. We worked with *Bininj/Mungguy* Traditional Owners and Kakadu rangers to trial an approach for monitoring and reporting on healthy Country indicators before and after agreed on-ground actions. This included an Indigenous-led Healthy Country Artificial Intelligence (AI) model to monitor magpie goose numbers and spread of the invasive para grass by rapidly surveying large, difficult-to-access areas with drones and interpreting the footage collected to show important changes to the ecosystem following on-ground management interventions. Other Hub research across northern Australia, on topics such as Indigenous land management, environmental monitoring techniques, fire and carbon, is also generating information to support the management of environmental resources in Kakadu. In addition, three projects were focused on ensuring the world-class rehabilitation of the Ranger uranium mine site.
- ***Improving management practices for tropical rainforests which minimise the impact of extreme weather events.*** This outcome was delivered through our project that mapped critically endangered littoral rainforest and coastal vine thickets between Townsville and Cooktown (Wet Tropics bioregion) and the current and projected future threats to its persistence and condition from the impacts of sea-level rise, storm surge and extreme weather events.

Because of the impact of COVID-19, in March 2020 the hub sought an extension to the final deadline for the NESP Northern Australia Environmental Resources Hub to 30 June 2021. The request for an extension was subsequently granted and a revision to the Head Agreement with Charles Darwin University was signed on 29 October 2020. The Hub then completed sub-contract variations with our partners to extend the program through to 30 June 2021.

Despite these challenges, the hub's portfolio of approximately 50 projects delivered a comprehensive and diverse set of research outputs for our policy and management partners.

Attachment A provides a project-by-project description of the outputs from these projects over the life of the hub. More detailed information is also available on the project pages of our website.

Research projects

Attachment A lists the projects funded under the Northern Australia Environmental Resources Hub and provides information on outputs and links to products for all projects (where available at the time of this report). Exceptions to the *NESP Data Management and Accessibility Guidelines* are also noted here.

Performance against milestones

Performance against funding agreement milestones

All milestones for the period and to date have been met as per Funding Agreement Milestones 1-32. The only remaining milestone for the Hub is delivery of a final financial report, within 60 days after acceptance of this report.

Performance against the research plan milestones

Information on project and milestone completion and performance is provided in Attachment A.

Measuring success

The National Environmental Science Program (NESP) is a long-term commitment to support environmental and climate research. The key objective of NESP is to improve our understanding of Australia's environment through collaborative research that delivers accessible results and informs decision-making. The focus of NESP is on practical and applied research that informs on-ground action and that will yield measurable improvements to the environment.

The program builds on its predecessors – the National Environmental Research Program and the Australian Climate Change Science Program – in securing for decision-makers the best available information to support understanding, managing and conserving Australia's environment.

NESP is delivered through multi-disciplinary research hubs or consortia, hosted by Australian research institutions. NESP has sought to achieve its objective by supporting research that:

- is practical and applied and informs on-ground action
- addresses the needs of the Australian Government and other stakeholders by supporting and informing evidence-based policy and improving management of the Australian environment
- is innovative and internationally recognised
- enhances Australia's environmental research capacity
- is collaborative and builds critical mass by drawing on multiple disciplines, research institutions and organisations to address challenging research questions
- produces meaningful results accessible to government, industry and the community
- includes synthesis and analysis of existing knowledge
- builds relationships between scientists and policy-makers to encourage collaborative problem-solving on environmental issues.

NESP research users are a broad range of stakeholders whose decisions may impact on the environment and include the Australian Government, state governments, industry, business, community groups and Indigenous land managers (or Indigenous communities).

The intended outcomes of NESP are:

- enhanced understanding of and capacity to manage and conserve Australia's environment
- improved climate and weather information for Australia through a greater understanding of the drivers of Australia's climate
- timely research that is used by policy- and decision-makers to answer questions and provide solutions to problems
- research outcomes that are communicated clearly to research users and the general public and stored in a manner that is discoverable and accessible.

Table 1. Quantitative performance measures.

Key performance indicator	Hub result for entire activity period (1 Jan 2015–30 Sep 2021; numerical only)	Explanation (if any)
1. Percent of projects (active or completed in the reporting period) for which there is a research-user actively engaged in the project.	**100%**	To better ensure that project outputs meet the needs of research users, and are incorporated into policy and/or management, each project was required to enter into a research user agreement that is signed off by project leaders and the principal research users. The research user agreement specified the outputs that would be produced by the project and the timeline and format for delivery of those outputs. The principal research user committed to making use of the outputs for specific policy and planning objectives. The agreement also specified the preferred method of engagement with the research users in the project.
2. Percent of projects approved under RPV1–6 in which research-users were actively involved in project design.	**100%**	In preparing Research Plans 1–6, we consulted with Commonwealth, state and territory agencies relevant to the project. We ensured that in the drafting of each project plan, research-users were explicitly identified and consulted.
3. Number of research outputs provided to end users **on time**[1] and as identified in the Research Plans.	**124**	This is a summation of research outputs listed in Attachment A and outputs reported from Annual Research Plans 2015–2020.
4. Proportion of research outputs provided to end users **on time** and as identified in the research plans.	**100%**	While we have reported 100% here, Covid-19 impacted on the delivery of all projects that were uncompleted in 2020. We received extensions to all of these projects and revised their project plans accordingly.
5. Number of instances where the hub has used NESP-generated information from another NESP hub.	**16**	This is a summation of outputs reported from Annual Research Plans 2015–2020 and outputs delivered in the last nine months up to September 2021.
6. Number of peer reviewed NESP-funded publications during the reporting period.	**91**	This is a summation of outputs reported from Annual Research Plans 2015–2020 and outputs delivered in the last nine months up to September 2021.

[1] On time – delivered on the date the outputs were expected to be delivered

Key performance indicator	Hub result for entire activity period (1 Jan 2015–30 Sep 2021; numerical only)	Explanation (if any)
7. Number of NESP research citations in other researchers' publications during the reporting period.	**119**	This is a summation of outputs reported from Annual Research Plans 2015–2020 and outputs delivered in the last nine months up to September 2021.
8. Number of researchers, including PhD and post-doc positions engaged as a result of NESP (total, full-time equivalent) during the reporting period.	**235 FTE**	This is a summation of outputs reported from Annual Research Plans 2015–2020 and outputs delivered in the last nine months up to September 2021.
9. Number of data sets provided to the hub, or made publicly available, by third parties for the purposes of informing NESP research.	**60**	This is a summation of outputs reported from Annual Research Plans 2015–2020 and outputs delivered in the last nine months up to September 2021.
10. Percentage of data sets made publicly available under open licence by the hub.	**95+%**	Our project leaders and researchers have been advised of their obligations in relation to data management. We have prepared a Hub protocol titled *Ensuring Open Access* that has been included in orientation workshops held in Qld, WA and the NT. Some datasets are restricted because they involve social research responses from individuals, involve culturally sensitive Indigenous knowledge, or the location of threatened species. Attachment A reports on data sets that are produced as outputs to projects.
11. Percentage of NESP research outputs (including publications, data and metadata) that are discoverable and accessible in accordance with NESP data accessibility requirements and the funding agreement.	**95+%**	Our project leaders and researchers have been advised of their obligations in relation to data management. We have prepared a Hub protocol titled *Ensuring Open Access* that has been included in orientation workshops held in Qld, WA and the NT. Some datasets are restricted because they involve social research responses from individuals, involve culturally sensitive Indigenous knowledge, or the location of threatened species. Attachment A reports on data sets that are produced as outputs to projects.
12. Number and FTE of Indigenous people employed in a project (separate into full and part time positions).	**475 individuals** **35 FTE**	This is a summation of outputs reported from Annual Research Plans 2015–2020 and outputs delivered in the last nine months up to September 2021. Includes permanent, casual and one-off engagements of Indigenous people.

Key performance indicator	Hub result for entire activity period (1 Jan 2015–30 Sep 2021; numerical only)	Explanation (if any)
13. Number of Indigenous researchers/graduates/post-graduate/PhD/post-doc positions in projects.	**23**	This is a summation of outputs reported from Annual Research Plans 2015–2020 and outputs delivered in the last nine months up to September 2021.
14. Number of Indigenous people trained in the use of environmental management tools and techniques.	**750+**	This is a summation of outputs reported from Annual Research Plans 2015–2020 and outputs delivered in the last nine months up to September 2021.
15. The number of management tools for Indigenous waters and lands that benefitted from NESP research and outcomes (including but not limited to Plans of Management for IPAs, co/joint-managed parks, Marine Park Plans of Management, Conservation Agreements).	**38**	This is a summation of outputs reported from Annual Research Plans 2015–2020 and outputs delivered in the last nine months up to September 2021.
16. Number and type of communication products that have been used to communicate research with Indigenous people.	**120**	This is a summation of outputs reported from Annual Research Plans 2015–2020 and outputs delivered in the last nine months up to September 2021.
17. Number of research, knowledge sharing and communication events held with Indigenous communities.	**193**	This is a summation of outputs reported from Annual Research Plans 2015–2020 and outputs delivered in the last nine months up to September 2021.
18. Number of public events, conference presentations, jointly authored/published papers with Indigenous participants/contributors.	**64**	This is a summation of outputs reported from Annual Research Plans 2015–2020 and outputs delivered in the last nine months up to September 2021.

NESP impact stories

The NESP impact stories for the final report have been organised around four themes with a number of snapshot impact stories including:

1. The importance of northern Australian rivers and their flows
    a. Understanding links between Gulf river flows & fisheries
    b. Shoring up food supplies for migratory birds
    c. A transdisciplinary approach to WA's Fitzroy River water planning
    d. Veins of the Country: a story by Mervyn Street
2. Managing threatened species and threatening processes
    a. Modelling and mapping for conservation outcomes across the north
    b. New ways to manage gamba grass and fire in the NT's Mary River National Park
    c. Filling knowledge gaps for the rehabilitation of Ranger uranium mine
    d. Managing north Queensland's endangered tropical littoral rainforest
3. Supporting Indigenous natural resource management and alternative economies
    a. Strengthening and sharing knowledge for land and sea management
    b. Keeping Country healthy in Kakadu National Park
    c. Supporting savanna fire management through carbon farming
    d. Caring for Country and improving Indigenous lives
4. New approaches for monitoring and communicating about environmental resources
    a. Finding finches: using eDNA to track endangered birds
    b. A giant leap forward in detecting unwanted visitors
    c. Using AI to protect baby turtles from feral pigs
    d. Engagement is a two-way street: creating symbols for science communication.

These NESP snapshot impact stories are provided at Attachment B. These stories showcase the contribution of NESP funded research to the environment, the economy, society, culture, public policy, quality of life, beyond contributions to academia. A hub wrap-up video was produced to showcase these impacts.

Financial information

Financial reporting

Financial information for the Northern Australia Environmental Resources Hub is provided at Attachments C and D and includes:

- income and expenditure statement
- recipient and other contribution statement
- asset schedule
- audit report.

Finance tracking

The Hub's allocation of $19.2 million of research funds, and our positive budgetary and financial management position, has enabled us to complete all program activities, including communication and engagement, in the final stages of the program's lifecycle (see attached Financial Statement up to 30 June 2021).

As a consequence of Covid-19 and the extension of the program to 30 June 2021, we utilised our remaining budget flexibility to manage its impact. As approved by the Hub Steering Committee at its meeting on 6 May 2020, we instigated the internal reallocation of funds within projects and the shifting of any unexpended funds across projects as required.

With approval from the Hub Steering Committee and the Commonwealth, we also extended the contracts of our knowledge brokering and communications team using partner cash contributions to 30 November 2021 and our three regional coordinators in the Kimberley, Kakadu and north Queensland to 30 September 2021 to allow for the communication of final project outputs, final reporting, organisation of seminars and workshops and other logistical support to projects and stakeholders.

The Hub's budget and finances were under-expended by $140,263 at 30 September 2021 as reported in the Finance Report (Attachment D). These funds equate to the amount of activity-generated income (refer to Clause 5.8 of the Funding Head Agreement) earned over the life of the program. These funds will be returned to the Commonwealth.

Appendix A: National Environmental Science Program (NESP) research priorities for the Northern Australia Environmental Resources Hub – revised 2017

NESP research priorities and cross-cutting issues for all hubs

CC	**Cross-cutting issues.** Research undertaken under all hub priorities should: • consider the impact of climate change in the research design, delivery and recommendations, as appropriate • consider the social and economic value of the environmental asset/s and research outcomes, as appropriate • where possible, be targeted at areas with high conservation value such as National and World Heritage places and Ramsar wetlands • be designed with consideration of how it may intersect and integrate with the priorities of other NESP hubs.

Northern Australia Environmental Resources Hub research priorities

A. Effective management of northern Australia's environmental resources	
A1	Identify lessons learned from the incorporation of Top End Indigenous fire knowledge into fire management, to inform the incorporation of Indigenous knowledge in fire management and carbon abatement planning nationally.
A2	Identify high-priority areas in northern Australia for threatened species and ecosystems to better target threat abatement and species recovery investments
A3	The development and direct trial of practical techniques that underpin on-ground management for the recovery of identified threatened species, including Kakadu National Park and adjacent Indigenous Protected Areas.
A4	Develop and trial spatially explicit tools to guide planning and management decisions that support a mix of multiple uses and protected areas while maintaining environmental values.
A5	Identify evidence-based methods for the assessment of development impact on species and ecosystems which can be better integrated into planning processes and EPBC Act approvals.
A6	Develop management practices for rainforests which minimise the impact of extreme weather events.
A7	Identify management actions to address the management of waste and debris in remote locations. This includes the issue of ocean rubbish and debris washing up on Australia's northern coastline and the management of hard waste in remote locations such as Cape York.
B. Understanding the pressures and impacts on environmental resources in northern Australia	
B1	Identify biodiversity impacts from changed land and water use (e.g. agricultural, development and infrastructure) to support best-practice land management
B2	Demonstrate the benefits and constraints of landscape and river connectivity to better manage biodiversity outcomes.

B3	Determine the impacts, including cumulative impacts, of natural stressors and current management regimes on biodiversity loss and landscape degradation to underpin on-ground management actions.
B4	Identify critical knowledge gaps in the understanding of environmental resources in northern Australia to better prioritise government investment.
C. Understanding and measuring the condition and trends of environmental, social and economic resources in northern Australia	
C1	Develop methods, and techniques to reduce the cost of estimating changes in soil carbon over time.
C2	Participation of Indigenous people in environmental management across northern Australia, including Indigenous Protected Areas.
C3	Develop better capacity to predict ecosystem failure to improve planning and management practice.
C4	Determine the economic contribution of environmental resources across northern Australia in supporting effective policy and planning decisions.
C5	Demonstrate how to better measure environmental drivers, pressures, stressors and responses in northern Australia, taking into account remoteness and limited specialist skills base within the region, including approaches to environmental accounting.