Natural Hazards Technology Program

Challenge Statements

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www.chiefscientist.nsw.gov.au/naturalhazards-technology-program

Program Overview

The Natural Hazards Technology Program (the ‘Program’) is a new $1.89 million competitive grants program in 2023/24 to accelerate technology innovation and adoption to better prepare for and respond to natural hazards by trialling field-ready technology with end-user NSW agencies. It builds on the success of the Bushfire Technology Pilots Program and expands the remit to provide tangible assistance in overcoming challenges from natural hazards.

This Program supports Recommendation 5 of the 2020 NSW Bushfire Inquiry and Recommendation 2 of the 2022 Flood Inquiry which highlighted the need for advancing technology to improve the preparation, response and recovery from natural hazards such as flood and bushfires.

The purpose of the Program is to accelerate the adoption of innovative technology to better prepare for and respond to natural hazards, specifically floods and bushfires. It aims to provide tangible assistance in overcoming challenges faced during all phases of natural hazards management, including Planning, Prevention, Preparedness, Response and Recovery.

The overall objectives of the Program are to:

- find technology solutions to challenges faced by NSW agencies in the management of natural hazards
- support innovative NSW businesses field-test their technologies with NSW agencies to:
  - refine and improve their product for market
  - build relationships with NSW agencies to increase opportunities for future collaborations
- build and improve NSW Government awareness of innovation possibilities in natural hazards management and operations through exposure to new technology.

The Program provides up to $250,000 in funding for companies to field-test their technology solutions over a 12-month period with partnering NSW agencies.

More information on the Program, including Program Guidelines and an Application Form, is at www.chiefscientist.nsw.gov.au/natural-hazards-technology-program.

Challenge Statements

This document provides the challenges set by end-user NSW agencies and should be read in conjunction with the Program Guidelines. Each application is required to align to either:

- **End-User Agency Challenges** – a challenge set by end-user NSW agencies requiring an innovative solution (applications can align to more than one challenge). Each challenge outlines a capability that the agency doesn’t currently possess and for which it is willing to explore solutions over the next 12 months.
- **‘Big Ideas’ Challenge** – a cutting-edge or emerging technology/innovation in its application to natural hazards that could deliver a significant impact. Please note the technology will need end-user agency support before it can go through the assessment process.

End-User Agency Challenges

Agencies provided challenges in user story format (as a user persona, I want to perform this action, so that I can achieve this outcome) to show the need and application of the technology along with any technical or functional requirements required. These challenges provide the high-level functional requirements without defining the required technology.

We encourage applicants to think outside the box and propose innovative and new approaches to the challenges listed in this document. The technical and functional requirements should be considered as the minimum or ideal rather than the total solution requirements. The Program allows for further exploration and refinement of the needs with the agency after the grant has been awarded.

It should be noted that there are more challenges than can be funded.

Big Ideas Challenge

The Big Ideas Challenge acknowledges the swift evolution and enhancement of technology. While it is crucial to address present issues and requirements, it is equally important to envision the future and explore how technology can revolutionise our approach to combating natural hazards. In light of this, we invite proposals featuring cutting-edge or emerging technologies applied to the realm of natural hazards, recognising the important role these advancements play in shaping future resilience.

When submitting applications for this category, applicants are encouraged to consider the broader goals, objectives and challenges facing NSW and its agencies.

This includes:

- Delivering world-class service to NSW in a way that is cost effective and uses public funds responsibly
- Adapting to changes in the frequency and severity of natural hazards while needing to use resources more efficiently for longer periods across different emergencies
- Investigating ways to use renewable energy sources without compromising reliability or capability
- Considering new and innovative solutions that replace established and proven capability or offer a safer working environment for staff, volunteers and the community.

Proposals for the big ideas challenge need technology that can be trialled with agencies within the grant period. While it is expected that some reconfiguration or refinement of technology will occur during the Program, the proposal must have a readiness that allows it to be tested in a real or simulated environment. For this reason, research-based applications are unlikely to meet the criteria.

It is noted that since these are outside of the challenges set by agencies, the technology will need end-user agency support from at least one agency before it can go through the assessment process.

Further details

As this is a competitive grant process, neither the Office of the NSW Chief Scientist & Engineer (OCSE) nor the agency/ies will provide additional information regarding the challenge or its requirements throughout the application phase. It is not assumed you will possess in-depth knowledge of agency processes, existing systems or technologies. Instead, the focus should be on articulating how your technology can practically and cost-effectively address the specific problem outlined, including any technical requirements.

List of challenge statements

Table 1 provides a summary of the challenges, with a full description of each challenge below.

Table 1: List of challenges and agencies

Number	Agency/ies	Name
Challenges to improve decision making capabilities		
1	Water NSW	Improved modelling for flood prediction and incident management
2	Transport for NSW (TfNSW)	Maintaining transport routes impacted by natural hazards
3	Forestry Corporation NSW (FCNSW)	Heavy plant construction models
4	NSW Rural Fire Service (RFS), Reconstruction Authority (RA)	Understanding evacuation behaviours
5	National Parks and Wildlife Service (NPWS)	Managing rockfall and landslide risk
6	RFS	Airborne intelligence processing
7	RFS	Command-and-control interface
8	Fire and Rescue NSW (FRNSW), RFS	Intelligence creation
9	RA, DCCEEW	Visualisation of natural hazards impacts
Challenges relating to new or improved equipment capabilities		
10	FRNSW	Firefighter respiratory protection
11	FRNSW	Water alternatives for firefighting operations
12	FCNSW, NPWS	Bushfire fuel moisture monitoring
13	NPWS	Remote ignition detection and suppression
14	RFS	Hazardous tree identification
15	FRNSW, RFS	Rapid asset condition and damage assessment
16	FRNSW	Delivery of emergency supplies to isolated locations
17	Department of Climate Change, Energy, the Environment and Water (DCCEEW)	Tracking seabed, beach and dune change over time
18	DCCEEW, Water NSW	Measuring water flow and bathymetry in rivers
19	DCCEEW, Water NSW	Water quality monitoring and predictive capabilities
20	DCCEEW	Monitoring and maintenance of dissolved oxygen in rivers

Challenges to improve communications		
21	Department of Customer Service (DCS), RFS, NSW State Emergency Service (SES)	Multilingual emergency warnings
22	DCS, RFS, SES	Auslan presentation of warnings
23	DCS, RFS, SES	Connectivity to the Hazards Near Me app
24	TfNSW	Voice connectivity and vehicle tracking for regional and remote staff
25	NPWS	Hearing aids for firefighters

1. Improved modelling for flood prediction and incident management

Challenge Agency: Water NSW

User story

As a dam operator, I want to use a predictive model to assist me in determining the volumes and timing of pre-emptive water releases based on anticipated inflows to minimise downstream flood impact, especially under potential and actual flood conditions, so that I have a clear understanding of the status of dams and their alert levels during flood events.

During flood incidents, I would like access to a singular 'Common Operating Picture (COP)' that displays the storage status plotted against alert levels. This should include current and forecasted rainfall, along with other key telemetry for large dams across NSW.

Technical and Functional Requirements

Through a combination of gauging data, satellite information and other potential inputs, this technology will need to provide predictive modelling on the timing and volume of inflows to major dams prior to and during flood events.

The aim is to provide the operator with accurate and advanced warning that will allow managed releases from the dam ahead of the inflows to minimise downstream flood impacts.

Solutions should include:

- The development of a COP/dashboard that interfaces with existing and planned telemetry sources and allows the user to monitor the current situation across the state or zoomed into a particular region/area of interest. An example of this type of system is used by SEQwater for their flood operations management.
- The model will be updated on demand and will be frequently updated during incidents. The solution will be implemented across the state.

2. Maintaining transport routes impacted by natural hazards

Challenge agency: Transport for NSW (TfNSW)

User story

As the agency responsible for maintaining roads and transport infrastructure, I need a way to prioritise and focus planned mitigation works on identified routes. The solution should consider any existing risk priorities, land use, adjacent environmental risks or hazards, and the location of the work compared to changing seasonal risks or climate change, so that routes are maintained and are as resilient as possible to natural hazard impacts.

To enable a strategic and outcomes-based approach to planning this work, the solution should help me identify the likely complexity of environmental and pre-work approvals and how often the work is required for each section, based on available data like vegetation type, topography and the diversity of threatened flora, fauna and heritage items.

Technical and Functional Requirements

The solution should deliver cost-effective technology and the ability to consume a range of data from other agencies to inform the planned works program in a way that ensures that the greatest amount of work can be delivered to areas before they are impacted by natural hazards. Ideally the technology would predict the geographical locations in NSW that could be impacted, based on a series of data inputs and allow the work program to be adjusted considering these factors.

The data to be considered could include:

- Weather and climate information and forecasts (short and long-term)
- Risk and likelihood information from lead agencies and their risk management process
- Significant asset data sets including Flora, Fauna, European and Indigenous heritage items
- Strategic and critical importance of the corridor for people and supply-chains, as well as emergency and recovery response
- Adjacent local and regional risk factors of the land and assets surrounding the routes.

Ideally the solution would plan and predict initial mitigation works and frequency of ongoing works as far in advance as possible (1-2 years) and be re-run as new data becomes available or is updated.

Solutions should include:

- Outputs that can inform the prioritisation of state-wide programs
- Estimations or ratings of job complexity and likely planning and completion timeframes
- Opportunities for collaboration on preparedness effort
- Estimates of program costings and future funding requirements.

3. Heavy plant construction models

Challenge agency: Forestry Corporation NSW (FCNSW)

User story

As a bushfire planner or incident controller, I want to be able to model time and scale scenarios for heavy plant construction of containment lines during fire operations in different terrain and vegetation types. This should factor using various sizes, types and combinations of machinery, so that it improves the allocation of heavy plant when resources are limited and provide a better understanding of the likelihood of containment strategy options being achieved in the proposed timeframes.

Technical and Functional Requirements

Heavy plant is a valuable asset for firefighting and can be in limited supply due to competition from civil works and the distances that they need to be transported. Heavy plant comes in various types and sizes (dozers, graders and front-end loaders, and from small trucks to float with police escort) and each of these will perform differently in different terrain and vegetation types (open grasslands to steep mountains).

Being able to rapidly model multiple heavy plant options and combinations using different types and sizes of machines when formulating strategies for containing bushfires will speed up the process for deciding on and executing strategies. Planning officers and incident controllers currently rely on individual experience and rule-of-thumb construction rates that are often in spreadsheets or printed tables. A prediction tool to model time and scale options for containment line construction during large scale, multiple bushfire situations will assist teams to work through complex decisions faster. This will enable improved allocation of heavy plant to fires when resources are finite, and a better understanding of the likelihood of heavy plant strategies being achievable in the proposed timeframes.

The ideal solution is a computer-based model that can ingest fire map shapes, terrain and vegetation layers, general construction rates for different types of heavy plant and be able to model various combinations of plant to provide options for decision making. The solution would produce a simple model or report that can be used to support ground truthing and planning for implementation.

4. Understanding evacuation behaviours

Challenge agencies: NSW Rural Fire Service (RFS), Reconstruction Authority (RA), NSW State Emergency Services (SES)

User story

As an evacuation risk specialist working with the RFS, RA, SES, TfNSW and councils to prepare emergency warnings, evacuation plans and determine evacuation capacities, I want to be able to use real-time data to understand the community's evacuation responses during and/or after natural hazards. This will provide an understanding of patterns of human behaviour and enable modelling of evacuation risk to allow for better evacuation planning, the creation of targeted warnings and influencing of behaviours for greater evacuation compliance.

Technical and Functional Requirements

Analysis, reconstruction of emergencies and development of case studies are important for providing empirical data for ongoing research, learning and development of emergency plans. There is currently no systematic way to capture and consider the way people behave and respond to an emergency. Limited information about community response is captured through qualitative interviews after the emergency but this is difficult to connect to other quantified data.

The use of new connected technology like connected vehicle data, smart phone data, remote sensing data, traffic cameras, social media posts and/or other emerging data sources would provide a rich source for understanding behaviour during an emergency.

Coupled with operational information and the progression of the emergency, warnings and community messages can be refined to achieve the desired outcomes and minimise the impact of the emergency.

Solutions should include:

- An analysis of the data including the number, type, speed and location of vehicles evacuating an area.

- Provide the information in real time (i.e., as an evacuation is in progress), however, all data would need to be analysed after the event.
- Identification of blockages and alternate routes that could expedite the evacuation.

5. Managing rockfall and landslide risk

Challenge agency: NSW National Parks and Wildlife Service (NPWS)

User story

As an agency managing land accessible to the public, NPWS has identified rockfalls and landslides as a safety risk and wants to develop a real–time, semi-quantitative assessment solution using live data and a geotechnical risk-mapping tool to establish and determine rockfall and landslide probability. This will assist NPWS in undertaking strategic assessments to identify key risks and priorities for rockfall and landslide mitigation treatment and aid in the implementation of Trigger Action Response Plans (TARP) during weather and natural disaster events. The tool will also identify areas which warrant professional geotechnical assessments.

Technical and Functional Requirements

Using existing available data sources like weather, seismic, visitation levels, geology, groundwater, historic rockfalls and social media, the probability and severity of rockfall and landslide events can be calculated and form the basis of a state-wide risk map.

NPWS has the established processes and formulas to determine geotechnical risk and landscape susceptibility but lacks an automated solution to integrate live and variable data like weather and visitor numbers which can inform land managers on high-risk areas based on real-time information.

Solutions should include:

- The output data needs to be live and updated as new data is collected, and where possible predict future risk trends based on forecasted data and information like weather.
- A simple viewing tool (ideally web-based) that can show the required outputs in a simple but comprehensive user interface.
- The ability for the data to be stored in the agency's GIS datasets and uploaded to software such as Power BI.
- Ideally, some parts of the outputs could be made publicly available via web or app-based alerts.

6. Airborne intelligence processing

Challenge agencies: RFS

User story

As an operational decision-maker I want to visualise the integrated outputs of two existing airborne intelligence sensors that have the capability to provide detailed and dynamic mapping of fire behaviour, vegetation structure and imagery. This will provide a single platform for decision makers delivering:

- live tactical and strategic mapping of fires and other hazards such as floods
- quality data relating to actual fuel availability
- potential impact data with an ability to also provide quality impact data soon after a fire passes through from a single flight.

Accessing this combined data will better inform decisions on the immediate response to fires and other emergencies, including the deployment of ground crews and aviation assets to bushfires, mitigation, and preparedness works which protect life, assets and the environment in NSW.

Technical and Functional Requirements

The RFS is committed to developing a superior airborne intelligence capability to support its emergency preparedness and response. In order to achieve maximum results and benefit, it is seeking to integrate two discrete systems – the Overwatch TK-9 Imaging System and emerging technology, the 3DEO Zion-B Lidar System. This would enable RFS aircraft to be flown for both:

- tactical mapping during a bushfire or other emergencies, and
- strategic mapping to inform resource management and preparedness decisions.

It is envisioned that an integration of the capabilities of both systems (Lidar and Overwatch) into a single output viewable by decision makers on web-based platform integrated within RFS systems will enable an RFS fixed-wing aircraft to fly to and ahead of an incident (be it fire or flood), or an area affected by an incident and provide decision makers with spatial information that is current and dynamic.

For example:

- **Tactical mapping** – each day during a bushfire, an aircraft will scan the fire using Overwatch to provide images of the current fire activity (heat signatures, hot spots and fire intensity) and Lidar would map the area ahead of the fire where the IMT estimates the fire path may be in two to three days. The Lidar data could also be used to help select landscape features of interest to fire crews, such as natural fire breaks, access roads and paths, therefore providing Planning and Operations with tactical information to assist with ongoing containment strategies.
- **Strategic mapping –** outside of the fire season, Lidar could be used to confirm Bush Fire Risk Management Plan vegetation fuel structure (load) and types to help Bush Fire Management Committees prioritise hazard reduction works. Overwatch scans could be used throughout the hazard reduction burn to confirm fire intensity during the event and/or confirmation of extinguishment. Lidar and imagery would then be re-used to assist with post-burn analysis such as confirmation of reduction in fuel loads and fire penetration/coverage and therefore confirm the success of the burn and its benefits.

Solutions should include:

- Live data processing and visualisation of the integrated scan data, imagery and Lidar sensors into a single output, able to be displayed in the RFS online GIS systems and made available to other agencies via a web-based service.
- Combined outputs able to be processed onboard the aircraft during flight without internet connectivity during the processing phase.

7. Command-and-control interface

Challenge agencies: RFS

User story

As an Incident Management Team Member, Incident Controller or State Operations Controller, I need the ability to execute command-and-control activities through a simple and where possible automated user interface that allows me to interact with many existing information systems without having to log in and out of these different systems. The user interface needs to draw on data and information from these systems and allow me to make time-critical operational decisions and distribute this decision back the relevant systems using a series of complex workflows data sharing architectures.

This ensures that the response is matched to the risk sooner and more effectively using the latest information and the risk of execution errors is minimised. This improves the community outcomes and volunteer safety.

Technical and Functional Requirements

Operational activity generates a large amount of data and activities in many different systems. The problem for incident command is to grasp the reality of what is happening in real time as it seeps through busy operational communication channels, dozens of situation reports and many information systems .While RFS now has a number of function-specific systems including command-and-control systems to manage day-to-day activities, many of the incident management processes are managed manually with drawing boards, paper forms, phone calls, spreadsheets and emails – this makes controlling large-scale operations difficult and cumbersome, and distracts people from their main duties.

Within time-critical operations, the incident control team need an interface and data architecture that is able to integrate data coming from many RFS systems, other agencies systems, text/picture information coming from communities, imagery/video/geospatial information, voice coming from operational communications, and text information coming from command-and-control reports.

The solution would be an integrated user interface based on principles of human-centred design that can integrate, collate and interpret information in real time to provide a unified, simple and effective view of the situation for managing large-scale and complex incidents, and to relay information and decisions through the organisation. The solution will allow various incident management functions to perform their tasks in specialised systems without having multiple windows open or move between systems.

Delivering this functionality will maximise firefighter safety and community outcomes during emergencies in NSW.

Solutions should include:

- Architecture and user interface to join existing such as RFS information systems and technology including Computer Aided Dispatch, ICON, Athena and Emergency Logistics System (Service Now based)
- The ability to execute complex workflows and tasks including notifications in existing systems without replacing existing systems.
- Saleable and dynamic complexity and abilities to suit the user, incident and systems being controlled with reliability and security for mission-critical applications.

8. Intelligence creation

Challenge agencies: Fire and Rescue NSW (FRNSW), RFS

User story

As an operational firefighter or specialist working in the Strategic Operations Centre (SOC), I am responsible for supporting Incident Controllers' decision-making by providing them with appropriate and timely intelligence to facilitate efficient and safe emergency services operations to protect life and property during a natural hazard event. While we have a high volume of information at our fingertips, it is structurally and semantically diverse; that is, we have data that is relevant, however it as scattered over a large heterogenous information landscape including many agency systems.

I want to be able to interrogate and interact with all relevant information sources so that I can provide the Incident Controller with intelligence that is timely, succinct and appropriate for what they need to formulate the most effective immediate and ongoing response to a natural hazard event, using the agency’s existing capabilities and available resources.

Technical and Functional Requirements

Operational activity generates a large amount of data and activities in many different systems. The problem for incident command is to grasp the reality of what is happening in real time through busy operational communication channels. Available data during natural hazard events consists of reports, common operating pictures, geospatial/remotely sensed information, weather forecasts and observations, Internet of Things (IOT), text and radio messages, social media and many other unstructured to structured formats. This is challenging for staff to review, collate and refine in a short space of time.

Disaster response decision-making does not accommodate the timeframe required to derive a complete or perfect intelligence situational awareness picture. The solution would have the ability to explore and harness all this information rapidly and collectively and provide a mechanism to serve up a valid intelligence product as part of a rapidly digestible natural hazard/emergency response technology solution utilised by personnel in the SOC and Incident Controllers in the impacted areas. The solution would also need to be adaptive and provide fluid human-technological interactions; that is, interact with SOC personnel to refine the intelligence outputs based upon firefighters' recognition-primed knowledge inputs of what the natural hazard operational response decision-making requirements would be.

There are two specific uses where this technology can have the most impact:

- The solution would need to be able to access and compile response-specific data relevant to a particular locale, fuse it with live or changing data from things like IOT sensors featuring real-time updates through live data feeds or available remotely sensing technologies including video and images. Where appropriate the system should identify and predict issues based on changing information and data, and present this output to the operator for consideration. The output must also be delivered in a way that leverages SOC capabilities and existing Connected Firefighter programs.
- The solution would further develop existing operational software systems to build the capability for an existing system to identify the area being affected by a fire and subsequently rapidly and intelligently scan and assess a wide range of other data to identify dangerous and unusual weather conditions such as: nocturnal winds, thunderstorm potential, complex fire-terrain interactions and other conditions suitable for extreme fire behaviour. Where appropriate, the system should identify and predict issues based on changing information and data, and present this output to the operator for consideration. The solution would display any critical operational insights in a dashboard and exportable report.

9. Visualisation of natural hazard impacts

Challenge agencies: RA, DCCEEW, SES

User story

As a state government scientist and a community engagement staff member, I want to make information on coastal hazards and flooding more accessible through a visualisation tool that can be viewed on mobile devices and online. This would support the work of governments on understanding and managing threats to the community posed by coastal inundation and flooding.

Technical and Functional Requirements

The solution needs to make the information more accessible to government end users so they are more readily able to understand risks exist so they can be considered in decisions and provide advice to the community of these risks and how they may change into the future with climate change.

The visualisation tool would need to consider end user needs, existing data sources and the responsibilities in different areas of government. This may involve the ability to overlay a combination of relevant information into a single view.

Ideally the solution would consider a slider type approach to viewing the existing and future projections of flooding, inundation and erosion extents, similar to that used by NOAA in the US https://coast.noaa.gov/slr/.

It should connect with existing government data platforms (https://www.seed.nsw.gov.au/), apps and information sources.

Solutions should include:

- Interface with both Apple and Android devices and modern web browsers.
- Ideally the overlay would include use of other available state data including cadastral boundaries, building footprints etc.
- Inundation and erosion extents based on future projections of sea level rise mapped at decadal intervals.
- Flood information for a range of available flood events.

10. Firefighter respiratory protection

Challenge agency: FRNSW

User story

As a fire agency, we have an obligation to protect our firefighters from exposure to respirable contaminants and want a solution for a respiratory protection device (RPD) that sits between self-contained breathing apparatus and P2 dust masks.

Technical and Functional Requirements

FRNSW currently have a negative pressure P3 Combi filter system. It is a cannister that attaches to a breathing apparatus mask that protects against particulates and the following contaminates:

- A2: High boiling point organic gases
- B2: Inorganic gases and vapours
- E2: Sulphur dioxide, hydrogen chloride and acid gases
- K2: Ammonia and organic ammonia derivatives
- Hg: Mercury (single use only)
- P3: Dust, fumes and aerosols.

The P3 respirator is classified as “A2B2E2K2 Hg P3 R D”.

Firefighter feedback on the P3 respirator is that it is too hard to breathe through, especially during times of heavy workload because of the product’s enhanced level of protection over standard particulate filters. FRNSW is looking for a solution that is fit-for-purpose and delivers improved breathing ability over the existing system while compromising protection as little as possible.

Image of current P3 Combi Filter System

Solutions should include:

- Alignment to:
  - ISO 17420-5:2021 – Respiratory protective devices – Performance requirements – Part 5: Special application fire and rescue services – Supplied breathable gas RPD and filtering RPD
  - AS/NZS 1715 – Selection, use and maintenance of Respiratory Protective Equipment
  - AS/NZS 1716 – Respiratory Protective Devices (www.afac.com.au) is desirable.

11. Water alternatives for firefighting operations

Challenge agency: FRNSW

As an emergency service organisation, I want to be able to undertake water-intensive firefighting activities to protect the community in a way that minimises the impact on the communities' water supply, so that it doesn't contribute to water scarcity issues resulting from climate change.

I need to do this without compromising the ability to deliver this expected service to the community in the required timeframes, allowing FRNSW to respond to emergencies in a responsible manner to minimise the use of precious resources.

Technical and Functional Requirements

Increased need for water from growing populations and industry, together with climate change is impacting potable water quality and availability. NSW will need to consider strategies to improve water security and reduce water use where practicable for future scenarios with reduced water availability.

FRNSW currently utilises compressed air foam systems (CAFS) as part of the options for firefighting strategies. The benefits in the use of CAFS include water conservation, reduction in structural water damage, reduced water runoff and reduced amount of foam concentrate required to extinguish fires. However firefighting foams have limitations.

Solutions should include:

- Innovative firefighting methods/systems that suppress fire with minimal water use with fewer restrictions than firefighting foam operations.
- The ability to be used in regional or isolated areas impacted by water scarcity, drought and climate risks which impact water availability.

12. Bushfire fuel moisture monitoring

Challenge agencies: FCNSW, NPWS

User story

As a hazard reduction burning (HRB) planner and land manager, I want to be able to access and utilise remotely located sensor data including automatic weather station, soil moisture and fuel moisture data to support hazard reduction burn planning and operations across land tenures. I require an understanding of when a particular identified area has the right fuel, soil and weather conditions to most safely and successfully undertake hazard reduction burns when windows of opportunity are reducing and are harder to find.

This will reduce the amount of travel required to assess fuel condition in planned HRB areas improve planning processes, enable more efficient allocation of resources to undertake HRB and inform risk modelling and emergency responses.

Technical and Functional Requirements

Areas planned for HRB need to be assessed to determine when burning operations can safely be undertaken. This currently requires travel to proposed sites to undertake conventional assessments of fuel moisture. This limits the amount of HRB that can be planned and undertaken.

Automatic and remotely located Internet of Things (IoT) sensors can provide measurements of local conditions that can inform the suitable timing for HRB operations without the need for long travel times. At a minimum the solution would provide sensors that can measure temperature, relative humidity, wind speed and direction, rainfall, soil moisture, solar radiation and fine fuel moisture at each selected location on the HRB. Preference would be given to many portable accurate but low-cost sensors, over fewer more accurate and permanently installed sensors.

The solution will also need technology to create an expanded IoT communication network using one or more wireless technologies that transmit data over long distances and provides the opportunity to connect and combine automatic weather station, soil and fuel sensor data. This would support hazard reduction burn planning and operations for land managers.

Solutions should include:

- The ability to connect many sensors in a geographical location using one or more communication technologies, to provide coverage in remote and isolated areas in variable terrain without traditional connectivity options like 4/5G, NBIoT Cat M1 and Wifi (but has the option to use these technologies when available or more convenient).
- The ability to cover areas with rugged terrain, thick vegetation and limited ability to locate base stations and repeaters where access to data back-haul may be limited.
- A communication network with ability to carry narrow band serial level IoT data from a range of sensors and manufacturers.
- Preference for two-way open-source communications protocol between the sensors and the connection gateway proving data in a consolidated location accessible online.
- Simple integration with data management portals that provide quick and easy-to-understand access to sensor information.

13. Remote ignition detection and suppression

Challenge agencies: NPWS

User story

As a land manager of large areas of remote land, I need automated technology that locates and validates fire ignitions and enables a rapid response involving a safe night-time suppression operation when conditions are more favourable, and the likelihood of success is higher. This provides an opportunity to reduce the time required by firefighters to ground-truth ignitions, improve the timeliness of intelligence and maximise suppression effectiveness during optimal conditions.

Technical and Functional Requirements

- An automated uncrewed aerial vehicle (UAV) that can operate in difficult terrain and operate in all weather conditions to reach new ignitions and provide a way to 'ground truth' the initial information received by remote sensors.
- After location and confirmation of a fire, the UAV should be able to hover overhead and receive instructions to carry out precision water bombing.
- Undertaking this activity at any time (including at night), the UAV would need the ability to carry water to the fireground, in support of ground-based crews.
- It should be a UAV platform that has 24-hour response capability and be fleet-scalable as the fire progresses.
- This could increase response capability during the most opportunistic conditions, improve safety, suppress wildfire spread and reduce risk exposure. (Firefighters would still be required on site to 'mop up' and confirm that the fire has been extinguished.)

Solutions should include:

- UAVs able to be strategically deployed to high-risk locations and scaled to match the risk or the size of the fire and operate 24 hours a day if required
- The ability to locate and report on the location and size of the fire
- Water-carrying capacity of ideally 800L, which is equivalent to the capacity of existing helicopters during the day.
- Two-way communication with ground crews
- Preference would be for aircraft that operate on renewable energy and help achieve the NSW Government's goal of Net Zero by 2050.

14. Hazardous tree identification

Challenge agency: RFS

User story

As a fireground incident controller or fire crew member, I need the technological capability to help safely and accurately identify and plot the geolocation of hazardous trees on a fireground or the site of a planned hazard reduction burn/mitigation works. This means that crews can be quickly alerted to the presence of hazardous trees on a fireground or when planning/conducting a hazard reduction burn or other mitigation works.

A technological solution to quickly and clearly identify hazardous trees, rather than a physical inspection and assessment within close proximity, will enhance the safety of this process and enable action to be taken to help reduce the risk to crews, including marking and mapping the tree, establishing an exclusion zone, moving operations to avoid the tree or extinguishing fire in the tree.

Technical and Functional Requirements

A hazardous tree is defined as a tree, limb or branch that is expected to fall within the timeframe of the current operation and impact personnel in its potential impact zone. In December 2023, RFS Captain Leo Fransen was killed when a tree fell on him while fighting the Hudson fire in remote north-west NSW. The safety of its members is of paramount priority for the RFS and it is keen to search for every possible technological means of helping to ensure its people can return home safely at the end of their shift.

Hazardous trees are a known and significant risk to fire crews. The RFS, in conjunction with Fire and Rescue NSW, the National Parks and Wildlife Service and Forestry Corporation, has developed joint operational guidelines outlining procedures to help identify and mitigate the risk of hazardous trees but these often rely on individual assessment, conducted manually at close range (i.e. within the most hazardous area). While some hazardous trees can be identified by sight (e.g. dead crowns, widow makers, a dry side), others are more difficult, such as trees that are hollow or burning/smouldering internally.

A technological solution to assist in quickly identifying these trees would significantly help to enhance firefighter safety, both by enabling assessment to occur from a safer distance and alerting fireground personnel to potential danger.

This could be achieved with the development of a highly portable tool using technology like infrared thermal imaging and/or X-ray technology that could immediately identify a tree as hazardous, identify its geolocation and directly plot this on operational maps. This dataset could be assembled on the ground or via drone and potentially through robotic technology. This new and innovative technology would have national and international applicability.

Solutions should include:

- Technology to remotely identify hazardous trees without the operator entering the fall zone which is two to three times the height of the tree.
- Mark the exact location of the tree in an existing digital mapping system with key information about the tree and its location
- Technology that can be handheld, vehicle-mounted or attached to uncrewed vehicles or robots.

15. Rapid asset condition and damage assessment

Challenge agencies: FCNSW, Department of Climate Change, Energy, the Environment and Water (DCCEEW), RA, NPWS

User story

As an agency specialist involved in post-natural hazard infrastructure recovery, I want an integrated platform that efficiently captures, compares and reports on critical asset conditions before and after natural hazard events, so that agencies, councils, relevant authorities and emergency response teams can rapidly determine damages, plan for recovery and submit accurate information for government co-funding applications.

This needs to include accurate, geo-referenced 3D imagery and/or point-cloud data of critical assets proving the best available data on transport routes and building levels needed for accurate flood modelling and evacuation planning of floodplains.

Technical and Functional Requirements

The ability for agencies to accurately collect and report on the conditions of assets and infrastructure, including built and natural, before and after natural hazards, allows for rapid assessment of the damage caused and the effort required to restore these as quickly as possible. The ability to capture and compare pre-impact data significantly enhances the ability for asset owners and other relevant government agencies to substantiate the damage caused and apply for funding, such as the DRFA to restore the asset.

For localised data collection, the technology needs to be deployed into the impacted area using standard vehicles operated by staff or volunteers to collect the raw data. Ideally small and compact sensors are available to be temporarily mounted to emergency services (people, cars, boats, RPAS, helicopters) already deployed in the impact area to rapidly collect and share the data. Using a variety of vehicles to collect the data will allow the agency to match the need and scale required with the available time to collect the data. The technology needs to be easily operated with little or no training before data collection occurs and readily accessible to the asset/infrastructure owner, emergency agencies and the NSW RA.

For wider area assessments, for example assessment of road networks, bridges and other transport infrastructure, the technology needs to be appropriate to scale to enable the rapid capture of data across large areas, especially along extensive linear features.

There are three broad scenarios where this could be used:

- In urban and rural areas, efficiently and accurately identify and record asset and infrastructure conditions before and after natural hazard events with a focus on critical infrastructure and essential public assets such as roads, bridges, tunnels, culverts, and stormwater infrastructure. Collecting this data in an accurate and timely way also informs future risk and planning activities by using things like floor levels and debris markers to determine water levels. This will also enable NSW to maximise the cost-share arrangement under the DRFA as it supports eligible assets owners to meet the eligibility requirements.
- After natural hazard impacts to allow mapping of the changes to geomorphology (river form) and riparian vegetation along rivers and the broader environmental responses to those changes more efficiently and effectively.
- Rapid and targeted assessment of assets and infrastructure like fire trails, bridges and stream crossings in State Forests and surrounding land. This network includes around 66,000km of roads and trails with hundreds of bridges and thousands of crossings that can be impacted after significant fire and flood events. Information collected will also support the RFS Fire Access and Fire Trail planning process by providing details of track condition and vegetation-related impacts on accessibility.

Solutions should include:

- Accurate georeferencing and mapping of assets, with a focus on 3D point clouds and imagery and easy comparison of asset conditions pre- and post-natural hazard events.
- Appropriate equipment to the scale and area to be covered and prioritise user-friendly interfaces for rapid assessment and reporting by infrastructure recovery coordinators, flood modellers, road managers and DFRA Managers. The equipment cannot rely on internet connectivity during the data collection phase.
- Enable comprehensive reports to be generated for submission to councils, relevant authorities, and the Australian Government to support disaster funding applications. This should include meta data that outlines how the data has been processed and provided.
- Open-source data outputs and Integration capabilities, with existing state databases, modelling software, and emergency response systems ensuring the output data/databases can integrate with standard GIS systems online mapping platforms as required.
- Security and quality measures to ensure the integrity and confidentiality of the captured data.
- Ideally technology and/or vendors that are listed in the Remote Sensing Services & Equipment (ReSSE) Prequalification scheme on Buy NSW.

16. Delivery of emergency supplies to isolated locations

Challenge agency: FRNSW

User story

As an emergency service organisation, we want to deliver emergency and resupply resources to communities that are isolated due to fire and/or flood in a safer and more cost-effective manner. This could potentially use Remotely Piloted Aircraft System (RPAS or drone) or other uncrewed delivery platforms, so that emergency workers are exposed to a lower degree of risk associated with deploying personnel into hazardous areas such as rafting in moving water or driving along roadways lined with dangerous fire-damaged trees.

Technical and Functional Requirements

Keeping emergency service workers safe is a key element of what FRNSW strives to achieve while servicing the needs of affected communities. After a major disaster, FRNSW is regularly requested to provide access to isolated communities to supply them with essential items such as medications and first aid equipment, as well as supplies such as food and grocery deliveries. In recent years, this has occurred in areas isolated due to floods, where personnel are deployed to swim or raft items across rapidly moving water, putting themselves in a dangerous environment to help others. Vehicles have also been used with personnel driving along roads that are still flooded or are damaged/debris filled, or roads that are extremely dangerous to pass due to fire-affected trees. Items are sometimes delivered by crewed helicopters, which is very costly and not always viable due to weather conditions.

The aim is to reduce the exposure of emergency workers to some of the more dangerous environments and improve FRNSW's capability to deliver these resources more rapidly at scale. The solution needs to be scalable, to allow delivery of heavier equipment and resources across dangerous landscapes. This currently relies on manual handling by large numbers of support people – for example to the middle of a landslide site.

FRNSW is interested in the future expansion of this capability to transport an injured person or a rescue worker to provide the quickest and safest means of traversing a dangerous area.

Solutions should include:

- Integration with existing systems used by the organisation and compliance with government legislative safety rules (for example, CASA regulations).
- Having a range of options depending on the delivery type, which would need to be built to withstand poor weather conditions and environmental hazards (heat, dust, water etc).

17. Tracking seabed, beach and dune change over time

Challenge agency: DCCEEW

User story

As a coastal scientist, I want to trial the use and application of newly developed sensors to track seabed, beach and dune change over time, and monitor Intermittently Closed and Open Lakes and Lagoons (ICOLLS). This will enable coastal stakeholders in NSW to understand the impact of extreme coastal storms and how long it takes for these locations to recover, and better inform the development of coastal management, planning and climate change adaptation, to minimise the risks from natural coastal hazards.

This includes the impacts of extreme storms on the beaches, dunes and ICOLLS including the entrance width, depth and berm heights.

Technical and Functional Requirements

Coastal monitoring data is foundational to inform the development of coastal management, planning and climate change adaptation, to minimise increasing risks from coastal hazards. Limitations of historical monitoring data has left uncertainty around storm impacts that hindered strategic planning in the past. Recent technological advances provide new opportunities to reduce this uncertainty using new sensors.

This proposal is specifically interested in technology which has the capability to penetrate the water and map the seabed and features above and adjacent to the water, using a single data collection method or sensor. Ideally these could use a variety of collection methods based on the size of area subject to data collection including:

- The use of unmanned aerial vehicles (UAVs) to monitor large sections of coastline.
- Permanently Installed or ground-based low-power solutions that can collect data more frequently in locations where conditions may change frequently like ICOLLS.

The technology and data would need to be utilised in a state-wide coastal monitoring program. This will also help identify and quantify the impact of extreme storm events in NSW, another big data gap for coastal management and modelling. This would include other Local, State and Federal Government agencies who provide prediction and modelling services including the impacts of flooding.

The challenge seeks to develop a seamless workflow from data collection to end-user application. The solution will need to interface with the State agency data portals like SEED, so it reaches the right end-users and provides a more efficient and quicker platform for processing NSW coastal monitoring data.

18. Measuring water flow and bathymetry in rivers

Challenge agencies: DCCEEW, Water NSW

User story

As a water manager, scientist, flood manager or community member, I want the capability to measure the velocity and cross-section of open-channel waterways, facilitating flow calculations without the need for entering water or accessing high-risk locations during floods. This will improve real-time flood and water quality management, response and future planning, contributing to better preparedness for both the government and the community.

This integrated capability should also offer an efficient and effective means to measure and monitor changes in flow and bathymetry, alongside environmental responses, before, during and after events.

Technical and Functional Requirements

- Implement an advanced solution by integrating non-contact, visual and wireless technology for river flow measurements.
- Utilise uncrewed devices equipped with diverse sensor packages to enhance efficiency, reducing the need for on-site visits.
- Ensure real-time data acquisition during events, addressing the limitations associated with conventional methods.
- Establish collaborations with reputable commercial providers for streamlined and effective implementation of this cost-efficient monitoring system.

19. Water quality monitoring and predictive capabilities

Challenge agencies: DCCEEW, Water NSW

User story

As a water manager, scientist or flood manager, I want to be able to measure and monitor changes to water quality in rivers and water storage, including the predicted likelihood or presence of algal bloom formation, especially blue green/cyanobacteria blooms. This will enable agencies to be better prepared for the management and response of flood and water quality issues and better predict and respond to impacts on fish health, town and recreational water quality.

Identifying the causes in real time and taking actions to prevent water quality impacts and bloom formation, where possible, helps ensure the maintenance of water quality and human health. This is particularly critical where water filtration plants are unable to effectively manage the effects of algal blooms.

Technical and Functional Requirements

Current methods for measuring and monitoring water quality in NSW are generally based on fixed sensors or samples collected by field staff. Most fixed instruments must be installed in the river channel and below the surface of the water to work. This makes them prone to failure during flood. Risks to staff safety and restrictions to site access often mean that water quality data is not collect during events, particularly floods.

Technology that can be deployed above the water and collect information using reflected and or refracted light could be cheaper, faster and reduce the risks of water quality monitoring equipment being damaged/lost during flood events or being left stranded out of water by low flows.

Solutions should include:

- Technology that collects data from above the water and continue to be used regardless of the water level and during flood events.
- A predictive modelling tool that provides a strong indicator of likely algal bloom formation or other known water quality issues and the key factors influencing it/them.
- The methodology used to calculate the risk of formation needs to be transparent so that management controls can be targeted at the contributing factors.
- The elements that need to be measured include but are not limited to temperature, dissolved oxygen, turbidity, salinity, pH, phosphorus and nitrate.

20. Monitoring and maintenance of dissolved oxygen in rivers

Challenge agency: DCCEEW

User story

As a water scientist I want to be able to measure, monitor and maintain dissolved oxygen levels in inland NSW river systems so that agencies can make management decisions in a timely manner with the ability to implement potential solutions not dependent on water availability.

Technical and Functional Requirements

Management of fish death events is dependent on water quality monitoring equipment installed and maintained in remote and extreme conditions with significant fluctuations in water depth.

Technology that is robust, needing minimal maintenance and low energy requirements is sought to expand current water quality monitoring sites. Information needs to be available in real time with reporting intervals no longer one hour. This data needs to be sent through communication networks that do not utilise technologies like 3/4G and Wi-Fi, which do not exist in the locations where equipment is installed.

In addition to monitoring, technology to improve dissolved oxygen levels are needed that can be activated remotely for when levels drop to thresholds endangering biota health. These strategies cannot always depend on the availability of water flows and also need to be feasible in remote areas and not dependent on the electricity grid nor generators to be low cost and carbon neutral. For example, the use of nanobubble technology can provide refuge habitats for fish when conditions become dire in key locations.

21. Multilingual emergency warnings

Challenge agencies: Department of Customer Service (DCS), RFS, SES

User story

As a public information officer of an emergency service organisation, I want hazard warnings to be automatically generated in the top seven non-English languages in Australia based on the authored English language warning, so that members of the community have the option of reading hazard warnings in their preferred language.

Technical and Functional Requirements

Hazard warnings include bushfire and flood warnings, flash floods and severe weather, and are shared via emergency service websites, social media, HazardWatch and Hazards Near Me. Examples of warnings can be seen on: www.hazardwatch.gov.au , www.rfs.nsw.gov.au, www.ses.nsw.gov.au.

Warnings are currently authored in English via a mix of templates, dynamic inputs (e.g.: location, warning priority) and free text. Warnings are created/updated and published very quickly and based on dynamic natural hazard events.

Hazard warnings generally use carefully selected terminology (using the Australian Warning System) based on experience and research to best ensure the community understand the warnings, risk and suggested actions.

Solutions should include:

- Integration of existing standards for translation and multi-language support including Australian and NSW government standards.
- Warnings that follow the Australian Warning System terminology www.australianwarningsystem.com.au/

22. Auslan presentation of warnings

Challenge agencies: DCS, RFS, SES

User story

As a public information officer of an emergency service organisation, I want hazard warnings to be generated in Auslan sign language based on the authored English language warning, so that members of the community have the option of consuming hazard warnings via Auslan sign language.

Technical and Functional Requirements

Hazard warnings include bushfire and flood warnings, flash floods and severe weather, and are shared via emergency service websites, social media, HazardWatch and Hazards Near Me. Examples of warnings can be seen on: www.hazardwatch.gov.au , www.rfs.nsw.gov.au, www.ses.nsw.gov.au.

Warnings are currently authored in English via a mix of templates, dynamic inputs (e.g.: location, warning priority) and free text. Warnings are created/updated and published very quickly and based on dynamic natural hazard events.

Hazard warnings generally use carefully selected terminology (using the Australian Warning System) based on experience and research to best ensure the community understand the warnings, risk and suggested actions.

Solutions should include:

- Content that complies to existing standards for Auslan.
- Warnings that follow the Australian Warning System terminology www.australianwarningsystem.com.au/

23. Connectivity to the Hazards Near Me app

Challenge agencies: DCS, RFS, SES

User story

As a member of the public, I want connectivity for the Hazards Near Me app (https://www.nsw.gov.au/emergency/hazards-near-me-app) in circumstances where my mobile device is impacted by a telecommunications outage, but the mobile device is still able to receive 5G cell tower signals, so that I receive critical safety information in the case of a natural hazard.

Technical and Functional Requirements

Often during emergencies, access to standard connectivity and telecommunications is lost by the public in impacted areas, because of either the impact of the emergency or loss of power, internet connectivity or large volumes of traffic.

The technology solution will enable a critical app, like Hazards Near Me, to receive limited network coverage when telecommunications are limited or out. This could include technology like a 'mesh' network that enables limited connectivity to Hazards Near Me – allowing the public to still receive warning updates impacting them.

24. Voice connectivity and vehicle tracking for regional and remote staff

Challenge agencies: TfNSW, NPWS

User story

As a regional staff member undertaking support activities during emergencies, I need the ability to maintain voice communications with control centres like the Traffic Management Centre (TMC) and enable them to track my location remotely. This will ensure that I have a way to communicate important information and my location to the control centre, and give the control centres the confidence that I am safe and able to raise help even when working alone.

I need the ability to do this in a way that is independent from consumer phone networks and where coverage of the public safety radio network is not yet active or congested with higher priority communications. Ideally, I would like the same hardware to communicate with my control centre regardless of the connectivity available.

Technical and Functional Requirements

Using existing devices like a PSN/GRN-connected radio or a standard mobile phone, the technology will enable the remote staff member to use voice and/or limited data connectivity to communicate with their control centre or base at a minimum. Where possible and available this should also enable remote connectivity to the existing and radio networks to enable communication with other agencies.

The location of the vehicle and other related telemetry should also be communicated over the technology to the agency tracking systems. The technology should offer a way to connect or enable existing lone worker functionality that allows staff to seek help in an emergency or to check in at regular intervals. This could be achieved by enabling connectivity for existing solutions or devices.

Solutions should include:

- Maintaining connectivity using the cheapest connectivity method
- Not requiring the agency to pre-deploy base stations or repeaters before expecting connectivity
- Providing a level of data connectivity with voice communications being the priority
- Delivering high availability and reliability in remote and rural locations impacted by natural hazards which generally include power and telecommunications outages to large areas.

25. Hearing aids for firefighters

Challenge agency: NPWS

User story

As a firefighter recruiter, I need hearing aid technology that will withstand the rigours of active firefighting, so that people with hearing loss can fully participate in fire suppression and response activities.

Technical and Functional Requirements

The current firefighter medical examination stipulates that hearing tests must be conducted without hearing aids in place. This precludes hearing-impaired, but otherwise fit and capable staff, from meeting the requirements for active firefighting with most firefighting agencies.

A recent independent review concluded that there are no hearing aids currently on the market that overcome the rigorous conditions experienced on the fireground and that a relaxing of this medical requirement could not be considered for this reason.

There are currently no known hearing aids capable of performing under the conditions experienced on a fireground, which limits the recruitment pool for firefighting. Issues with existing models that need to be overcome include:

- failure of unit on exposure to water or sweat
- battery failure on the fireground, exposing the firefighter to loss of hearing and situational awareness
- a failed in-ear hearing aid acting as an earplug and further contributing to lack of hearing
- A failed in-ear device not able to be removed in the field
- exposure of external devices to excessive or prolonged heat
- tight fitting headwear (such as helmets) negatively impacting implanted hearing devices.

Addressing this challenge has benefits that extend well beyond the fire management industry.