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Review of Post-Disaster Science Response and Coordination: 2023 North Island Severe Weather Events

Final

Prepared for:

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Director
Resilience to
Nature's Challenges

RESILIENCE TO NATURE'S CHALLENGES | Kia manawaroa – Ngā Ākina o Te Ao Tūroa | National SCIENCE Challenges

1 August 2024

Brendan Morris Consulting Limited is a hazards and emergency management consultancy. Based in Hamilton, the company offers services throughout New Zealand.

The primary objective of the company is to provide leadership in hazards and emergency management to middle and senior management within local and central Government. The company also provides policy, strategy, and business continuity management services.

Version control

Version	Date	Status	Comments
1	4 June 2024	Initial draft	
2	10 June 2024	Updated draft	Post review by Richard Smith and Tom Wilson
3	24 June 2024	" "	Additional detailed review comments/suggestions
4	1 August 2024	Final	Post-consultation reviewed and amended

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Acknowledgements

I would like to acknowledge the support of everyone who gave their time to participate in interviews and in follow-up activities. Feedback was of high quality and notable for being direct, candid, and respectful of all parties, and this was greatly appreciated.

I would like to offer my special thanks to Richard Smith and Tom Wilson for their time in helping me get my head around the complexities of the science sector and their patience in supporting me through the review.

Approved by:

Brendan Morris, Director

Issued: 1 August 2024

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Executive Summary

This is an independent review of the science response to the 2023 North Island Severe Weather Events (NISWE). This review helps inform future arrangements for an effective science response in emergencies, as well as the role of the wider science system and agencies in disaster risk management.

Science and research are critical elements of the response to major emergencies. The NISWE were collectively the most severe and destructive weather events in New Zealand's recent history, resulting in significant devastation to property and ongoing recovery for communities. A state of national emergency was declared in response to Cyclone Gabrielle on the morning of 14 February – for only the third time since the introduction of the Civil Defence Emergency Management (CDEM) Act 2002.

During the NISWE response, scientists, researchers and the science system mobilised in several ways including rapid provision of advice to central and local government, collection of perishable data, and through the Ministry of Business, Innovation & Employment (MBIE), identification of critical science needs and associated new research investments through the Extreme Weather Research Platform.

This review began in late February 2024. The primary methodology used is qualitative interviews of key agencies involved in NISWE science response around five themes, being science response and coordination arrangements, science response roles, science advice products, data and information sharing arrangements, and funding arrangements.

27 in-confidence interviews were held with 46 participants from 23 organisations involved in response and recovery. Detailed notes were taken and compiled by theme and question, then summarised. Various reports were reviewed, summarised, then combined with interview summaries to draw conclusions and recommendations.

In summary, the review findings and recommendations are as follows:

Perspective on the NISWE science response

There were significant management challenges associated with Cyclone Gabrielle due to the widespread, complex, and unprecedented nature of the event. While this review seeks opportunities for improvement and corrective actions, the response had positive elements. The effective use of personal relational relationships and networks was notable, the Chief Science Advisor (CSA) Forum was largely effective, and the National Emergency Management Agency (NEMA)/Te Uru Kahika CSA roles were considered critical to response effectiveness.

MBIE secured funding rapidly and an enduring feeling from interview participants was that individuals and agencies largely acted with good intent during response. The Resilience to Nature's Challenges (RNC) programme is credited with laying a foundation for relationship building that assisted response. These are all positive aspects that should be acknowledged and can be built upon in the future.

Science response and coordination arrangements

Interview feedback suggests that while mobilisation of most agencies occurred quickly, initial science response was disjointed with no apparent process for initial response actions and a lack of clarity of roles and responsibilities. Timely collection of perishable data and cross-over of responsibilities was challenging to response coordination. There was a perception of a need for improved coordination

between agencies engaged in science[1] and the wider event response coordination, with little flow of usable intelligence to the National Crisis Management Centre (NCMC), and a similar perception with Iwi/Māori, links to local communities, the health sector, and regional council operations.

There is likely less maturity in coordination of arrangements for severe weather response than for other hazards such as earthquake and volcanic, and that leadership and coordination was clearer and more visible in the Canterbury Earthquake Sequence with the mandate of the Natural Hazards Research Programme. The complexity of the NISWE must be considered, however. Pre-event planning, explicit recognition of coordination as a function, and clarity on leadership and coordination roles are most important for improving response coordination.

This review recommends that in relation to science response and coordination arrangements, pre-event planning for science response following severe weather events be developed including hazards to be covered, scenarios/response options and data collection protocols. It is recommended that NEMA response leadership and coordination capacity be supported via creation of a 'Science Desk' in the National Coordination Centre (NCC)/NCMC and adequate suitably skilled surge staffing capacity.

It is also recommended that a 'Severe Weather Science Advisory Panel' be created to support response, and that support be provided to an ongoing forum to support science research with the conclusion of RNC and the benefits it provided to relationship building both pre- and post-event.

Science response roles

Interview feedback indicates a lack of awareness of science roles across the wider science and emergency management sectors[2]. Feedback also suggests that current science response roles do not effectively enable response and that science response role definitions require improvement. Some interview participants reported that better definition of some roles in severe weather hazards is required – particularly for flood hazards.

There is strong support among interview participants for better defining science response roles as one of the key changes required to improve response coordination and this is also supported at a high level within the Government Inquiry into the NISWE. This review concludes that changes are required to the response roles in the National CDEM Plan.

This review recommends that in relation to science response roles, that updated and improved definitions, greater clarity and expansion of all science response roles is undertaken as a part of the review of the National CDEM Plan and Guide 2015, in particular:

- Development of formal national/regional leadership and coordination roles.
- Addition of 'flood hazard and risk' roles.
- Development of roles for agencies currently undefined within the plan but important to science response.

Science advice products

Interview feedback was widely divergent on the process used for product selection and effectiveness of science advice products. Feedback was largely positive on the MBIE Extreme Weather Platform

[1] Agencies that either directly fund, manage, and/or conduct physical science in support of emergency response. Includes 'wider science' sector agencies below, local authorities, and some infrastructure providers.
[2] The 'wider science' sector includes Government departments that have responsibilities under the CDEM Act, Crown Research Institutes, universities, independent research organisations, and private science providers. The 'wider emergency management sector' also includes Government departments, local authorities, emergency services, some critical infrastructure providers, and emergency welfare services agencies.

process used and individual outcomes for 'Stage 0'[3] products despite this. A need for greater transparency around the suite of decisions made and clearer links to community needs was emphasised during interviews.

Development of pre-event processes for science products, including imagery gathering and prioritisation and clarification of roles is critical to effective response.

This review recommends that in relation to science advice products, the process for developing proposals is improved to provide greater transparency on the balance required between science services and research and the type of science or engineering required. It is also recommended that a methodology for project evaluation be developed and that a separate collection process be developed for remote sensing imagery and data.

Data and information sharing arrangements

An apparent long-term trend of reinventing data and information sharing protocols at the time of large disaster events has continued during the NISWE leading to the initial prevalence of ad-hoc, informal sharing arrangements. Interview feedback and NISWE review outcomes support development of a centralised approach to data and information management in helping to underpin intelligence and the building of a Common Operating Picture (COP).

There is a strong need for confirmation of pre-event data and information sharing arrangements and further work to improve data sharing protocols, especially for remote sensing data/imagery. The difficulties in sharing remote sensing imagery due to licensing restrictions were of particular concern due to the high demand for and reliance on this data in applications such as mapping of post-event impacts.

This review recommends that in relation to data and information sharing arrangements, a pre-event process is developed for creating, managing, and hosting a meta research database and data clearinghouse modelled along the lines of the United States-based Earthquake Engineering Research Institute. It is also recommended that consideration is given to setting up a 'permanent home' for a centralised system, and that agencies work pre-event to improve data sharing protocols/arrangements, including for remote sensing data/imagery.

Funding arrangements

The fast mobilisation of funding and inherent flexibility of the Strategic Science Investment Fund (SSIF) Extreme Weather Platform worked well during the Cyclone Gabrielle response despite the funding model constraints, event pressures, and reported issues with the funding proposal process. Some interview participants felt that the SSIF funding process through Crown Research Institutes (CRIs) was exclusionary of other agencies and that imagery requirements would be better served by separate, specific funding arrangements.

Concerns were also raised about the sustainability of the SSIF as a funding solution and around its suitability for funding short-term science services during response. Concerns were also raised about the viability of any separate fund within the current political climate.

This review recommends that in relation to funding arrangements, options for establishing a dedicated contingency fund be investigated for rapid science response. If similar funding arrangements to NISWE are used again, it is recommended that greater flexibility for inclusion of science providers is built into the funding model. It is also recommended that a separate funding mechanism be developed for remote sensing imagery and data collection.

[3] Science input to support immediate response totalling $2.65 million, mostly allocated to immediate and urgent science response activities by 22 March 2023. Public safety was the key consideration for funding.

Purpose

To provide an independent review of the science response to the 2023 North Island Severe Weather Events (NISWE) to help inform future arrangements for an effective science response in emergencies, as well as the role of the wider science system and agencies in disaster risk management.

Background and context

Background

When disasters or emergencies and other major incidents happen science and research are critical elements of the response. The science and research response helps generate new knowledge and understanding about the incident, potentially reduce harm, and inform decision-making. Science and research (and other knowledge sources such as Mātauranga Māori) also make important contributions across the other phases of comprehensive disaster risk management including in reduction, readiness, and recovery.

Context

Under the National Civil Defence & Emergency Management (CDEM) Plan 2015 (and associated Guide) science and research agencies have a range of roles and responsibilities, some broadly defined (such as contributing knowledge for supporting community resilience) and some quite specific (such as hazard monitoring to support warnings and alerts).

Scientists and research organisations have been involved in the response to several recent large-scale natural hazard events in New Zealand. This has included a significant number of Resilience Challenge-affiliated researchers, undertaking collection of perishable data for research as well as providing analysis and advice for the response and recovery. The 'Resilience to Nature's Challenges' National Science Challenge (RNC)[4] involvement in post-disaster response is unique among the National Science Challenges and reflects a legacy inherited from the Natural Hazards Research Platform[5] (and its role in the Canterbury Earthquake Sequence (2010-2011) and Kaikōura earthquake (2016)), as well as a loosely defined delegation under Ministry of Business Innovation & Employment's (MBIE) role in the National CDEM Plan. There are unclear expectations about roles and responsibilities for Crown Research Institutes (CRIs), universities and collaborative virtual organisations like RNC and QuakeCore.[6]

In the national response to the 2023 NISWE, scientists, researchers and the science system mobilised in several ways including rapid provision of advice to central and local government, collection of perishable data, and, through MBIE, identification of critical science needs and associated new investments through the Extreme Weather Research Platform.

The science response to the 2023 NISWE is notable for:

[4] RNC began in 2014 and will end on 30 June 2024. The overall objective is to 'enhance New Zealand's resilience to natural disasters.'

[5] The platform ran from 2009 – 2019. The strategic intent of the platform was 'to provide the evidence basis and sound advice on natural hazard risk management that enables individuals, communities, businesses and central and local government agencies deliver against social and economic obligations.'

[6] QuakeCoRE is a Centre of Research Excellence (CoRE), one of ten currently funded by the New Zealand government (Tertiary Education Commission). Refer to https://quakecore.nz/about-us/

- The role of Chief Science Advisors (CSAs) of various government agencies and regional councils for liaison and coordination across the science system and with the formal emergency management response
- MBIE's facilitation of reprioritised funding to enable urgent science services to be undertaken
- The explicit consideration of arrangements for coordination of research activities.

Learning from the NISWE and other event responses

There is a desire to learn from these recent experiences to help inform future arrangements for an effective science response in emergencies, as well as the role of the wider science system and agencies in disaster risk management.

The National Emergency Management Agency (NEMA), MBIE and RNC are interested in learning from recent NISWE and previous response experiences to help inform improvements to future science response arrangements. This review was commissioned by the Resilience National Science Challenge, in close consultation with NEMA and MBIE.

The Resilience Challenge is unique among the National Science Challenges in having a role to support coordinated science response on natural hazard events. RNC has provided this support for a number of events including the Kaikoura Earthquake in 2016 and several severe weather events over the past seven years. RNC was asked by MBIE in June 2024 to provide formal support for coordination through funding made available from the Strategic Science Investment Fund (SSIF) to a number of research projects collectively called the Extreme Weather Research Platform (EWRP). The RNC Governance Group requested a review be undertaken of the wider science response, including the interactions and information flows and project scoping which occurred before formal establishment of the EWRP. There was widespread support for this initiative as an opportunity to identify lessons for both connecting science effectively into emergency responses, and to inform future arrangements for a more formalised research coordination function.

Potential and perceived conflicts of interest were managed through commissioning an independent contractor with deep knowledge and networks in both the science and emergency management systems, and who wasn't otherwise involved in the emergency or science responses for the NISWE 2023.

The 2023 North Island Severe Weather Events and science response

Summary of the NISWE

The following summary relates primarily to the Auckland Anniversary weekend floods (main impact **27 January 2023**) and Cyclone Gabrielle (main impact **12-14 February 2023**).[7]

The Government Inquiry into the Response to the North Island Severe Weather Events ('Government Inquiry') provides a summary of the impacts of the NISWE:

> *'The severe weather events and the impacts were enormous. Cyclone Hale caused widespread flooding and slips, and washed-away slash clogged many rivers in Tairāwhiti. The Auckland Anniversary heavy rainfall brought 200-300mm of rain to Auckland, overburdening*

[7] For a more comprehensive summary, refer to Section 2 of the NEMA 2023 North Island Severe Weather Events Internal Operational Lessons Report: https://www.civildefence.govt.nz/assets/Uploads/documents/publications/May-2024-NISWE-NEMA-Internal-Operational-Lessons-Report-FINAL.pdf

the stormwater system and leading to flooding in adjacent areas. Parts of Northland had 200-300mm of rain, and some higher elevations on the Coromandel Peninsula had 300-400mm. Cyclone Gabrielle was one of the worst storms to hit New Zealand in living history, with a state of national emergency declared — only the third since the Civil Defence Emergency Management Act 2002 (CDEM Act) came into force."[8]

In addition to overwhelming stormwater infrastructure and flooding low-lying areas, the Auckland Anniversary event caused hundreds of landslides. Three people died because of the event in Auckland City, and one in Onewhero, Waikato. Several hundred people were injured, hundreds of houses were rendered uninhabitable, and nearly 100 roads were closed due to flooding or slips.[9] Northland, Waikato, and Bay of Plenty also experienced flooding from the event, and both State Highway 1 to Whangārei and the North Auckland railway line were impassable for months.[10]

Just over two weeks after the Auckland Anniversary weekend storm, New Zealand was struck by Cyclone Gabrielle. As with Cyclone Bola, Gabrielle's movement was slowed by a blocking anticyclone, prolonging the heavy rain.[11] Impacted regions were Northland, Auckland, Waikato, Bay of Plenty, Gisborne (Tairāwhiti) and Hawke's Bay. The Tararua District was also impacted.

Hawke's Bay and Tairawhiti were severely affected, where in some areas, 300 to 400 millimetres fell in 48 to 60 hours. Esk Valley, just north of Napier, received 500 millimetres in 24 hours, half of this in six hours in the middle of the night.[12]

Tragically, eleven people died (eight in Hawke's Bay), and dozens were rescued by helicopters and small boats. Hundreds of people were injured, hundreds of homes became uninhabitable, and there were widespread power outages and loss of cell phone coverage. An estimated 10,000 people were forced to leave their homes, at least temporarily.[13]

A state of national emergency was declared on the morning of 14 February – for only the third time since the introduction of the CDEM Act 2002.

Overview of the science response

A timeline of the key events and activities in the NISWE science response is provided in **Appendix 2**.

While not comprehensive, the timeline aims to capture the series of key science response events and activities from the start of the Auckland Anniversary Weekend floods until the RNC Symposium and Extreme Weather Research Programme introduction to funded programmes webinar in June/July 2023.

The timeline is based primarily around dates provided by the NEMA CSA, MBIE Science Policy team, and dates drawn from NISWE response reviews.

[8] Section 2, Chapter 1 (6), Government Inquiry into the Response to the North Island Severe Weather Events, p. 31.

[9] https://teara.govt.nz/en/floods/page-5

[10] " "

[11] " "

[12] " "

[13] " "

Scope and methodology

Scope

NISWE definition

For the purposes of this review, the Auckland Anniversary Weekend flood event and Cyclone Gabrielle are the two events that are collectively referred to as the NISWE. It is acknowledged that this definition is different to the Government Inquiry, which also includes Cyclone Hale, and that Cyclone Hale set pre-conditions for further impacts to several regions during the following events – particularly Northland, Waikato (Thames-Coromandel), and Tairāwhiti.[14] Cyclone Hale and the Auckland Anniversary Weekend flood event placed significant stress and obligations on parts of the science system prior to the additional requirements of a national-level response to Cyclone Gabrielle.

NISWE interview feedback

While this review addresses both the Auckland Anniversary Weekend flood event and Cyclone Gabrielle, almost all interview feedback provided relates to the Cyclone Gabrielle response. This is due to several factors including the scale and intensity of the event, the size of impacts, the level of activation, the high level of agency involvement, the need for central science response coordination, and the complexity of response. While locally devastating, the Auckland Anniversary Weekend floods were not at a level that required triggering of a large, immediate central coordination of science response.

Science response funding

It is noted that with respect to science response funding, the scope of this review does not go beyond considering collective science response and recovery funding provided via the MBIE Extreme Weather Science Response 'Urgent scientific research and data collection' and 'Extreme Weather Recovery Advice Fund.' While enquiries were made into specific agency funding to support NISWE science response, the complexity and diversity of funding arrangements – even within individual agencies – made any attempt at establishing an overall funding picture unrealistic with the time constraints of this review.

MBIE funding support[15] totalling $9.1 million[16] for the NISWE science response was as follows:

- **Stage 0** ($2.65 million): science services to support immediate response with a focus on public safety. Most funding was allocated by 22 March 2023. Projects included LiDAR collection, aerial photography and assessment of landslide risks, flood and catchment risk assessments, satellite imagery, air quality, and groundwater contamination.
- **Stage 1** ($5.95 million): time-bound evidence-based science services, and perishable research and data collection. Processes were largely in place by 22 March 2023 with approvals starting on 31 March 2023 and all contracts agreed by 30 June 2023. Projects included supporting critical infrastructure recovery, integrated ecological impact assessment, cyclone-driven coastal erosion assessment, impacts on rangatahi and whānau wellbeing, and emergency event data catalogue development.

[14] Section 1 (13), Government Inquiry into the Response to the North Island Severe Weather Events, p. 6.
[15] https://www.mbie.govt.nz/science-and-technology/science-and-innovation/funding-information-and-opportunities/investment-funds/extreme-weather-science-response
[16] Excluding the $2.21 million set aside for Māori-determined priorities, which is outside the scope of this review.

- **Stage 2** ($0.5 million): science to support recovery and resilience for regional councils (these processes are currently active in the 2023/24 FY).

Further information on individual projects is available on the RNC website: https://resiliencechallenge.nz/extreme-weather-research-platform/#ewrp-projects

Methodology

This review began in late February 2024 with fundamental information gathering and identification of key contacts. The primary methodology used is qualitative interviews of key individuals and agencies involved in NISWE science response. Interviews were based on the following themes:

- Science response and coordination arrangements
- Science response roles
- Science advice products
- Data and information sharing arrangements
- Funding arrangements.

A list of the standard questions asked by theme is provided in **Appendix 3**.

27 interviews were held between 26 March and 14 May with a total of 46 participants. Participating key individuals and agencies and names of people interviewed are provided in **Appendix 4**. Of the 23 key individuals and agencies invited to participate, two declined (from Massey University and Bay of Plenty Regional Council), and one was added (BRANZ).

Interviews were held in confidence, recorded, and detailed notes were taken throughout each interview. The interview notes were compiled by theme and question, then summarised to capture the essence of feedback provided. Various reports were reviewed – some provided by participants, and some available in the public domain, including recently released NISWE reviews.

The interview feedback and report summaries were used to draw conclusions and develop recommendations. The initial draft report was reviewed in detail by Richard Smith and Tom Wilson, amended, and then sent to all interview participants for feedback in early July. Feedback was assessed and amendments made to produce the final report.

Destruction of all confidential information provided during the review process and deletion of all interview recordings was completed as part of final report production.

Interview feedback

Science response and coordination arrangements

Effectiveness of science response mobilisation

Feedback suggests that initial mobilisation was somewhat ad-hoc and not as effective as it could have been. The size, scale, and multi-hazard complex nature of Cyclone Gabrielle is acknowledged alongside this. The following feedback is notable:

- Initial mobilisation of most agencies occurred quickly. Some agencies were slower and/or less willing to stand up and mobilise capability and capacity than others that were more well-practised in response.

- Response was disjointed at first with little coordination, no apparent process for initial response actions, and a lack of clarity around roles and responsibilities. Response coordination improved once the CSA Forum started meeting regularly.
- There was a perceived initial delay in identifying science issues and clarity on what response questions should be being asked ('*tell us what you are doing*' instead of '*tell us what you need'*).
- Some organisations were omitted from the first funding round process[17], which is perceived by some to have either impacted science advice products or led to missed opportunities.
- Agencies and individuals generally responded with best intentions, which assisted response effectiveness. Existing relationships helped response, and the engineering mobilisation appears to have been somewhat ad-hoc but effective – likely due to familiarity with existing activation procedures.

Roles, groups, and networks of most importance to response coordination

Feedback highlighted the most important elements as:

- Personal relationships and professional networks: these were by far the most identified and important element for response coordination. Often the relationships were described as informal, and this applied across all sectors of the response including local and central Government agencies, CRIs, universities, and other advisory groups.
- Chief Science Advisors forum: the forum is widely considered to be an effective coordination mechanism across the wider response for helping with prioritisation and in understanding agency needs.
- NEMA and Te Uru Kahika Chief Science Advisors: these roles were critical to response coordination – the latter role being a strong advocate for the regions. Feedback also reinforced the importance of these roles working in tandem during response.

The following feedback is also noted:

- The importance of the MBIE Science Policy team role is noted, especially with respect to operating at pace with best intentions during response.
- Some recognition was made of the value of the Regional Science Managers forum.
- The development of relationships is linked to the existence of the RNC collaboration.
- There was little mention of the use of formal existing groups or professional organisations during response.

Effectiveness of coordination among agencies engaged in science and between agencies engaged in science and the wider response

Coordination among agencies engaged in science

Feedback was as follows:

- Good 'coordination' was reported by some interviewees where existing personal relationships existed between agencies – especially informal, initial conversations.
- Some tensions were identified between CRIs initially with respect to pitching of individual projects, and this is perceived to be at least partially due to a desire to retain projects in-house and/or retain commercial value.
- Achieving coordination among agencies with collection of perishable data was reported as challenging, as was the cross-over in responsibilities for some activities such as landslides,

[17] Refer to 'Stage 0' description above.

and projects where agency systems did not align. Despite this, interviewees reported that agencies consistently worked with 'best intent.'
- There is evidence of duplication of effort among agencies, especially in remote sensing.

Coordination between agencies engaged in science and the wider response

Overall, feedback indicated that science was not well integrated with the wider response. The following feedback is notable:

- Coordination between agencies engaged in science, subcontractors and end users within individual projects was generally reported as satisfactory,[18] while there was generally less satisfaction expressed with coordination between agencies engaged in science and Government agencies.
- A national/regional disconnect in coordination and reporting was noted with little flow of intelligence from agencies engaged in science to the NCMC.
- The heavy reliance on both the NEMA and Te Uru Kahika CSAs was reinforced as key to coordination during response. While effective, relying solely on the Te Uru Kahika CSA for coordination with regional science managers was a time-consuming process. The role of Special Interest Groups during NISWE response was not perceived as adding significantly to response coordination effectiveness.
- Feedback indicates that while use of personal relationships proved valuable, coordination was less effective where these did not already exist.
- Some feedback indicated discomfort with a lack of connections to Iwi/Māori networks and researchers, regional council operations, and the health sector.
- Lesser impacted regions reported that the ability of the coordinated science response to efficiently address the nuances of regional priorities were:
    - Inadequate for Northland, where landslides were small-scale but numerous and collectively damaging to road infrastructure, and
    - Less than desirable for and Waikato, where Whangamarino wetland response became a major social, cultural, and environmental issue for the region.

General comments on response coordination

- There is less maturity in coordination arrangements for severe weather response than for other hazards such as tsunami, seismic, and volcanic.
- Existing arrangements and funding improves inter-agency response effectiveness, such as with GeoNet and MetService.
- There was a lack of event-available response capacity within the NCMC/NEMA Hazard Risk Management Team to support response coordination, as they were already fully committed in other functions (e.g. Intelligence and Operations).

How coordination changed throughout the response

There was limited and variable feedback on how coordination changed throughout response and lack of a strong, definitive trend.

The following general observations were made:

- Immediate response had little coordination with an initial lack of awareness of clarity on science issues, what agencies could offer, and who was coordinating response.[19]

[18] The Remote Sensing Data Collection process being one exception (covered further with 'Science advice products' Section - Effectiveness of science products).
[19] Note: these comments are like the initial science response mobilisation feedback.

- Ongoing response was more coordinated with standing established groups (including the CSAs Forum, Regional Science Managers) and more 'rhythm' to response.
- Science support for recovery was reported as less coordinated, with a focus on individual regions and little strategic coordination apparent.
- While there was still urgency in the immediate and ongoing phases, the pace of response slowed as it progressed.

How science response effectiveness and coordination compared to other large events

While comparisons between Cyclone Gabrielle and previous large events were made, the different context of the event is important. As a large, severe weather event, Cyclone Gabrielle is a multi-hazard, multi-dimensional, complex, and widespread event. As such, it presents many more challenges in terms of data gathering and distributed management of impacts compared to more localised events such as the Canterbury Earthquake Sequence. The following comments must be viewed with this in mind.

Feedback suggests that the response to the Canterbury Earthquake Sequence was more effective than the NISWE response in the following ways:

- The science leadership role and mandate of the Natural Hazards Research Platform, which made science leadership clear and visible within the Emergency Operations Centre.
- Pre-existing sector relationships were very well established for both research and response.
- There was better coordination of research for the emergency management sector (e.g. liquefaction, seismic), and impact to buildings was included, whereas it was unclear as to why building research was not included in NISWE response.
- A multi-sector technical clearinghouse was developed and used.

Response to the NISWE were viewed as more effective to previous events due to the speed of response funding reprioritisation by MBIE and the use of the CSAs, especially the NEMA and Te Uru Kahika CSAs.

Other observations about the NISWE response in relation to previous events:

- There is little evidence of improvement in remote sensing and data management.
- More agencies appeared unaware or unfamiliar with local arrangements and the emergency management system compared to Canterbury and Kaikoura earthquake events.
- There was a lack of clarity on responsibilities for coordinating some hazards such as flooding due to distributed responsibilities.
- Sector relationships were not as well developed as those developed during the Canterbury Earthquake Sequence.
- The absence of Natural Hazards Commission Toka Tū Ake (NHC) in damage data coordination was a 'gap'.

What will be most important for effective science response coordination in the future

There was strong feedback on the three most important elements for improving science response coordination in the future – all of which are inter-related:

1. Pre-event Planning:
    - Develop scenarios and 'playbook' response options.
    - Determine what science needs to address and what questions should be asked.
    - Develop specifications, protocols, checklists, etc. for data gathering.
    - Response arrangements, funding decision making, etc.

2. Coordination:
    - Coordination structures/arrangements needed, explicit recognition of the role of the coordination function in response, especially the leadership role of NEMA/NCMC.
    - Improve connections between response agencies and with communities, including Iwi/Māori networks.
3. Roles and Responsibilities:
    - Clarity on mandates for leadership and coordination, especially for initial activation.
    - Improve clarity on roles and responsibilities for all data and information requirements associated with severe weather events (remote sensing, hazards, social/cultural, etc.).

The following elements are also considered important:

- Post-event funding: increased clarity on funding mechanisms and a 'standing fund' for immediate science needs (with pre-agreed requirements).
- Remote sensing and data sharing: consistent feedback on the need to improve geospatial information collection and sharing.[20]
- 'Severe Weather Science Advisory Panel'/Science Desk: creation of a 'panel' like seismic, volcanic and/or tsunami[21] hazards, and centralisation of the science function at a 'science desk' in the NCMC.
- Resilience to Nature's Challenges: there is a need to retain the professional networking and relationship development benefits associated with RNC in some form into the future, as the personal relationships and connections developed from this platform significantly improved NISWE response.

Science response roles

The roles referred to in this section relate to those contained within sections 81 and 85 of the schedule to the National CDEM Plan Order 2015.

Understanding of science response roles in the science and emergency management sectors

There was near unanimous feedback that while many individuals within agencies engaged in science have a good understanding of current science response roles, there is poor understanding of the emergency management system from the science system, and poor understanding of the science system within the emergency management system.

There is a lack of awareness and/or familiarity with the science response roles in the National CDEM Plan and with 'where science sits' within the Coordinated Incident Management System (CIMS) framework. There is a lack of awareness and understanding about the response capabilities and expertise of many agencies that participated in the NISWE.

Do current science response and coordination roles enable effective response?

The general feeling among interviewees is that current roles are not particularly effective at enabling response. This is primarily due to the lack of clarity on leadership and coordination roles, a lack of clarity on some agency roles that are defined in the National CDEM Plan, and the absence of formal response roles for many agencies involved in response.

[20] Refer to 'Data and information sharing arrangements' Section (Effectiveness of data and information sharing arrangements)
[21] Without a legislative response role like the Tsunami Experts Panel.

Changes required to roles to enable improved response coordination

The following changes are identified:

Improved definition and formalisation of science response roles:

- Review of current National CDEM Plan agency roles, particularly perceived gaps in the National Institute of Water and Atmospheric Research (NIWA's) role around flood response.
- Development of response roles where these are absent, starting with science organisations most involved in NISWE response (CRIs, Government, Universities), then supporting organisations (professional groups, contractors, subject matter experts (SMEs)). One starting point cited for example was to unpick the cross-over landslides roles between GNS Science (GNS) and Manaaki-Whenua to 'better utilise collective capabilities.'
- Identify where connections are needed between agencies in response and map this out.
- Formalise, clearly define, and 'lock in' the role of CSAs in response.
- Define coordination as a function, and define NEMAs:
    - Role in science leadership and coordination
    - The level of resourcing required to support this
    - How science response will be coordinated within the NCMC.

The need for better definition of science response roles was mentioned considering a need to avoid duplication of effort and the need for pre-event planning was also noted.

Science advisory panel:

- 'Severe Weather Science Advisory Panel': establishment of a panel with similar functions to volcanic (Volcanic Science Advisory Panel), earthquake (Aotearoa Earthquake Science Advisory Panel), and tsunami (Tsunami Experts Panel)[22] hazards is seen as potentially advantageous to response outcomes by many interviewees.

Science advice products

How effectively science advice needs were identified, gaps in identifying needs, and how these were filled

There was a wide divergence of views overall on how effectively science needs were identified and gaps in science needs throughout the response, and no strong alignment across interviewees. Despite this, the following general statements can be made:

- Acknowledging the severe time pressures and constraints and limitations of the current funding process, the Stage 0 (immediate response) science needs process is viewed as timely and adequate – primarily by those who were closest to the coordination and decision-making process. It was also acknowledged that debate and/or community-level input at this stage is impractical.
- The following feedback relates to Stage 1 (recovery):
    - Satellite imagery: the process and outcomes were identified as the 'biggest gap' with respect to science products by nearly all interviewees (Note: this is discussed below).
    - There is a need to focus more on science services and community needs and be clearer up front on the balance needed between science services and research.

[22] Minus the direct legislative requirements for tsunami response.

- There is a 'wide suite' of science needs associated with severe weather events (such as biodiversity, catchment-wide ecosystems, multi land-use), and these are less well understood than some other hazards, such as seismic.
- Project decision-making relied heavily on a few individuals[23] and wider extreme weather science response expert advisory panel[24] representation was seen as desirable by some interviewees.

Effectiveness of science products

There was a lot of divergent commentary and opinion on the value of individual science advice projects. Evaluation of effectiveness is problematic in many cases as the feedback simply boils down to opposing individual opinions on the value of individual project outcomes.

Commentary on individual project methodological feedback and disagreements on outcomes is avoided. However, the following feedback was largely consistent and showed strong alignment among interviewees:

Remote sensing: this was the biggest gap between what was urgently needed to underpin science advice and where coordination and delivery did not occur effectively within an appropriate timeframe. This applies more to Stage 1 funding of additional LiDAR and satellite imagery than to the initial LiDAR and aerial imagery collection in Stage 0.

Feedback indicates the following reasons for this – *a lack of*:

- Dedicated pre-event funding or clarity on who should fund imagery collection.
- Clarity on roles and responsibilities for coordinating collection,[25] including Land Information New Zealand (LINZ's) role.
- No pre-event planning for collection.

The above factors created inertia in clarification of requirements during Stage 1 – particularly for satellite imagery. Delays in obtaining satellite imagery further compounded the process to reach agreement on the type (resolution) of imagery needed and areas to be prioritised across a range of stakeholders. This led to delays in obtaining imagery, and feedback indicates a strong feeling that this led to suboptimal outcomes in terms of capturing perishable data and usefulness of imagery for some projects (such as landslide mapping).

In addition, data sharing and access of remote sensing imagery proved to be a major challenge following completion – this is discussed in the following section.

Other projects: the outcomes of the following projects were mentioned positively by a few interview participants:

- LIDAR survey of bank breaches and flood deposits in Hawke's Bay and Tairāwhiti
- Rapid assessment of landslide impacts and provision of initial aerial photographs/life safety assessment
- Rapid flood hazard assessment and modelling for Hawke's Bay and Tairāwhiti
- Understanding how extreme weather events impact rangatahi and whānau wellbeing (in terms of bring balance into the social sciences).

There were some frustrations expressed around the length of time taken and process used to develop the proposal for the integrated ecological impact assessment.

[23] Feedback was also unanimous that all panel individuals 'worked with best intent for the benefit of all.'
[24] This independent NISWE advisory panel was appointed by MBIE to provide advice on project prioritisation, lead research organisations, and proposal fundability.
[25] Also for data storage and sharing which is discussed in the following section.

Main channels for science advice into the emergency management system at local and national levels

The main channels were:

- Local level: primarily via individual relationships and connections between agencies engaged in science and local authorities and communities (where these already existed), but also via Regional Science Manager links to CDEM and communities.
- National level: primarily via CSAs and the CSA Forum, especially the NEMA and Te Uru Kahika CSAs. Other channels included the LINZ data platform, the extreme weather science response expert advisory panel, and the Director RNC.

Data and information sharing arrangements

Primary data and information sharing arrangements used among scientists and emergency management agencies

Feedback suggests the primary arrangements were:

- A lack of any formal arrangements at the start of response.
- Initial development of a Google spreadsheet to identify data capture activities that were underway.
- Informal, ad-hoc direct sharing of data and information to agencies in various forms, especially time-critical data (including dropping off hard drives to Councils, sharing data on personal websites).
- Hosting of some remote sensing data/imagery via the LINZ Data and Basemaps services (aerial photos, LiDAR, satellite imagery).
- Direct data provision from agencies engaged in science to NEMA/NCMC, and less so via Fire and Emergency New Zealand (FENZ).
- As recovery progressed, limited use of the RNC website and the Extreme Event Data Catalogue.

Effectiveness of data and information sharing arrangements (including use of the Extreme Event Data Catalogue)

Overall, feedback indicated that data and information sharing arrangements were less than effective due primarily to a lack of pre-event arrangements and the largely ad-hoc data sharing arrangements used. The following feedback is notable:

Centralised data management system: there was broad acknowledgement of the need to develop a centralised data management system – variously described by interviewees as a data clearinghouse, geospatial portal, or data portal. Feedback suggests that a centralised system would enable data sharing, increase visibility of agency activities and intent, and help to avoid duplication of effort.

A centralised system should be capable of:

- Receiving, storing, and having accessible event data and information in real time.
- Having data and information in accessible formats.
- Being centrally discoverable at the time of the event.
- Having geospatial/GIS mapping capabilities.
- Being able to be archived for future needs with appropriate categorisation and accessibility.

Imagery accessibility issues: there is consistent feedback that satellite imagery and some aerial imagery was difficult to share once obtained. This was due to licensing restrictions and accessibility

limitations placed on data by private satellite providers, which required individual licensing agreements to be signed.

Some Councils were unable to share privately sourced data. While LINZ can share restricted data via ArcGIS Online, this cannot be done via open data channels, which meant that at the time of the event much of the privately provided, restricted data could not be widely shared. These issues are like those experienced during the Covid response with the use of a NZ Police system for intelligence.

Extreme Events Data Catalogue: most interviewees felt that while the intent of the catalogue was good it was developed too late in the response to be useful, is not particularly user-friendly, and does not have database or geospatial capabilities. Interviewees were less than optimistic about its future usefulness during the next major event.

Funding arrangements

What worked well/didn't work so well with NISWE response funding[26]

What worked well:

- MBIE 'stepping up' and securing funding from the SSIF.
- Fast mobilisation of funding for Stage 0 and relatively quick turnaround of project funding for Stage 1.
- CRI willingness to pivot work programmes and inherent flexibility in the SSIF.
- The targeted funding flexibility of the recovery advice fund towards local initiatives.
- A few interviewees felt the funding process worked well given the funding model constraints and event pressures, including use of the CSAs to help inform funding decision-making.

What didn't work so well:

The primary feedback relates to the impacts of a perceived lack of fit-for-purpose funding processes, including:

- Short proposal timeframes for both funding stages.
- The overall experience of developing and submitting proposals in the first 4-6 weeks was described by some interviewees as 'ad-hoc', 'clumsy', and/or 'unnecessarily time-consuming.'
- The SSIF funding process through CRIs was viewed by some as exclusionary of some agencies, despite efforts to address this via CSAs and the extreme weather science response expert advisory panel.
- There were no pre-established arrangements to guide science advice product priorities, and this impacted funding decisions.
- As a foundational requirement for science, imagery may be better served by separate, specific funding arrangements to avoid delays.

How future science response funding arrangements could be improved

The primary feedback was:

- Create a dedicated contingency fund for rapid science response during emergencies that is consistently available, particularly for perishable data.
- Allow for greater flexibility and adaptability in funding arrangements.

[26] All feedback for this question relates to the MBIE $9.1 million extreme weather science response funded urgent scientific research and data collection (Stage 0 and Stage 1) and recovery advice fund provided by the SSIF by 30 June 2023.

- Plan pre-event for the types of data needed (specifications, protocols).
- Clearly define roles and responsibilities for the funding process, including which agency holds the funding, triggers the funding process, and coordinates the application, decision-making, and management processes.
- There are doubts that the SSIF is a sustainable funding solution and a broad view that 'we were lucky' to secure funding during the NISWE. Feedback from some interviewees also suggests that the SSIF may not be well suited to short-term science services for emergencies, needs agreement from research organisations via variations, and may impact other long-term research outcomes.

Review of relevant guidance and reports

Overview

Dozens of guidance documents and reports were assessed in support of this review. These guidance documents and reports comprised everything from legislation, formal terms of reference, and publicly released post-event reviews to draft, in-confidence working papers.

Many documents were provided from individuals within participating organisations, and all helped in gaining a greater understanding of the review themes. The following section provides a brief description of the most relevant guidance and reports *that can be cited within this report*.

Guidance and reports of most relevance to this review

A brief description of the following guidance and reports is provided below.

National CDEM Plan Order (2015)

Section 81 of the schedule introduces science and research organisations, while section 85 of the schedule provides roles and responsibilities of science and research organisations.

Section 85 of the schedule defines the roles of the following agencies:

- MBIE: coordinates Crown funded research in support of CDEM and assists with science advice integration and funding during readiness and response.
- GNS: manages GeoNet to detect land movement[27] (landslides); advises on issuing of warnings/advisories for geological hazards; provides advice to NCMC, agencies and CDEM Groups; contributes to public information management on geological hazards.
- MetService: maintains forecasting service and issues warnings to the public; provides advice to NCMC, agencies and CDEM Groups; contributes to public information management on weather hazards.
- Regional councils and some territorial authorities: monitor rainfall, lake and river levels, and volumetric flows for flood prediction and management.
- NIWA: provides public information on climatic and seasonal risks (including drought), and marine geological, seafloor, and coastal hazards and processes; provides advice to NCMC, agencies and CDEM Groups.

Full text of the schedule sections 81 and 85 is provided in **Appendix 5**.

[27] In addition to tsunami, seismic, and volcanic hazards.

Science and Research after emergencies and other major incidents: MBIE (2019, in draft)

This document outlines the roles of science and research after incidents, identifies the types of incidents that may require a rapid response and principles to guide response, and where roles of science and research agencies/providers intersect with science provision in the aftermath of incidents, including emergencies. The guidance encourages agencies to be highly responsive, mobilise quickly, and work together collaboratively in response.

The following roles of science and research are defined in the aftermath of an incident:

- Science services: immediate technical or operational mitigation of further hazards to ensure community safety
- Scientific research and development: initiation of research in unique conditions or research into the incident over a longer timeframe aimed at creating new findings and/or advancements in knowledge
- Collection of perishable data: collection of data during windows of opportunity following events – either for science services or for scientific research and development
- Informing advice to Government: this may be necessary to inform policy and decision-making such as evacuations or inform regulations and may be based on science services or scientific research and development.

Guidance is provided on reprioritisation of funding when an incident requires a rapid response from the science system. The primary factor for consideration is public safety. Additional factors include environmental, cultural, and economic preservation, scientific importance, urgency, public interest, and Te Tiriti o Waitangi.

The document also suggests roles relating to science and research for Government departments, CRIs, Advisory Groups, Regional Councils and Territorial Authorities, the CSA Forum, National Science Challenges, Universities, Independent Research Organisations, and private science providers, and other public sector agencies.

The document proposes post-event agency actions, although it is noted in the draft that these were intended for further development.

NEMA Internal Operational Lessons Report (2024)

Following any significant emergency NEMA reflects on its role in the response. The NEMA internal operational lessons report was commissioned to ensure NEMA identifies and shares its lessons from these events and identifies areas for improvement. The findings from the report will be reflected in leadership and operational improvements.[28]

The following lessons excerpts are of most relevance to this review:

Lesson 3. Development of the Intelligence function

NCC/NCMC processes and procedures: Science, intelligence and geospatial capability and capacity need to be enhanced to build situational awareness and support decision making during emergencies.

Science input:

- The capability and capacities of the science system by the NCC/NCMC was ad-hoc and uncoordinated across functions.

[28] National Emergency Management Agency (May 2024) 2023 North Island Severe Weather Events: NEMA's Internal Operational Lessons Report, p. 1.

- There was opportunity for science agencies to surge in, providing more timely advice and products, support and enhance analytical capabilities across a range of functions, and better direct requirements of science agencies.
- One of the two main insights was: the lack of pre-established processes and protocols for science input in extreme weather events (as compared with geophysical events e.g., earthquake and volcano) hindered this response.

Intelligence capability:

- There was an absence of pre-established inter-agency information sharing protocols.
- Information came in via multiple channels and had to be manually collated, assessed, and managed. In the absence of Common Operating Picture (COP) tools, Intelligence staff were performing as a data collection and collation function. This meant repeating information that already existed elsewhere rather than focussing on producing value-add intelligence outputs about impacts and the 'so what'. They were unable to produce, in a timely manner, maps or interact with data for analysis.

Geospatial imagery and Light Detection and Ranging (LiDAR) data:

- Geospatial imagery and LiDAR data was essential for supporting the response and recovery – particularly given the scale of the event across multiple regions. This was, however, hindered by challenges with regards to timely access to appropriate geospatial imagery and data, resulting in duplication of effort and purchasing.
- The two critical issues were the lack of a clear central government funding mechanism for purchasing imagery collection, and (at least initially) coordination of this effort which consumed considerable time across agencies and CDEM Groups.
- There is a need for clear pre-event identification of requirements and determining agency or function responsibility for the coordination and commissioning of geospatial imagery collection and analysis.
- The Standard Operating Procedure (SOP) for the sub-function was under-developed.

Lesson 3 recommendations:

- 3.1 NEMA should develop science sub-function processes, protocols, and resourcing.
- 3.2 NEMA should develop common GIS protocols and standards to ensure consistent and timely situational awareness products across all agencies and levels of response.
- 3.4 NEMA should clarify central government funding mechanisms for imagery collection before events.
- 3.6 NEMA should invest in further intelligence and GIS capacity and capability (both inhouse and via surge support).

Lesson 6. Working with known gaps

Technology, equipment and facilities

There continues to be a need for a shared, system-wide "single source of the truth".

- The National Controller observed that the absence of an integrated COP meant that changes to the situation that could affect decisions were not readily and continuously visible. The lack of a shared, system-wide "single source of the truth" COP impacted decision making, resource utilisation, and workflows at a national, regional, and local level.
- The Intelligence function found that the inability of stakeholders to directly access information from a central repository led to a high demand on them to respond to individual information needs from various stakeholders.

- The absence of data sharing protocols between NEMA and other agencies also led to an inability and sometimes unwillingness among agencies to share information with the NCC/NCMC.

Lesson 6 recommendations:

- 6.1 NEMA must define what a Common Operating Picture for NEMA and the NCC/NCMC looks like, and how it will be utilised, with an eye towards scalability and future integration into broader system-wide solutions.

Government Inquiry (2024)

The purpose of the Government Inquiry is to ensure that the design of New Zealand's emergency management system is appropriate to support readiness for, and responses to, future emergency events (such as landslides, tsunami, earthquake, volcanic activity, floods and storms) by identifying lessons from the 2023 North Island severe weather events.[29]

The following recommendations are noted in relation to this review:

- Recommendation 4A: Legislate for and invest in NEMAs primary function and purpose to hold system leadership for emergency readiness and response. In making these changes:…. …. IV leadership for natural hazards and support for other emergencies remains with NEMA (p. 23).
- Recommendation 5A: Explicitly clarify the roles of central, regional, and local levels of government in a national state of emergency (p. 23).
- Recommendation 6C: Build a larger pool of skilled and experienced controllers, hydrologists, and other specialists, who provide expert information and can be seconded across New Zealand (p. 24).
- Recommendation 8A: Legislate for and invest in a single common operating platform and picture for emergency management to be adopted by every council and NEMA (p. 24).
- Recommendation 12A: Formally recognise the following as necessary critical infrastructure sectors (in addition to current lifeline utilities):….
  II. waste management
  III. stopbank and flood protection systems….
  V. river management systems.

Auckland flood response review (2023)

The purpose of the review is to report on the performance of the immediate official emergency response to the Auckland weather event of 27 – 28 January 2023 and identify any actions that need to be implemented immediately to ensure better preparation for the next event.[30]

The following points are of some relevance to this review:

- Improving core systems, tools and technologies: the following opportunities were noted:
  - Opportunities to rationalise and combine multiple databases, files and spreadsheets. The highly distributed nature of the source material made it difficult, at least in the early stages of this response, to produce timely intelligence products from centralised data (p. 71).

[29] Report of the Government Inquiry into the Response to the North Island Severe Weather Events, March 2024, pp. 118-119.
[30] Bush International Consulting (2023) Auckland flood response review: Independent, external review of events, January 27-29, 2023, p. 74.

    - Developing data sharing protocols and systems with partner agencies, including pre-established information sharing protocols with lifeline utilities and other key CDEM partners that balance privacy and public information imperatives (p. 71).
- Recommendation 12: Develop a centralised approach to and system for intelligence capture and analysis, reflecting CIMS protocols, to ensure improved situational awareness in emergency response events (p. 17).

NEMA CSA observations on Cyclone Gabrielle (2023)[31]

The NEMA CSA has provided the following written response coordination observations on the NISWE throughout the period February – July 2023:

- Science coordination was recognised early as a major challenge, along with ongoing challenges in resourcing coordination, and importance of the CSA Forum for sharing science needs and priorities, capabilities and problem-solving – especially on complex issues.
- There were immediate challenges in understanding research being undertaken, capacity for research, funding sources/programmes, roadblocks and possible options (such as LiDAR processing, host agency for disaster loss data).
- There was a need for research and data coordination, especially requirements for open access meta database of all current/future research, and a data clearinghouse for raw data being gathered as part of response assessment data.
- Geospatial data and associated analysis were challenging to coordinate, fund, and service within the current system - perhaps exacerbated by the multi-hazard impacts across such a large area of the country. This must be a priority to address.[32]
- The use of the MBIE SSIF Extreme Weather Science Response fund was very useful in primary data collection (imagery) but stretched the mandate of the fund, and demand requirements exceeded available funding.
- Response coordination could have been improved by establishing a science function within the Intelligence function or a separate 'Science Desk' along with appropriate resourcing from the NEMA Hazard Risk Management Team.
- The scale of the NISWE and the number of regions affected meant that the event was very challenging, and this was compounded by previous storm events and the Covid recovery.
- The science advice and associated support was incredibly diverse, ranging from weather and flood-warnings to landslide life-safety assessment, flood sediment clean up advice to psychosocial health advice, satellite imagery analysis to assessing social and economic impacts.[33]

Beaven, S. et al. (2016) Research Engagement after Disasters: Research Coordination Before, During, and after the 2010-2011 Canterbury Earthquake Sequence, New Zealand[34]

This article argues that active coordination of research engagement after disasters has the potential to maximize research opportunities, improve research quality, increase end-user engagement, and manage escalating research activity to mitigate ethical risks posed to impacted populations.

[31] Observations drawn from a range of unpublished presentations, draft thought papers, and a published article.
[32] Office of the Prime Minister's Chief Science Advisor (2023) Annual Report, p. 15.
[33] p. 13.
[34] Beaven, S., Wilson, T.M., Johnston, L.C., Johnston, D.M., Smith, R.T. (2016) Research Engagement after Disasters: Research Coordination Before, During, and after the 2010-2011 Canterbury Earthquake Sequence, New Zealand. Earthquake Spectra 32 (2): 713–735.

The findings on research coordination align with Sendai Framework calls to improve support for policy/science interface for decision-making following disasters:

- Risks and opportunities with post-disaster research can only be managed effectively when jointly and equally managed between response operations and research communities.
- The Natural Hazards Research Platform made linking, coordination, and collective decision-making possible in the Canterbury Earthquake Sequence by establishing wide research connections.
- The wider the research connections, the less likely the perceptions of research exclusion, and the more likely the amount and nature of research undertaken during the event – and hence of managing the response and recovery effectively.
- Research coordination arrangements should be widely disseminated, transparent, and at least to a degree, understood by all involved in response.
- The advantages of using a consortium or platform structure to coordinate research activity will be significantly increased if this is an existing, well-established structure, with a relevant permanent research coordination function.

Discussion and conclusions

Perspective on the NISWE science response

The Government Inquiry[35] described the NISWE and their impacts as 'the most serious in recent history'. The size and scale of Cyclone Gabrielle as an inter-regional, multi-hazard event that ultimately resulted in the declaration of a state of national emergency was always going to lead to significant management challenges for the emergency management system, including science response.

The role of post-event reviews is by necessity to focus primarily on issues, challenges, opportunities for improvement and corrective actions. It is important to highlight the positive aspects of the NISWE science response alongside these elements – despite the pressures faced during the events.

The NISWE were notable for the effective use of informal personal relationships and networks, especially during the initial response. The CSA forum was widely used and considered to be an effective forum, and the NEMA and Te Uru Kahika CSA roles were critical to effective response coordination. MBIE secured funding rapidly to support science advice and positive feedback was received for much of the delivery of science advice products in Stage 0.

An enduring feeling from interview participants was one of 'good intent' from individuals and agencies participating in response. Whether knowingly or otherwise, agencies engaged in the NISWE response appear to have largely responded along the lines of the 'rules of engagement' proposed by MBIE in the Draft 2019 Guidelines.[36] These rules of engagement state that actions and engagement after a major incident should be guided by the following principles: responsiveness, goodwill, due care, caution, flexibility, collaboration, and reciprocity.

The RNC programme was widely credited with creating long-term relationships that helped underpin response. The findings of Beaven et al. with respect to the advantages of a research consortium supports this feedback.

[35] Report of the Government Inquiry into the Response to the North Island Severe Weather Events, March 2024, p. 29.
[36] Science and Research after emergencies and other major incidents: MBIE (2019, in draft), pp. 21-22.

Conclusion: Perspective on the NISWE science response

There are numerous positive aspects to the NISWE response that can be built upon in the future, and these should be acknowledged, especially considering the severity and unprecedented nature of the Cyclone Gabrielle response.

There are significant advantages to retaining a collective approach to research coordination both pre- and post-event.

Science response and coordination arrangements

Interview feedback suggests that while mobilisation of most agencies occurred quickly, initial response was disjointed with no apparent process for initial response actions and a lack of clarity of roles and responsibilities. Existing personal, often informal relationships were important in managing response, and the role of RNC in encouraging relationship development is acknowledged. The CSA Forum is widely considered to be an effective coordination mechanism for the wider response, with the NEMA and Te Uru Kahika CSAs both individually and jointly critical to response coordination.

Response coordination between agencies engaged in science was reported as more effective where personal relationships existed. There is some evidence of initial tensions between CRIs during project development with respect to pitching of individual projects, and coordination of the collection of perishable data and some cross-over of responsibilities was reported as challenging.

While coordination within projects was generally satisfactory, there was a perception of less coordination between agencies engaged in science response and national agencies, with little flow of usable intelligence to the NCMC. Some feedback also indicated less satisfaction around coordination with Iwi/Māori, links to local communities, the health sector, and regional council operations – particularly in those regions that were less affected (Northland, Waikato). Feedback from Northland Regional Council highlighted issues with national recovery structures, planning, and delivery.

Interview feedback suggested there is less maturity in coordination of arrangements for severe weather response than for other hazards such as volcanic and seismic. Feedback indicated that relationships were more mature pre-event in response to the Canterbury Earthquake Sequence and that the science response leadership and coordination role was clearer and more visible given mandate of the Natural Hazards Research Platform. Feedback also indicated better coordination of research and use of a multi-sector data clearinghouse. The multi-hazard, multi-dimensional, complex and widespread nature of the NISWE must be acknowledged alongside these observations. The NEMA Internal Operational Lessons Report, NEMA CSA observations, and findings of Beaven et al. with respect to the advantages of a research consortium supports this feedback.

There was strong interview feedback on the three most important elements for improving response coordination:

1. Pre-event planning, including scenario development, playbook response options and response arrangements including funding and science needs
2. Explicit recognition of coordination as a function, the role of NEMA in coordination and leadership, and improving connections to communities including Iwi/Māori
3. Clarity on roles and responsibilities for leadership and coordination, especially for initial activation and for data/information requirements.

Clarity on post-event funding, improving remote sensing data sharing, and creation of a Severe Weather Science Advisory Panel and NCMC 'Science Desk' are also considered to be important for improving response coordination.

Conclusion: Science response and coordination arrangements

Response coordination was disjointed initially due to the lack of pre-existing roles and processes. The use of personal relationships and the CSA Forum helped to overcome some of the response coordination challenges.

Timely collection of perishable data and cross-over of responsibilities was challenging to response coordination. There was a perception of less coordination between agencies engaged in science and national agencies, with little flow of usable intelligence to the NCMC, and a similar perception with Iwi/Māori, links to local communities, the health sector, and regional council operations.

There is likely less maturity in coordination of arrangements for severe weather response than for other hazards such as volcanic and seismic, and that leadership and coordination was clearer and more visible in the Canterbury Earthquake Sequence with the mandate of the Natural Hazards Research Programme. The complexity of the NISWE must be taken into account, however.

Pre-event planning, explicit recognition of coordination as a function, and clarity on leadership and coordination roles are most important for improving response coordination. Post-event funding clarity, remote sensing data sharing, and creation of a 'Severe Weather Science Advisory Panel' and NCMC 'Science Desk' are also important.

Science response roles

Interview feedback strongly indicated a lack of awareness of science roles across the wider science and emergency management sectors, and a lack of familiarity with 'where science sits' within the CIMS framework. This is perhaps unsurprising as there has been relatively little development of science as a distinct function within the emergency management sector.

Interview feedback suggests that current science response roles do not effectively enable response. Most interview participants interpret this to mean that role definitions require improvement, while some argue that agencies need to 'get on and respond with good intent regardless of what the National CDEM Plan says.' There is little evidence to suggest that good intent alone will ensure effective response outcomes, but almost all interviewees believe that good intent helped improve response coordination in the NISWE science response.

Some interview participants noted that better definition of roles is particularly important in severe weather-related hazards – particularly flooding. This is due to multiple-agency roles and involvement at various levels (Government agencies, CRIs, local government, universities, and private consultancies) combined with overlapping responsibilities.

There is strong support among interview participants for better defining science response roles as one of the key changes required to improve response coordination. This is supported at a high level by recommendation 5 of the Government Inquiry and an insufficient level of clarification within the current National CDEM Plan. Part of the purpose statement of the MBIE Draft 2019 Guidance is insightful in this regard:

> *'This guidance is intended for Government agencies, science providers and other organisations or groups who may have a role in relation to science and research after an incident. Currently, the way these roles intersect with existing responsibilities is not well-*

defined or widely- known, and there are limited imperatives on science providers to carry out science and research following major incidents.'[37]

There is also strong support for enhancing science response coordination via creation of a science advisory panel like those for seismic, tsunami, and volcanic hazards.

Conclusion: Science response roles

There is a need to improve the definition of science response roles within the National CDEM Plan.

The current National CDEM Plan roles require re-evaluation and enhancement, and consideration should be given to defining additional agency roles within the Plan.

Non-agency specific roles that proved effective in the NISWE should be formalised.

Science response would likely benefit from creation of a 'Severe Weather Science Advisory Panel.'

Science advice products from the Extreme Weather Science Response Platform

Interview feedback is notable for the wide divergence of viewpoints on the process used and effectiveness of the science advice products developed from projects funded by the MBIE Extreme Weather Science Response Platform. While noting the constraints of time and the SSIF funding process, feedback was largely positive on the process for determining immediate needs for Stage 0.

Some interview participants felt there was too much emphasis on short-term science services and too little on long-term, catchment-wide products. Others felt the exact opposite. While more interview participants preferred a greater emphasis on short-term science services, the need for greater transparency around the suite of decisions made and clearer links to community needs was emphasised.

While the extreme weather science response expert advisory panel members reported an awareness of the need to achieve a balance in science advice products between science services and research and a balance across disciplines, this was less apparent to stakeholders in the wider response.

The evaluation of individual products is problematic as this often comes down to differences in individual opinions on outcomes. The outcomes for geospatial imagery are clearer however, with widespread dissatisfaction on the process (including identification of resolution and coverage areas) for gaining timely and fit-for-purpose geospatial imagery needed to underpin science advice activities. There is also agreement on positive science advice product outcomes from several projects, particularly those delivered in Stage 0.

While funded via the SSIF during Cyclone Gabrielle, some feedback indicated that separate funding arrangements for imagery as foundational data is preferable to the current 'bundling' arrangements alongside other science advice products, but clarification of arrangements is critical. The NEMA Internal Operational Lessons Report and NEMA CSA observations support this feedback.

Development of pre-event processes for science products, including imagery gathering and prioritisation and clarification of roles are also required. The MBIE Draft 2019 Guidance makes a start on process development and the need for pre-event development is supported by the NEMA Internal Operational Lessons Report.

[37] p. 3.

Conclusion: Science advice products

There were positive outcomes in product delivery, especially during initial response.

Further clarity and transparency on the balance between science services and research and improved links to community outcomes is required.

Significant improvement on pre-event processes for science products, especially geospatial imagery collection is required, and further clarity on roles and funding arrangements is also required alongside this.

Data and information sharing arrangements

Interview feedback indicated that there has been little improvement over time with data and information sharing arrangements during response and a tendency to 'start from scratch' with each new event. While critical response information was delivered by any available means, arrangements were described by many interview participants as informal and ad-hoc during response.

The need for a centralised data management system was broadly supported as key to improving response outcomes with real-time accessibility, being centrally discoverable, and having geospatial capabilities being among the most important response requirements. Similar themes can be found within the Government Inquiry, Auckland flood response review, and the NEMA Internal Operational Lessons Report.

Several post-event reviews discuss NISWE issues around management of geospatial information, data sharing, intelligence capture and analysis, and the lack of ability to develop a Common Operating Picture. The importance of effective data sharing arrangements and a centralised data management platform to support the intelligence function and building of a COP were common themes discussed by interview participants who were familiar with data and information management. Similar themes can not only be found in the reviews mentioned above but in previous reviews including the Covid-19, the Port Hills Fire, the Whakaari eruption, and the 2017 Ministerial (TAG) reviews.

The difficulties in sharing remote sensing imagery due to licensing restrictions were of particular concern due to the high demand for and reliance on this data in applications such as mapping of post-event impacts such as landslides, flood extents, sediment deposition and land/infrastructure damage.

Conclusion: Data and information sharing arrangements

An apparent long-term trend of reinventing data and information sharing protocols at the time of large events has continued during the NISWE leading to the initial prevalence of ad-hoc, informal sharing arrangements.

Interview feedback and review outcomes support development of a centralised approach to data and information management in helping to underpin intelligence and the building of a Common Operating Picture.

There is a strong need for confirmation of pre-event data and information sharing arrangements and further work to improve data sharing protocols, especially for remote sensing data/imagery.

Funding arrangements

The fast mobilisation of funding and inherent flexibility of the SSIF worked well during the Cyclone Gabrielle response despite the funding model constraints and event pressures. The lack of perceived fit-for-purpose funding processes led to reported short proposal timeframes and ad-hoc, time-consuming proposal processes. Some interview participants felt that the SSIF funding process through CRIs was exclusionary of other agencies and that imagery requirements may be better served by separate, specific funding arrangements.

During the interviews, doubts were expressed about the sustainability of the SSIF as a funding solution and around its suitability for funding short-term science services during response. It is also unclear whether any separate stand-alone response funding arrangement such as a contingency fund would be viable in the current political climate.

Conclusion: Funding arrangements

There is benefit in retaining the speed of funding arrangements seen in the Cyclone Gabrielle response, and in increasing the flexibility of funding arrangements in the future.

Clear pre-event funding roles and processes including clearer definition of science advice priorities and data specifications will almost certainly help improve response effectiveness.

A dedicated, flexible contingency fund is a preferred option among interview participants for sustainable science response funding.

Recommendations

Recommendation 1: Science response and coordination arrangements

It is recommended that:

A. Pre-event planning for science response to the range of hazards expected during and immediately following severe weather events be developed to guide post-event science response. Planning should include at a minimum:

- Definition of the hazards to be covered, including at least river flood hazards (flood extents, channel assessment, sedimentation, river scheme asset impacts, etc.), landslides/land impact assessment, infrastructure, ecology/biodiversity, risk assessment, and catchment-wide initiatives.
- Development of science needs for different response scenarios and 'playbook' response options for addressing science needs. This would help to address one of the concerns of science providers expressed during the initial response to the NISWE: 'tell us what you need and how we can help with that rather than asking what we are doing or planning to do.'
- Develop agreed data collection specifications and protocols as required.

It is further recommended that NEMA lead development of pre-event planning for science response, likely as part of the establishment of a Severe Weather Science Advisory Panel.

B. Support for NEMA leadership and coordination of science response be enhanced via creation of a science sub-function and 'Science Desk' or a separate unit within the Intelligence function within the NCMC, and that sufficient resourcing be available to support this sub-function in response. While the capability to support this sub-function existed in the NISWE, the capacity did not, and this negatively impacted response coordination. It is further recommended that surge capacity for the sub-function be provided as a priority by NEMA in the first instance, but also by qualified staff from partner agencies as required.

C. Consideration be given to creation of a 'Severe Weather Science Advisory Panel' to encourage pre-event relationship building and preparedness and post-event response coordination. The panel would provide advice across the 4R's for the range of hazards associated with severe weather through trans-disciplinary and multi-institution collaboration – like the earthquake, tsunami[38] and volcanic advisory panels.

D. It is recommended that emphasis be given to the assessment of long-term, catchment wide hazards and risks and options for recovery and adaptation following the immediate response to severe weather events. This would enable the development of strategic opportunities for at least a better understanding of cumulative impacts and multi-hazard assessments, build back better options, and all aspects[39] of recovery.

[38] Noting that the Tsunami Experts Panel has a primarily response-focussed role with a smaller readiness role.
[39] Governance, social, cultural, economic, built environment, and natural environment.

E. With the conclusion of RNC, consideration be given to supporting an ongoing forum to support science research and the professional relationship building and networking benefits that go with this. There is clear evidence that the RNC programme contributed to relationships that underpinned response coordination and contributed directly to response and recovery coordination during the NISWE. It is further recommended that NEMA, MBIE and the RNC partner organisations consider this alongside broader science and research conversations.

Recommendation 2: Science response roles

It is recommended that:

A. Updated and improved definitions, greater clarity and expansion of all science response roles is undertaken as a part of the review of the National CDEM Plan ('the Plan') and the Guide to the National CDEM Plan ('the Guide'). The following sub-recommendations are noted:

- Development of formal science response leadership and coordination roles and recognition of roles and responsibilities for these within the Guide as follows:
    - NEMA at the national level via the NEMA CSA.
    - The Te Uru Kahika CSA at the regional/CDEM Group level.
    - MBIE via clarification of direction for public-good science system roles for science response coordination.
    - A potential future collaborative, multi-institutional science entity roles in coordination of scientific research and development (versus science services).

- Recognition and addition of the following peril-based activities to the Plan:
    - Flood hazard assessment, modelling, and mapping; and
    - Flood forecasting (note dependency upon the outcomes of the Weather Forecasting System Review and potential policy and funding changes required to support this).

- Development of science response roles for NIWA[40], Manaaki Whenua Landcare Research, Ministry for the Environment, Ministry for Primary Industries, and Office of the Prime Minister's Chief Science Advisor within the Plan as organisations fundamental to response coordination.

- Development of supporting roles for other agencies/organisations involved in science response within the Guide, including[41]:
    - Government departments
    - Chief Science Advisor Forum

[40] Flood hazard-related roles only, noting that NIWA already has existing roles defined within the National CDEM Plan.
[41] Based on existing MBIE Draft (2019) Guidance document, pp. 6-11.

- Regional Councils and Territorial/Unitary Authorities
- Universities, independent research organisations, and private science providers
- Other public sector agencies.

Recommendation 3: Science advice products

It is recommended that:

A. The process for developing science advice product proposals is improved to provide greater transparency on the balance required between science services and research and the type of science[42] or engineering required. The process for selecting priority areas should also be transparent.

It is also recommended that a methodology for project evaluation be developed, including consideration of the links to and/or impacts on community response and recovery outcomes.

B. A separate collection process be developed for remote sensing imagery and data as a foundational requirement for post-event development of science advice products. The process should be led by MBIE initially with support from NEMA and LINZ, align with other Government initiatives, and cover at least:

- Assessment and collation of end-user needs and priorities (including resolution and coverage areas)
- Procurement of remote sensing imagery and data
- Development and distribution of products to end-users.

Recommendation 4: Data and information sharing arrangements

It is recommended that:

A. A pre-event process is developed for creating, managing, and hosting a meta research database and data clearinghouse. This centralised system should be capable of:

- Receiving, storing, and having accessible event data and information in real time.
- Having data and information in accessible formats.
- Being centrally discoverable at the time of the event.
- Having geospatial/GIS mapping capabilities.
- Being able to be archived for future needs with appropriate categorisation and accessibility.

[42] Such as human health and safety, economic, cultural, social, or environmental focussed.

B. The data clearinghouse be modelled along the lines of those used by the Earthquake Engineering Research Institute.[43]

It is further recommended that development of the data clearinghouse is aligned with All-of-Government Common Operating Picture initiatives.

C. Consideration be given to setting up a 'permanent home' for the oversight, governance and management of a centralised system.

D. Work is undertaken to improve pre-event data sharing protocols/arrangements among agencies participating in science response. This should include work to address licensing issues associated with remote sensing data/imagery and align with any Government initiatives to improve remote sensing imagery procurement coordination for response or recovery.

Recommendation 5: Funding arrangements

It is recommended that in relation to collective response funding:

A. Options for establishing a dedicated contingency fund be investigated for rapid science response, led by MBIE. It is anticipated that if feasible, this arrangement may provide for greater sustainability and flexibility than the arrangements used in the NISWE.

B. If similar funding arrangements to those utilised in the NISWE are used in the future, that greater flexibility for inclusion of science providers is built into the funding model, and that greater emphasis is placed on regional-level science provision.

C. It is noted that regardless of the future funding option chosen, funding to support pre-event planning and post-event response coordination is required in addition to post-event science services, research and advice.

D. A separate funding mechanism be developed for remote sensing imagery and data collection as a foundational input into the development of science advice. It is further recommended that NEMA, LINZ and MBIE lead the initial development of this funding mechanism.

[43] https://eeri.org/ For an example of a data catalogue refer to: https://learningfromearthquakes.org/2023-02-06-nurdagi-turkey/

Appendix 1: Glossary

CDEM	Civil Defence Emergency Management
CIMS	Coordinated Incident Management System
COP	Common Operating Picture
CRI	Crown Research Institute
CSA	Chief Science Advisor
EWRP	Extreme Weather Research Platform
FENZ	Fire and Emergency New Zealand
GNS	GNS Science, Te Pū Ao / Institute of Geological and Nuclear Sciences
LINZ	Land Information New Zealand
MBIE	Ministry of Business, Innovation & Employment
NHC	Natural Hazards Commission Toka Tū Ake
NEMA	National Emergency Management Agency
NCC	National Coordination Centre
NCMC	National Crisis Management Centre
NISWE	North Island Severe Weather Events
NIWA	Taihoro Hukurangi / National Institute of Water and Atmospheric Research
RNC	Resilience to Nature's Challenges
SME	Subject Matter Expert
SSIF	Strategic Science Investment Fund
SOP	Standard Operating Procedure

Appendix 2: Timeline of key science response events during NISWE

Date ('23)	Event/Activity and Comments
27 Jan →	**Auckland Anniversary Weekend floods**
26 Jan	*Metservice issues heavy rain warning for Auckland 6am to 10pm Friday 27.*
26 Jan	Auckland Council Hydrology team providing intel on interpretation for flood risks.
27 Jan	*Virtual Auckland Emergency Management (AEM) IMT stood up and meeting at 1650 called due to severe flooding in West Auckland.*
	Mass evacuations reported by FENZ in Henderson at 1758.
	Declaration of emergency for Auckland City at 2127.
28 Jan →	Science response: hydrology team data collection, ongoing weather warning and rainfall gauge advice to Auckland Emergency Management. Property stability and landslide assessments begin.
9 Feb	NEMA coordination meeting - role of science in Auckland led flood recovery.
9 Feb →	**Cyclone Gabrielle**
	MetService issues heavy rain forecast for 12-14 February with high confidence.
	States of emergency extended in Auckland and Coromandel.
12 Feb	*Areas of the upper North Island began experiencing widespread power outages and property damage from flooding and landslides as edges of cyclone sweep the country.*
12 Feb →	*Regional science response deployment (Intel, hydrology – warnings, assessment, etc.)*
13 Feb	*Rapid escalation in severity with multiple emergency declarations and widespread regional impacts.*
14 Feb	***National declaration at 0843 over the Northland, Auckland, Waikato, Bay of Plenty, Tairawhiti and Hawke's Bay areas. Extended at 1317 to include the Tararua District.***
14 Feb	Upper North Island Severe Weather Event January 2023 - National Recovery Coordination Group meeting.
	Agencies mobilise and initiate contact within networks (primarily personal contacts).
16 Feb	NEMA CSA discussion with NIWA regarding funding for NISWE response.
17 Feb	Upper North Island Severe Weather Event January 2023 - National Recovery coordination communication from NEMA Chief Science Advisor to CSAs.
	Informal discussion between NEMA CSA and MBIE regarding funding support for science.
17 Feb ?	Initial development of Google spreadsheet to track data collection activities
20 Feb	**CSA meeting on science coordination meeting called by NEMA CSA.**
	Various follow-up science coordination meetings.
22 Feb	**Formal planning meeting between NEMA CSA and Ian Cossar MBIE re science response funding.**
	NEMA CSA discussion with Ruth Fairhall, Policy Advisory Group Department of the Prime Minister and Cabinet to open lines of communication.
	Regional Sector science and data needs after the North Island extreme weather events paper distributed. Paper developed by Te Uru Kahika on behalf of the regional sector for science system partner organisations.
24 Feb	Landslide life safety meetings - Tokomaru Bay.

26 Feb	**Minister of Research, Science and Innovation** reprioritises funding of $9.5 million within the SSIF appropriation 22/23 FY. Funding immediately made available for time-bound, evidence-based science services and perishable research and data collection to address immediate needs and inform response decisions.
27 Feb	NEMA CSA joins Scientific and Technical Advisory Committee meeting for first time.
	MBIE chairs data clearinghouse meeting.
28 Feb - 2 Mar	Flood silt cabinet paper preparation - major effort between NEMA, Ministry for the Environment, Ministry for Primary Industries, and the Department of Internal Affairs.
1 Mar	**First MBIE Stage 0 funding allocation of $2.15 million made** (Note: subsequent Stage O allocations made on 15 March, 24 March, and 6 April).
3 Mar	NEMA and Te Uru Kahika CSA meeting on science priorities and coordination leads to regional science managers network standing up.
	CSA science coordination meeting.
	Scientific and Technical Advisory Committee meeting.
6 Mar	**MBIE letter to SSIF contract holders and National Science Challenges** noting support for reallocation of existing funding towards the NISWE science response.
7 Mar	Meeting with National Controller about state of geospatial products.
8 Mar	**SSIF Stage 1 process developed and agreed** to with input from CSAs and the Extreme Weather Response Advisory Panel.
10 Mar	First meeting with Amber Bill (Executive Director of Recovery Task Force).
	NEMA CSA meets with NHC re land use.
13 Mar	**Meeting of MBIE extreme weather science response expert advisory panel.**
14 Mar	***National Transition Period begins***
15 Mar	**CSA Forum meeting - dominated by NISWE.**
20 Mar	**First Regional Science Managers hui.**
	Various "hot debrief" sessions held throughout this week.
21 Mar	**Reclassification of some Stage 1 SSIF requests as Stage 0 by extreme weather science response expert advisory panel;** confirmation of overall MBIE funding of $2.65 million for Stage 0 allocated to LIDAR, satellite imagery, air quality, and groundwater contamination.
Mar - May	Stage 1 SSIF allocation processes continued to fund time-bound evidence-based science services, and perishable research and data collection.
31 Mar	**First Stage 1 SSIF approvals made.**
	Multi agency Geospatial data meeting to address issues arising.
April	Various meetings getting MBIE funded projects up and configured.
11 May	**Hazard Risk Board meeting.**
16 May	NEMA After Action Review workshop.
18 May	National Landslides Working Group meeting.
31 May	Disaster waste conversations ongoing.
13 Jun	Strategic conversations between NEMA and Te Uru Kahika CSAs and NIWA.
June	Lot of meetings about forecasting and flood risk management.
29-30 June	RNC Symposium.
17 Jul	**RNC Extreme Weather Research Platform – intro. to funded programmes, webinar.**

Appendix 3: Standard NISWE review interview questions

Science response and coordination arrangements:

- How effectively was science response to the NISWE mobilised?
- What roles, connections, groups, and/or networks (formal and informal/ad-hoc) were most important to response coordination?
- How effective was the coordination:
    - Between CDEM and agencies engaged in science?
    - Among agencies engaged in science?
- How did coordination change throughout the response? Immediate (hours/days); Ongoing (weeks); Recovery (months)
- Thinking about other large science responses as far back as the Kaikoura earthquake, how did this science response compare with those for effectiveness and coordination?
- What will be most important for effective science response coordination in the future?

Science response roles:

- Are the current science response roles well understood across the science and emergency management sectors?
- Do the current roles for science response and coordination enable effective response?
- What changes in roles are required (if any) to enable improved response coordination outcomes?

Science advice products:

- How effectively were science advice needs identified, were there any gaps in identifying needs, and how might these have been filled?
- What were the main channels for science advice into the emergency management system at local and national levels?

Data and information sharing arrangements:

- What primary data and information sharing arrangements were used among scientists and emergency management agencies?
- How effective were data and information sharing arrangements (including use of the Extreme Event Data Catalogue)?

Funding arrangements:

- What worked well/did not work well with response funding for the NISWE? (e.g. MBIE Extreme Weather Science Response, CRI-SSIF, RNC, etc.)
- How could future funding arrangements for science response be improved?

Other comments, observations, or themes:

Appendix 4: Participating organisations and interviewees

Auckland Council

- Jonathan Benge, Head of Research, Evaluation and Monitoring
- Ross Roberts, Head of Engineering Resilience

Auckland University

- Liam Wotherspoon, Professor Civil and Environmental Engineering

BRANZ

- Chris Litten, General Manager - Research
- Anna de Raadt, Better Buildings Research Team Leader

Department of Conservation Te Papa Atawhai

- Mike Bunce, Chief Science Advisor
- Paul Jansen, Principal Advisor Terrestrial Biodiversity

Gisborne District Council

- Murry Cave, Principal Scientist

GNS Science

- Gill Jolly, Chief Science Advisor, MBIE / Formerly Natural Hazards and Risks Theme Leader, GNS (during NISWE)
- Sally Dellow, Earth Structure and Processes Manager
- Chris Massey, Engineering Geologist
- Kerry Leith, Engineering Geologist

Hawke's Bay Regional Council

- Anna Madarasz-Smith, Science Manager

Manaaki Whenua – Landcare Research

- Graham Sevicke-Jones, General Manager Science and Knowledge Transition
- James Shepherd, Senior Researcher - Remote Sensing

MBIE

- Linda Moore, Principal Policy Advisor, Science Policy Team | Future Research System Branch
- Vanessa Bennett, Principal Investment Manager, Strategic Investments, Science System Investment and Performance Branch, LSE
- Prue Williams, General Manager Future Research System
- David Hutchinson, Chief Science Advisor

MBIE/EQC; University of Auckland

- Ken Elwood, Chief Engineer MBIE/EQC / Professor Engineering, Civil and Environmental Engineering

Ministry for the Environment – Manatū Mō Te Taiao

- Alison Collins, Departmental Science Advisor
- Andy Hicks, Senior Analyst

- Anne-Gaelle Ausseil, Principal Science Lead
- Sophie Heighway, Manager, Climate Impacts

Ministry for Primary Industries

- Damian Diack, Director Extreme Weather Recovery
- Gerald Rys, Principal Science Advisor in the Office of the Chief Departmental Science Advisor
- Debbie Ward, Director Forestry Insights

Neo Leaf Global

- Roger Fairclough, Director

National Emergency Management Agency

- Tom Wilson, Chief Science Advisor
- Ashleigh Fromont, Team Leader Hazard Risk Management

NIWA

- Andrew Tait, Chief Scientist - Climate, Atmosphere and Hazards
- Emily Lane, Principal Scientist - Natural Hazards and Hydrodynamics

Northland Regional Council

- Mark Trüdinger, Emergency Management Recovery Specialist / Group Recovery Manager
- Graeme MacDonald, CDEM Manager
- Jason Donaghy, Natural Resources Monitoring Manager

Office of the Prime Minister's Chief Science Advisor

- George Slim, Consultant, Rhadegund Life Sciences Ltd

Resilience to Nature's Challenges

- Richard Smith, Director

Te Tira Whakamātaki

- Melanie Mark-Shadbolt, Tumu Whakarae / CEO

Te Uru Kahika - Regional and Unitary Councils Aotearoa

- Chris Daughney, Regional Councils Chief Science Advisor

Toitū Te Whenua – Land Information New Zealand

- Rob Deacon, Principal Geospatial Specialist - Customer Delivery
- Ben P. Jones, Kaiārahi / Leader – Capability & Practices

University of Canterbury

- James Brasington, Professor, School of Earth and Environment; Director Waterways Centre

Waikato Regional Council

- Rick Liefting, Team Leader Regional Resilience
- Derek Phyn, Senior Spatial Analyst
- Bryan Clements, Team Leader – Spatial Analysis and Modelling
- Mike Scarsbrook, Environmental Science Manager

Appendix 5: National CDEM Plan excerpts

The following text provides National CDEM Plan Order 2015 Schedule excerpts from Sections 81 and 85.

Science and research organisations

81 Introduction

(1) Knowledge, information, and advice services are provided to agencies and CDEM Groups by universities, Crown research institutes, private organisations, and international networks.
(2) Improving the co-ordination, promotion, and accessibility of science and research is fundamental to CDEM.
(3) The Ministry of Business, Innovation, and Employment co-ordinates Crown-funded research in support of the National CDEM Strategy's goals and objectives.
(4) Those arrangements aim to build research capacity that—
    (a) enables avoidance or mitigation of risks that have potential for significant consequences for New Zealand's economy, environment, or social well-being; and
    (b) develops community, organisational, and infrastructural resilience to those consequences; and
    (c) supports the dissemination of knowledge and advice, and their application by CDEM practitioners.
(5) The Earthquake Commission, under the Earthquake Commission Act 1993, may facilitate research and education regarding natural hazards, the means of reducing the impact of natural hazards, and improving emergency management practices.
(6) Science and research providers also undertake public and privately contracted research services involving other funding sources in support of CDEM.
(7) In readiness for, and response to, an emergency, the science and research organisations may assist with—
    (a) hazard monitoring; and
    (b) the provision of hazard and risk information; and
    (c) scientific advice to agencies managing an emergency; and
    (d) public information on hazards and risks and safety measures.

85 Role of science and research organisations during readiness and response

(1) Lead and support agencies may access a range of science and research organisations during an emergency to provide definitive scientific advice or to communicate risk (those organisations include universities, Crown research institutes, and private organisations).

(2) GNS Science—

- (a) manages the GeoNet system for the detection of earthquakes, land movement, volcanic activity, and the potential for local-source tsunamis; and
- (b) assesses the threat of tsunamis with the support of a multi-agency tsunami experts panel; and
- (c) provides advice to the NEMA on the issuing of national advisories and warnings about geological hazards; and
- (d) provides scientific advice to the NCMC, agencies, and CDEM Groups as needed; and
- (e) contributes to the management of public information on geological hazards and associated emergencies.

(3) The Meteorological Service of New Zealand Limited—

- (a) maintains a weather forecasting service and issues weather warnings to the public; and
- (b) contributes to the management of public information about weather hazards and associated emergencies; and
- (c) issues, as necessary, volcanic ash advisories for the civil aviation industry; and
- (d) provides scientific advice to the NCMC, agencies, and CDEM Groups as needed.

(4) Regional councils and some territorial authorities monitor rainfall, lake and river levels, and volumetric flows for flood prediction and management.

(5) National Institute of Water and Atmospheric Research Limited—

- (a) provides public information on—
  - (i) climatic and seasonal risks (including drought); and
  - (ii) marine geological, seafloor, and coastal hazards and processes; and
- (b) provides scientific advice to the NCMC, agencies, and CDEM Groups as needed; and
- (c) provides representatives on the tsunami experts panel.

(6) The Ministry of Business, Innovation, and Employment, during and after an emergency, may take additional steps to—

- (a) integrate consistent and coherent scientific advice to agencies and CDEM Groups; and
- (b) divert existing funding or allocate new funding to ensure that the appropriate technical resources in core physical and social science, engineering, and risk management are available nationally to support the needs of agencies and CDEM Groups.