Update of the Hawke's Bay 10 Year Hazards Research Plan

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EXECUTIVE SUMMARY

Hawke's Bay Regional Council, on behalf of the Hawke's Bay Civil Defence Emergency Management Group, undertakes research into hazards that could impact Hawke's Bay, and into what these impacts mean for the Hawke's Bay community, environment, economy and infrastructure. Such research contributes to the Group's and Council's goals and objectives relating to public safety, and risk reduction, to facilitating a prosperous, and sustainable Hawke's Bay. These goals and objectives are documented in a variety of plans including the Long Term Council Community Plan, Hawke's Bay Civil Defence Emergency Management Group Plan, Regional Resource Management Plan, and Regional Coastal Environmental Plan.

Hazard research directions are identified in a 10 Year Hawke's Bay Hazards Research Plan which seeks to mitigate regional risk by sponsoring ongoing science and research leading to a greater understanding of the natural and technological hazards that have the potential to affect the region. This plan is reviewed periodically to identify hazard research projects that have been undertaken both as part of the research plan or by other agencies, report on projects that are currently underway, and identify new projects for the future. A programme of research review work was started in 2004/05, with the last review completed November 2008 and a 10-year plan documented in GNS Science Report 2008/304.

The most recent hazards research review was undertaken in 2014. To undertake the latest hazards research plan review, a workshop was held with relevant scientists and staff (primarily from regional and district councils) from the Hawke's Bay Region. Presentations were made to update staff on hazard research that had taken place since 2008 and on opportunities for the future. Staff were then able to discuss what hazard research they thought was a priority for the future. The results of the 2014 hazards research plan review are outlined in this document, along with presentation of an updated 10-year Hazard Research Plan.

1.0 INTRODUCTION

Hawke's Bay is vulnerable to a variety of geophysical, meteorological, hydrological, and anthropogenic hazards. Investigation into the location, magnitude, frequency, and impacts from hazards has been conducted by Hawke's Bay Regional Council since the 1980s (Hawke's Bay Regional Council, 2008) (see Appendix 1 for a bibliography of research). An overview of these hazards, and a risk profile of the region, is documented in the Civil Defence Emergency Management (CDEM) Plan (Hawke's Bay Civil Defence Emergency Management Group, 2014). The CDEM plan also provides a ranking of the hazards deemed of most significance to the region and thus considered a priority (Appendix 2).

The Hawke's Bay CDEM Group and the Hawke's Bay Regional Council have responsibilities under the Resource Management Act (1991), the Civil Defence Emergency Management Act (2002) and the Local Government Act (2002) to manage the natural and non-natural hazards of the region in such a way as to ensure harm and loss from hazards is avoided or mitigated, and that communities are assisted in becoming more resilient to hazards. The Hawke's Bay CDEM Group and Hawke's Bay Regional Council have dedicated funding for a hazards research programme to inform the fulfilment of these duties. Dedicated funding may also be provided by the city and district councils of Hawke's Bay to research local hazards issues that are deemed important. Additionally, significant investment in natural hazard research applicable to the Hawke's Bay is funded by the Natural Hazard Research Platform (http://www.naturalhazards.org.nz), other national partners (e.g., Ministry of Civil Defence and Emergency Management, Earthquake Commission) and international collaborators, such as the US National Science Foundation and their GEOPRISMs programme (http://geoprisms.org/).

The 10-year Hazard Research Plan aims to identify and prioritise what hazards research needs to be undertaken for the region. The first Hazards Research Plan was written in 2003 (Dellow et al., 2003). A review of this plan was undertaken in 2008 and a new Research Plan developed to reflect priorities identified in the review (Wright et al., 2008). Since 2008 a variety of research projects have been completed as per the directive of the plan, with some still underway and some uncompleted. Appendix 3 is a summary of the 2008 10-year hazard research plan and outlines the hazards research projects that were included in the 2008 plan and the status of those projects.

Following the review of the Hawke's Bay CDEM Group Plan adopted in 2014, it was decided timely to undertake another review of hazards research requirements, and update the 10-year Hazards Research Plan. The following section outlines the methodology for the 2014 review and update.

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2.0 METHODOLOGY

A three-step process was undertaken to complete the 2014 Hawke's Bay research review and subsequent development of a new 10-year plan. First, a literature review was undertaken to identify hazard research completed in the region since 2008, both under the research plan and by other agencies. This was followed by a workshop with Hawke's Bay staff (primarily from regional and local authorities) and scientists to discuss research completed and identify research priorities for the future. Information from the workshop was then analysed and synthesised into a new 10-year plan.

2.1 LITERATURE REVIEW

As there had been at least two previous research reviews undertaken in 2003 and 2008 (Dellow et al., 2003; Wright et al., 2008), a bibliography documenting hazards research in the Hawke's Bay had already been developed. This project sought to update the bibliography and add known research projects completed since 2008. Appendix 1 details the updated bibliography. The bibliography was updated from a range of sources and includes projects commissioned by agencies in the Hawke's Bay, projects commissioned by research agencies and universities, and projects focussed at a range of levels (local, national and international where relevant links exist to the Hawke's Bay).

There is also significant new international research occurring on the East Coast of New Zealand, as the US National Science Foundation has selected the Hikurangi Margin as one of three places in the world where a large amount of research effort will be spent on understanding subduction plate boundary phenomena over the next decade, aiming to answer questions about why subduction zones behave the way they do. A summary of the Hikurangi Margin research is provided in Appendix 4 as there is an aspiration to build and support such research nationally and internationally over the next decade.

2.2 WORKSHOP

Following the compilation of the bibliography, a workshop was held with staff from Hawke's Bay Region to outline hazards research that had been completed (or is underway), and to discuss priorities for future research. The workshop was a one day event and the agenda for the workshop is presented in Appendix 5.

At the beginning of the workshop, participants were asked to come up with one idea about what research gaps there might be, and what research might be needed in Hawke's Bay in future. The following table (Table 2.1) reflects the range of initial research concepts that people articulated.

Table 2.1 Key gaps, areas of potential research, and themes and linkages between these.

Gap or important hazard issue	Relevant theme/s (from below)
How findings are presented to public	1
How information is developed so community can understand it	1
How well do we use what we already know	2
Joint research opportunities – Gisborne and other councils	6
How we prioritise hazards	3, 5
Policy and planning for climate change in coastal areas	2
Translating technical information into impacts and consequences	3
Educating the public about tsunami risks	2
Incorporating hazards information into district plans	2
How hazards information is translated onto property level information	1, 2
Hazard impacts on lifelines	3
How the hazard information can benefit the public "positive experience"	1, 2
Short-time frame warnings, and evacuation planning	1, 4, 2
How hazard research can be used for land and water management	2
Coordination of land-use management with hazards info	2

Key themes collated from the above suggestions:

1 Hazard research: public education and communication (N=5)

2 Applying research: policy, planning (N=9)

3 Risk and consequences/impacts modelling (N=2)

4 Preparedness and response planning (N=1)

5 Understanding and analysing hazard research (N=1)

6 Opportunities for collaboration and councils to work together (N=1)

Following an initial discussion of suggested (or identified) gaps in research, the next part of the workshop was dedicated to presenting information gleaned from previous hazards research, including what was known about different hazards, and where the gaps might be from a researcher's perspective.

It was noted that there was potential to link projects undertaken in Hawke's Bay with national (e.g., Hazards Platform) or international (e.g., Hikurangi Margin GEOPRISMs initiative) research work.

As part of the discussions, there was also a session exploring whether a joint project incorporating research around the Hikurangi Margin Plate Boundary could be developed, and whether there was general support for such a project. This project might be similar to the "It's Our Fault" programme of earthquake research in the Wellington Region, or the "DEVORA" programme of volcanic research in the Auckland Region. Participants expressed general support for an integrated programme of research based on the Hikurangi Margin (proposed "The East Coast LAB (Life at the Boundary)").

In the afternoon, the workshop focussed on identifying future priorities for research. Participants discussed general ideas for future research in the collective group, and then smaller break-out groups were formed to identify and prioritise specific projects. Participants in the break-out groups were asked to list up to 10 projects that they deemed worthy of future research, prioritise these projects as high (H) medium (M) or low (L), and discuss how such projects might be implemented. In devising their project lists participants could draw upon the list of projects that already existed from the 2008 update of the Hazards Research Plan (Appendix 3), or consider completely new projects.

2.3 SYNTHESIS OF WORKSHOP DATA

Following the workshop, notes from the discussion were analysed and summarised into main themes, or projects, that could be undertaken as part of the new 10-year plan. These projects are listed in Table 2.2. The projects were broken into three categories:

a. Uncompleted projects from the existing 2008 plan

b. Projects suggested by CDEM during the workshop presentation and discussed with the wider group

c. Projects that arose as part of break-out group discussions.

Where projects were deemed to link with those identified in the 2008 plan, a project number was assigned that corresponded with the number in the previous plan (Project No.). Project priorities (Priority) were given, and listed in the table as High (H), medium (M) or low (L). For each project, it was also noted whether projects could be undertaken under the umbrella of an “East Coast LAB” initiative (ECLAB).

Uncompleted projects retained their previous priority rankings from 2008 as no participant objected to the ranking or wanted to change it. However, it was evident that a number of uncompleted projects were not discussed further during the break-out group discussions including 17 (landslide data collection), 21 (tephra database), 22 (tephra magnitude and frequency) and 23 (extension of severe weather database), possibly suggesting that participants did not consider them to be a future focus. There was mention that perhaps the tephra database (21) and severe weather database (23) could be removed or integrated into other projects.

CDEM suggestions for new projects were not specifically prioritised, so no prioritisation was assigned to them. Priorities were, however, given for projects identified during break-out group discussions. Numbers beside the priorities ascribed during the group discussions (e.g., (1) or (2)) indicate the number of groups that prioritised a project a specific way.

Table 2.2 Potential projects for the new 10 Year Hazards Research Plan.

Project No (From 2008 plan).	Uncompleted projects from the existing Plan	Priority	ECLAB – potential for inclusion or related
10	Scientific information transfer	H	Y
11 & 18	Information acquisition storage and access (staff and public)	H & M	Perhaps related to some outputs
13	Consequences modelling and research	H/M	Co-funding opportunity
16	Geological units characterised to inform ground shaking hazard maps	M/H	N
17	Landslide data collection	M	N
19	Wave inundation forecasting	M	Related
20	Asses joint occurrence of high sea and high rivers	M/L	Related
21	Tephra database	M/L	N
22	Tephra magnitude and frequency	L	N
23	Extension of severe weather database	L	N
	New Ideas: CDEM suggestions		
	Subduction plate boundary research vertical land deformation		Y
	Weather and coastal research (unspecified)		Related
	Volcanic ash remobilisation		N
	Earthquake research – continue with active fault mapping work, and build on learnings from the 2010–11 Canterbury earthquakes		N
	Tsunami – local source/paleo/historic		Y
	Fire, tech and HSNO (Hazardous Substances and New Organisms) risks		N
	Climate change and increased risk from extreme weather events and tsunami, coastal hazards etc.		Related
	Lifeline failure		Could be related
	Maximum credible event for different hazards		Related
	Managed coastal retreat and pre-event recovery planning		Y
	Public education and near source tsunami – understanding of natural warnings		Y
	New Ideas: Group Discussion	**Priority (n)**	ECLAB
	Ash fall impacts on HB (all) and management	H (1)	N
11 & 18	Hazard information sharing database (public and staff)	H (2)	Related for some hazards
	Climate change implications for other hazards (50 years)	M (2) & H (1)	Related

Project No (From 2008 plan).	Uncompleted projects from the existing Plan	Priority	ECLAB – potential for inclusion or related
	Managed retreat scenarios	L (1)	Y – could be part
13	Scenario development (RiskScape) with impact modelling	H (3)	Some scenarios related
20	River sea interface (joint occurrence of high seas and high rivers) especially Wairoa	M (1) /H (1)	Y – related
19	Wave inundation and coastal hazard forecasting	M (2) & H (1)	Y – related
	Maximum credible weather events	M (1)	Possible related
	Lifelines vulnerabilities	H (3)	Possibly related
	Fire and HSNO study – more work	H (1)	N
	Living on the Edge – social science	?	Y for coastal
	Evaluation and monitoring of public education	M (1)	Y for some hazards
	Integration of CDEM into schools and with elderly	H (1)	Y education part of ECLAB purpose
	Lifelines interdependency research	M/H (1) & H (1)	N
	Liquefaction studies – engineering and planning	M (1)	N
	Contingency planning especially tsunami and other high priority hazards	H (1)	Y for some hazards
	Large or great pre-historic earthquakes (e.g., 900 yr. BP earthquake event) – was there a tsunami?	M (1)	Y
16	Geotechnical properties database mapping – soil types and codes	H (1)	N
	Potential linkages with MBIE and MFE land damage assessment framework – identifying future “red zones”		
	Potential linkages with national hazards databases and models		

2.4 POST-WORKSHOP FEEDBACK

Following the workshop, participants were also invited to send in any suggestions they might have for research under the 10-year plan. Suggestions included:

- Review of ground amplification potential, and update of amplification/liquefaction maps;
- Consequences based coastal erosion model (perhaps for the RiskScape risk modelling tool);
- Slope stability and rock fall hazard investigation (e.g., Te Mata development area/Havelock, Napier Hill, etc);
- Make use of any outcomes from the updated National Seismic Hazard Model;
- Present seismic shaking data in terms of loading code subsoil classes (e.g., as for Wellington). This could be further refined by any site specific studies;
- Flood mitigation and warnings for Wairoa;
- Advice on the how projects should be prioritised and ranked.

2.5 OTHER INFORMATION

Other information that was useful when identifying and prioritising future hazard research projects included the 2-yearly Hawke's Bay Hazard Research Survey (Hawke's Bay Civil Defence Emergency Management Group, 2013). This survey was conducted by the Civil Defence Emergency Management Group. It asked territorial authorities and professionals involved in land use planning decision making about the hazards they deemed important, and where future research areas might lie. Respondents thought that they required the most information on river and coastal floods (100%); transport accidents (e.g., air, train, ship) (85%); and geologic, climate and biological hazards (72%). Suggestions for future research included flood mapping and modelling, earthquake research (including liquefaction), tsunami research, lifelines research, and public education research.

2.6 DEVELOPMENT OF A 10-YEAR RESEARCH PLAN

The amalgamated data from the literature review, workshop, and post-workshop suggestions, were developed into an updated 10-year research plan, which is presented in Section 3.0. The rank order of the projects were then decided upon based on the workshop prioritisation and post-workshop feedback.

3.0 UPDATE OF THE HAWKE'S BAY 10 YEAR HAZARDS RESEARCH PLAN

The updated 10-year hazards research plan, based on workshop findings and post workshop deliberations, is summarised in Table 3.1.

Table 3.1 Updated Hawke's Bay Regional Council 10-year Hazards Research Plan.

2014 Ranking	Projects in progress (from 2008 plan)	Year of initiation of idea	Priority	Year/s project will be undertaken	Prior Project No. Reference for 2008 (Appendix 3)	Details and comments
1	Create a system for standardised collection of geotechnical properties (joint project to review liquefaction risk and establish geotechnical database).	2008	In progress	2013-15	14	Joint Project to review liquefaction risks and establish geotechnical database for Hawke's Bay (HB) commissioned June 2013. Project partners HB CDEM Group, Natural Hazards Research Platform, GNS, EQC, HDC and NCC. Work to be completed 2015.
2	Hazard information acquisition, storage and access – effective hazard and risk communication – created via GIS Portal "Home of Hazards".	2008	High(2) In progress	2014-15	11	Determine all sources of natural hazard information held by Councils (PIMs, LIMs, GIS, event reports, resource database, planning maps, research reports). Create database (GIS based) that all can access. Lead: HBRC
3	Fault-line mapping review work. Continuation of the fault-line mapping review work in Hastings and Wairoa.	2008	In progress	2015-17	-	Continuation of the fault-line mapping review work in Hastings and Wairoa (as per the work completed in CHB). Lead: GNS
4	Earthquake research – active faults and earthquake sources in Hawke's Bay.	2014	In progress	2015-17	-	Re-assess the locations, rates and role of earthquake fault sources in the National Seismic Hazard Model for Hawke's Bay region. This will link with work already done for liquefaction project (ranked 1 in 2014). Make sure the HB-relevant information in the National Seismic Hazard Model is as up to date as possible. Lead: GNS

2014 Ranking	Projects in progress (from 2008 plan)	Year of initiation of idea	Priority	Year/s project will be undertaken	Prior Project No. Reference for 2008 (Appendix 3)	Details and comments
5	Hazards and impacts/consequences modelling of earthquake and tsunami – primarily through the RiskScape programme.	2008	High(3)	2015-2019	13	To be conducted over several years. Initial focus on earthquake and tsunami consequences – scenarios and impacts. Stage 1: collect quality data, particularly inventory/ asset data. Stage 2: Consider maximum credible events via RiskScape and the impacts these events will have. Lead: GNS/NIWA
6	Flood mitigation and warning for Wairoa	2014	-	2014-2016	-	Complete Draft Flood Action Plan for the Wairoa River with the aim of describing the river stage heights, potential areas of impact, evacuation of flood hazard zones in the city reach of the Wairoa River. Identification of roles and responsibilities of the players, and clarification of liaison expected between the District and Regional Council. Initiative based on Whanganui River Plan in Wanganui. Lead: HBRC
7	Hazard information acquisition, storage and access – effective hazard and risk communication to HBRC public	2008	High(2)	2015-2016	18	Review effective hazard and risk communication to HB public. Undertake surveys and focus groups of community members to determine what hazard information is required, and how it is best delivered. Lead: HB CDEM Group
8	Update earthquake ground motion model for HB	2008	Med/High(1)	2014-15	16	Develop and update earthquake ground motion model for HB, based on the National Seismic Hazard Model, and evaluate return periods/ground motions for various earthquake events. Lead: GNS

2014 Ranking	Projects in progress (from 2008 plan)	Year of initiation of idea	Priority	Year/s project will be undertaken	Prior Project No. Reference for 2008 (Appendix 3)	Details and comments
9	An update of ground shaking behaviours, presented as loading code soil types on maps	2014	-	2016-17	-	The current liquefaction project (Ranking 1) includes the development of an updated earthquake ground motion model for HB based on the National Seismic Model, and evaluates return periods/ground motions for various earthquake events, but does not include updating the maps TLAs are using currently. This project will create maps to present seismic shaking data in terms of loading code (NZS 1170.5) subsoil class types (e.g., as for Wellington). This research could be applied to urban areas in Hawke's Bay. A general overview could be further refined by any site specific studies. As an example: A couple of sites in and near Hastings have been investigated by GNS for clients which indicate for those sites the subsoil class D given by the code is probably closer to class C which means a considerable reduction in building seismic loadings. If that applied over much of Hastings, then incorporating it may have significant benefits to a number of building owners in Hastings. Lead: GNS
10	Vertical land deformation from a subduction plate boundary earthquake event	2014	-	2018-19	-	Determine, as best as is practical, those areas in the HB that are likely to experience subsidence verses those areas that are likely to experience uplift in future subduction zone earthquakes for HB. May have to consider a number of plausible rupture scenarios. Linking with GNS Hazards Platform and GEOPRISMs work. Lead: GNS

2014 Ranking	Projects in progress (from 2008 plan)	Year of initiation of idea	Priority	Year/s project will be undertaken	Prior Project No. Reference for 2008 (Appendix 3)	Details and comments
11	Hawke's Bay rockfall and cliff collapse hazards pilot research. Regional-scale hazard and risk assessment.	2014	-	2019-20	-	Regional hazard and risk assessments provide useful tools to inform land use planning decisions. Results from such assessments adopt common metrics which allows specific hazards to be assessed and compared. Detailed site-specific (at the individual house-scale) assessments, carried out independently without a regional scale framework can result in inappropriate levels of advice and engineering works. Regional assessments therefore, provide frameworks that allow consistent and defendable planning decisions to be made. This proposed research will assess the level of risk to life property and businesses from rockfall and cliff collapse hazards in a specific pilot area of the Hawke's Bay region. The research will also develop, in collaboration with MBIE, appropriate guidelines for detailed site-specific assessments and engineering mitigation works. This project will link with information in the National Landslide Database. Lead: GNS
12	Tsunami frequency and magnitude research	2014	Medium(1)	2019-20	-	Over the last two years, the record of past large earthquakes from Ahuriri Lagoon, Napier, has been improved with many more core samples and radiocarbon ages providing evidence for more earthquakes than previously recognised and constraining the timing of earthquakes more precisely (Hayward et al., in preparation). An important question that arises out of this work is:

2014 Ranking	Projects in progress (from 2008 plan)	Year of initiation of idea	Priority	Year/s project will be undertaken	Prior Project No. Reference for 2008 (Appendix 3)	Details and comments
						"Did the past large earthquakes recorded at Ahuriri Lagoon cause tsunamis that impacted the Hawke's Bay coastline?" If the answer is 'yes' then estimates of tsunami hazard for Hawke's Bay are likely to increase (i.e., greater frequency and magnitude of events). A project focused around this question could involve: 1. A spatial and temporal gap analysis about what is currently known about large tsunami impact in Hawke's Bay over the Holocene (the last ~10,000 years) 2. Comparison of the tsunami record with the earthquake record to determine whether there are any potentially synchronous events 3. Improved radiocarbon analysis of known paleotsunamis[1] to better enable correlation with their source events 4. Field reconnaissance for new evidence of paleotsunamis in Hawke's Bay and analysis of potentially tsunamigenic deposits[2] 5. Assessment of how the new findings affect what is known of the tsunami hazard of Hawke's Bay. A project such as this would link directly with the USA's NSF through the Integrated Earth Systems program and through the GEOPRISMs (see Appendix 4). Lead: GNS

1 Tsunami occurring prior to the historical record or for which there are no written observations.

2 From an earthquake capable of generating a tsunami

2014 Ranking	Projects in progress (from 2008 plan)	Year of initiation of idea	Priority	Year/s project will be undertaken	Prior Project No. Reference for 2008 (Appendix 3)	Details and comments
13	Re-mobilisation of volcanic ash	2014	High(1)	2020-21	-	Volcanic eruptions deposit ash into river and stream catchments. Depending on the amount of ash, this can take 1-10 years to be flushed out of the catchment. The re-mobilisation of volcanic ash out of catchments is not well understood and less is known about the impacts on infrastructure. Impacts could include changes in flooding patterns, loss of protection to flood schemes, and loss of transport infrastructure, like bridges. A region like the Hawke's Bay will be impacted by ash re-mobilisation, yet the impacts of this are not well understood nor characterised. Lead: GNS
14	Climate change implications for other hazards (50 years) – including extreme weather events, coastal hazards, tsunami, etc.	2014	Med(2)/ High(1)	2021-22	-	A suggested analysis of data from the new 1.5 km NZCSM operational weather-model NIWA runs – e.g., could compare 30-year hindcast of recent decades vs futurecast (rain, hail, snow, wind, temperature). Includes updating sea-level rise projections and effect on tsunami, groundwater/flood hazards to update 50 and 100 year outlook on hazardscape for HB/Gisborne. Core funded under the Hazards Platform and co-funded by Hawke's Bay. Lead: NIWA.

2014 Ranking	Projects in progress (from 2008 plan)	Year of initiation of idea	Priority	Year/s project will be undertaken	Prior Project No. Reference for 2008 (Appendix 3)	Details and comments
15	Wave inundation forecasting	2008	Med(2)/ High(1)	2022-23	20	This project involves understanding the correlations between multiple hazards drivers in coastal and estuarine flooding. It will also benefit from the 40 year storm-surge and wave climate around the NZ coast completed under the WASP project undertaken by NIWA (WASP= Waves and Storm-surge Projections). To be considered as part of proposed Coastal Strategy, a long term vision for the region's coastline (Hawke's Bay Regional Council, 2014) in light of the predicted impacts of climate change, following the Komar Report (Komar, 2007). Lead: NIWA
16	Assess joint occurrence of high sea levels and high river flows. River sea interface – interactions and hazards posed (esp. for Wairoa).	2008	Med(1)/ High(1)	2023-24	19	Understanding the interactions between multiple hazard drivers in river and estuarine inundation e.g., the interplay between river flood flows and coastal storm-tide and wave set-up. The project will benefit from the 3 year Natural Hazards Platform project on storm-tides in estuaries and low land rivers (finishing at the end of 2014) and the Waves & Storm Surge Projections (WASP) project completed 2 years ago to develop a 40 year storm-surge and wave climate around the NZ coast and changes by end of the century due to climate-change. Processes governing wave run-up and overtopping on mixed sand/gravel beaches needs to be better understood – most research to date has been on sandy beaches. Improved methodologies using short deployments of NIWA's mobile Camera system or other sensing instrumentation and tie back to offshore wave

2014 Ranking	Projects in progress (from 2008 plan)	Year of initiation of idea	Priority	Year/s project will be undertaken	Prior Project No. Reference for 2008 (Appendix 3)	Details and comments
						conditions especially swell. Run-up could be linked to wave model forecasts. Co-funding with NIWA research or proposal for funding. Would fit well into East Coast LAB framework. Lead: NIWA/HBRC
17	Consequences based coastal erosion model (perhaps for RiskScape)	2014	-	2023-24	-	Riskscape software doesn't currently deal with coastal erosion hazards. In terms of 'loss modelling' being able to model loss from coastal hazards (not necessarily just erosion) would be useful. For example, with regard to the Haumoana/Te Awanga coastal erosion situation, storm surge and coastal inundation events will be amplified by sea level rise, causing subsequent coastal erosion, and these effects could potentially be put through the Riskscape model. NIWA is also ramping up its core research on probabilistic approaches to predicting future coastal erosion (incl. climate change) for both sandy and gravel coastlines – so there is a possibility of using Hawke's Bay as a test site along with other Australasian sites to benchmark these new approaches. Lead: HBRC/NIWA.
18	River-coastal transitions systems	2014	-	2024-25	-	Joint Annual Exceedance Probability combined water levels and morphological modelling connecting river sediment to coast, to understand the interactions between coast and sea in a hazards context. Some modelling work is already being undertaken by NIWA, and could link to the Hawke's Bay context as a pilot study. Lead: NIWA

2014 Ranking	Projects in progress (from 2008 plan)	Year of initiation of idea	Priority	Year/s project will be undertaken	Prior Project No. Reference for 2008 (Appendix 3)	Details and comments
19	Maximum credible weather events - wind	2014	Medium(1)	2024-25	-	HIRDS v4 for high intensity rainfall design and a national project to update river flood magnitudes and frequency have both been funded by Envirolink Tool funds – which will include the HB/Gisborne region. A further study could update and assess the wind gust climate for the region and whether wind strengths have changed – also update AEP values for different wind quadrants. Lead: NIWA
20	Extension of the severe weather database	2008	Low	2025-26	23	Augment and integrate information on historic sea weather events for Hawke's Bay from NIWA national weather event database. Undertake spatial and temporal analysis of past events providing context of weather related risk analysis and an educational resource. This will provide an update of weather hazardscape for Hawke's Bay (from past events), produce educational materials to raise awareness and CDEM scenarios to exercise. Based on the HBRC/Gisborne District Council (GDC) historic events records and the Historic Weather Events catalogue produced by NIWA http://hwe.niwa.co.nz/, along with 'The Climate and Weather of Hawke's Bay' publication (Chappell, 2014) (which provides a standard guide to patterns of rainfall, temperature, sunshine, etc. for HB). Lead: NIWA

2014 Ranking	Projects in progress (from 2008 plan)	Year of initiation of idea	Priority	Year/s project will be undertaken	Prior Project No. Reference for 2008 (Appendix 3)	Details and comments
21	Managed retreat scenarios	2014	Low(1)	2025-26	-	Undertake research into the viability and implementation of managed coastal retreat in the Hawke's Bay. Answering questions such as: Is managed retreat a sustainable long-term management approach to coastal hazards, including tsunami? How can a plan for managed retreat be developed and implemented? Could a recovery plan include strategies for how retreat might be managed after a major storm or tsunami event? Lead: TBC

* "High", "Medium", "Low" priority refers to the workshop prioritisations that were assigned. The rank order was then decided based on the workshop priorities and post-workshop feedback.

** "Prior Project Reference for 2008" refers to reference numbers that link with project numbers quoted in the 2008 plan.

4.0 OTHER ISSUES OF IMPORTANCE

A range of issues were considered important by workshop participants, but fell beyond the reach of the Hazards Research Plan. These issues mostly related to mitigation of regional risk and contingency planning (Table 4.1). Such issues should be considered and accounted for as part of the CDEM planning process. It was also considered essential to ensure that connections were made with national databases (e.g., landslide and tephra databases) so to make effective use of the information contained in databases.

Table 4.1 Other issues considered important by workshop participants.

Proposed project	Year of initiation of idea	Workshop Priority	Details and comments
Scientific information transfer system	2008	High	Implement a system for the transfer of information from the scientific community to end-users. National project required – will link with initiatives being undertaken under the National Science Challenges.
Fire, technological and HSNO risks – more work required	2014	High(1)	Ensure all site plans are up to date for HSNO purposes (including buildings identified, where the waters supplies are, what hazardous substances are on each premise, where the hazardous substances are situated and best access). Ensure regular reviews of site plans to take account of changes to HSNO risks.
Lifelines research: Vulnerabilities, failures and interdependencies research	2014	High(3) High(2)/M(1)	Lifelines interdependency research was given a high ranking in the 2014 workshop. An interdependency assessment was completed as part of the 2001 Lifelines Project – see Chapter 13 of 'Facing the Risks' (Hawke's Bay Engineering Lifelines, 2001). But it is recommended the HB Engineering Lifelines Group review this work in light of updated research over 13 years.
Integration of CDEM into schools and with elderly	2014	High(1)	Support research initiatives that ensure local communications programmes are designed to meet the needs of schools and the elderly, and respond to any barriers.
Contingency planning for high priority hazards (e.g., local tsunami)	2014	High(1)	As only limited contingency planning has been completed to date, the workshop recognised this as a priority. It is included as a significant priority in the HB CDEM Group work programme.
Evaluation and monitoring of public education	2014	Medium(1)	Included in the HB CDEM Group work programme as part of on-going monitoring and evaluation. Specific public education projects may also provide additional information on improving public education, for example, the evaluation of the effectiveness of public education for near source tsunami hazard was specifically mentioned.

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5.0 SUMMARY

The 10-year Hawke's Bay Hazards Research Plan was updated for 2014. To update the plan, a literature review was undertaken to identify hazard research completed in the region since 2008 (when last plan was completed), followed by a workshop with scientists and Hawke's Bay staff to identify research priorities for the future. Information from the workshop was then analysed and synthesised into a new 10-year plan. Immediate priorities include:

- Finishing existing projects (e.g., liquefaction risk project)
- Populating Riskscape with asset data and making use of it to model risk
- Starting a project to aid the acquisition, storage, access and transfer of scientific hazard information to stakeholders and the public, with the ultimate outcome of enabling effective usage
- Understanding more about earthquake hazards, and the impact of flooding in urban areas (i.e., Wairoa).

A number of climate and weather related projects were suggested to be of importance, especially given climate change concerns. Other projects deemed of importance include specific projects related to particular perils (e.g., tsunami, earthquake, and landslide). Several projects related to mitigation of regional risk and contingency planning have been noted as important, but fall within the responsibility of the CDEM planning process.

A summary of the 10-year Hazards Research Plan for 2014 can be found in Appendix 6.

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6.0 ACKNOWLEDGEMENTS

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APPENDICES

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A1.0 APPENDIX 1: BIBLIOGRAPHY OF HAZARDS AND HAZARD MANAGEMENT RESEARCH RELEVANT TO HAWKE'S BAY (UPDATED TO MID-2014)

Hazard	Description of Data	Reference
Earthquake	NZ-wide magnitudes and frequencies of earthquakes	Aitken, L. and Webb, T.1998. The where and when of New Zealand Earthquakes. Tephra. 17 (June): 7-11.
	Seismic modelling of strong movement during Tikokino earthquake	Abercrombie, R.E. and Benites, R.A. 1998. Strong motion modelling of the 1993 Tikokino earthquake, southern Hawke's Bay, New Zealand. New Zealand Journal of Geology and Geophysics 41 (3): p. 259-270
	Historic HB earthquake (M_L 5.7)	Bannister, S.C., B.J. Perin, and T.H. Webb, Normal faulting through subducted oceanic crust: the 19 July 1985 earthquake of Hawke's Bay, New Zealand. Tectonophysics, 1989. 162(3/4): p. 303-313.
	Hikurangi Fault - movement	Barnes, P., Fault kinematic adjustments during the last 2 Myr in the transition area between continental collision and Hikurangi Margin subduction, in Geological Society of New Zealand and New Zealand Geophysical Society. Joint Conference (1998 : University of Canterbury). 1998. p. 35.
	Kidnapper's Fault	Barnes, P. and A. Nicol, Late Quaternary back-thrusting and basin inversion: Kidnappers Fault, Hawke Bay, in Geological Society of New Zealand. Conference (1997 : Wellington, NZ). 1997. p. 12.
	Hikurangi Fault - movement rates	Barnes, P.M. and B.M. de Lepinay, Rates and mechanics of rapid frontal accretion along the very obliquely convergent southern Hikurangi margin, New Zealand. Journal of geophysical research. Solid earth, 1997. 102 (B11): p. 24931-24952
	North Island strain rates and deformation	Beanland, S. and J. Haines, The kinematics of active deformation in the North Island, New Zealand, determined from geological strain rates. New Zealand Journal of Geology and Geophysics, 1998. 41(4): p. 311-323
	Hikurangi Margin	Beanland, S. 1993. "Active faults of the North Island shear belt; Hikurangi Margin, New Zealand." Institute of Geological & Nuclear Sciences abstract (126): 37.
	Magnitude, intensity, return periods of faults in Hawke's Bay	Begg, J.G., Hull, A.G., Downes, G.L., 1994. Earthquake hazards in Hawke's Bay: initial assessment. Institute of Geological and Nuclear Sciences client report 333901.10.
	Fault, magnitude, return period, in Hawke's Bay	Begg, J.G., Hull, A.G., Robinson, R., 1996. Earthquake hazards analysis - Stage 1. Recurrence of large earthquakes determined from geological and seismological studies in Hawke's Bay area. Institute of Geological and Nuclear Sciences client report 1996/33591D.10.

Hazard	Description of Data	Reference
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	Hikurangi subduction zone effects on marine terraces	Berryman, K., Age, height, and deformation of Holocene marine terraces at Mahia Peninsula, Hikurangi subduction margin, New Zealand. Tectonics, 1993. 12(6): p. 1347-1364
	Earthquake hazards- Gisborne	Berryman, K., Beanland, S. and Mazengarb, C., 1988. Proceedings of the East Cape United Council Civil Defence Seminar. Natural Hazards and Planning, in particular Earthquake Hazards. Gisborne, 28th April 1988.
	Magnitude, intensity, return periods of faults in Hawke's Bay	Berryman, K., McVerry, G., and Villamor, P., 1997. Hawke's Bay region earthquake hazard analysis programme. Stage 2. A numerical assessment of the earthquake hazard in the Hawke's Bay region. Institute of Geological and Nuclear Sciences client report 33591D.10.
	Limestone cropping	Caron, V., C. S. Nelson, et al. 2004. "Contrasting carbonate depositional systems for Pliocene cool-water limestones cropping out in central Hawke's Bay, New Zealand." New Zealand Journal of Geology and Geophysics 47(4): 697-717.
	Cost per return period of earthquake	Caseley, A.M., Adye, M.J., Pearse, L.J., and Binney, P. 1996. Disaster damage risk management review. Hawke's Bay Regional Council.
	Maximum shaking intensity vs return period for particular earthquakes	Caseley, A.M., Adye, M.J., Pearse, L.J., and Binney, P. 1996. Disaster damage risk management review. Hawke's Bay Regional Council.
	Return periods for particular fault lines in Hawke's Bay	Caseley, A.M., Adye, M.J., Pearse, L.J., and Binney, P. 1996. Disaster damage risk management review. Hawke's Bay Regional Council.
	Estimated damage and costs from different earthquake return periods	Caseley, A.M., Adye, M.J., Pearse, L.J., and Binney, P. 1996. Disaster damage risk management review. Hawke's Bay Regional Council.
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Hazard	Description of Data	Reference
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	Infrastructure seismic risk	Cousins, W.J. and Smith, W.D. 2001. Hawkes Bay Regional Council Infrastructural Assets Seismic Risk Assessment. GNS Report 2001/48
	Liquefaction, intensity, earthquake scenarios	Dellow, G.D., Hengesh, J.V., Heron, D., Brown, L., and Hull, A.G., 1999. Earthquake hazard analysis program: Stage II: Part II - Evaluation of liquefaction potential in the Hawke's Bay Region. Institute of Geological and Nuclear Sciences client report 1996/6.
	Intensity, return periods of earthquakes to affect Gisborne	Dellow, G.D., Mazengarb, C., Cousins, J., Scott, B., and Townsend, T., 1997. Executive summary report geological hazards in the Gisborne District. Institute of Geological and Nuclear Sciences client report 1997/44692D.
	Damage costs to houses and farms as a function of intensity in the 1987 Edgecumbe earthquake	Dowrick, D.J. 1991. Damage costs to houses and farms as a function of intensity in the 1987 Edgecumbe earthquake. Earthquake Engineering and Structural Dynamics 20:455-469.
	Damage ratio, intensity	Dowrick, D.J., Rhoades, D.A., Babor, J. and Beetham, R.D., 1994. Damage ratios for houses in the MM10 zone of the magnitude 7.8 Hawke's Bay, New Zealand earthquake of 1931. Institute of Geological and Nuclear Sciences client report 313918.10.
	The modified Mercalli earthquake intensity scale	Dowrick, D.J. 1996. The modified Mercalli earthquake intensity scale; revisions arising from recent studies of New Zealand earthquakes Bulletin of the New Zealand National Society for Earthquake Engineering. 29 (2) p. 92-106.
	Attenuation of Modified Mercalli intensity in New Zealand earthquakes	Dowrick D.J. and D.A. Rhoades 1999. Attenuation of Modified Mercalli intensity in New Zealand earthquakes. Bulletin of the NZ Society for Earthquake Engineering 32, 55-89.
	Anti-seismic measures	Eiby, G.A. 1975. "A history of anti-seismic measures in New Zealand." Bulletin of the New Zealand National Society for Earthquake Engineering: 255-259.
	Liquefaction	Fairless, G. J. and J. B. Berrill 1984. "Liquefaction during historic earthquakes in New Zealand." Bulletin of the New Zealand National Society for Earthquake Engineering: 280-291.

Hazard	Description of Data	Reference
	Earthquake triggered landslides - NZ frequencies, magnitudes, extent	Hancox, G. 1998. Landslides and ground damage caused by earthquakes. Tephra. 17(June): 15-20.
	Large earthquakes of the past 7200 years – southern HB	Hayward, B.W., H.R. Grenfell, A.T. Sabaa, R. Carter, U.A. Cochran, J.H. Lipps, P.R. Shane, and M.S. Morley, Micropaleontological evidence of large earthquakes in the past 7200 years in southern Hawke's Bay, New Zealand. Quaternary science reviews, 2006. 25(11/12): p. 1186-1207
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	Tectonic uplift – Kidnapper's Coast	Hull, A.G., A Late Holocene marine terrace on the Kidnappers Coast, North Island, New Zealand: Some implications for share platform development processes and uplift mechanism. Quaternary research, 1987. 28(2): p. 183-195.
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	Probabilistic ashfall hazard modelling	Hurst, A.W.; Smith, W.D. 2004 A Monte Carlo methodology for modelling ashfall hazards. Journal of volcanology and geothermal research, 138(3/4): 393-403
	Hawke's Bay survey data for volcanic hazards	Johnston, D.M. 1997. Physical and social impacts of past and future volcanic eruptions in New Zealand. Unpublished Ph.D. thesis, Department of Soil Science, Massey University.

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	Hikurangi Margin	Lewis, K.B., J.Y. Collot, et al. 1995. "Seamount impacts and frontal accretion on the north-central Hikurangi Margin interpretations of merged EM12D and MR1 swath data sets." Institute of Geological & Nuclear Sciences abstract(441): 1 p.
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	Eruption frequencies and thicknesses	Scott, B.J. 1997. Volcanic Impacts, Gisborne District Council. Institute of Geological and Nuclear Sciences Client Report 1997/44692D.17.
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Landslides	Landside processes in HB	Brooks, S.M., M.J. Crozier, N.J. Preston, and M.G. Anderson, Regolith stripping and the control of shallow translational hillslope failure : application of a two-dimensional coupled soil hydrology-slope stability model, Hawke's Bay, New Zealand. Geomorphology, 2002. 45(3-4): p. 165-179
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	Summary of landslide hazards in Hawke's Bay	Johnston, D.M. and Pearse, L.J. 1999. Natural Hazards in Hawke's Bay. Hawke's Bay Regional Council Technical Report AM 99/03
	April 2011 storm induced landsliding	Jones, K.E.; Levick, S.R.; Page, M.J.; Lynch, B. 2011. Processing and classifying satellite imagery to assess the April 2011 storm induced landsliding in Hawke's Bay, New Zealand. [p. 51] IN: *Abstract for the Surveying & Spatial Sciences Biennial Conference 2011.* [Wellington, NZ?]: [New Zealand Institute of Surveyors?]
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Hazard	Description of Data	Reference
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		Wilmshurst, J.M. 1997. "The impact of human settlement on vegetation and soil stability in Hawke's Bay, New Zealand." New Zealand Journal of Botany 35(1): 97-111.
Winds and storms	Storm damage northern HB	Harmsworth, G.R.; Hope, G.D.; Page, M.J.; and Manson P.A. 1987. Aokautere An Assessment of Storm Damage at Otoi in Northern Hawkes Bay. EMI 8701 HBRC Plan No 3568
	Cyclone Bola interim report	Hawkes Bay Catchment Board and Regional Water Board, 1988. Storm Report (Interim) Cyclone Bola 1988. HBRC AM 8807

Hazard	Description of Data	Reference
	HB July 1985 Storm event report	Hawke's Bay Regional Council. 1985. Report on Storm of 26-28 July 1985. AM 8501 HBRC Plan No 3471
	Storm frequency and magnitude Lake Tutira	M.J. Page, N.A. Trustrum, A.R. Orpin, L. Carter, B. Gomez, U.A. Cochran, D.C. Mildenhall, K.M. Rogers, H.L. Brackley1, A.S. Palmer, L. Northcote. 2010. Storm frequency and magnitude in response to Holocene climate variability,Lake Tutira, North-Eastern New Zealand. Marine Geology 270 30-44
	Watershed erosion	A.R. Orpin, L. Carterb, M.J. Paged, U.A. Cochran, N.A. Trustrum, B. Gomez, A.S. Palmer, D.C. Mildenhal, K.M. Rogers, H.L. Brackley, L. Northcote 2010. Holocene sedimentary record from Lake Tutira: A template for upland watershed erosion proximal to the Waipaoa Sedimentary System, northeastern New Zealand. Marine Geology 270 11-29
	Estimated 3 second gust speeds for return periods 475 and 142 years in Hawke's Bay	Porteous, A.S. and Burgess, S.M. 1999. Meteorological hazards to Hawke's Bay engineering lifelines. NIWA Client Report WLG99/78. National Institute of Water and Atmospheric Research Ltd. 55p.
	Estimated 3 second gust speeds for return periods 475 and 142 yrs in Hawke's Bay	Reid, S.J., and Wratt, D.S., 2000. Extreme winds in Hawke's Bay. A supplement to NIWA Client Report WLG99/78: Meteorological hazards to Hawke's Bay engineering lifelines. National Institute of Water and Atmospheric Research Ltd.
	Frequency of high winds, wind direction	Thompson, C.S., 1987. The climate and weather of Hawke's Bay. New Zealand Meteorological Service, Wellington, New Zealand. 46p.
Tsunami	National tsunami risk (probability/magnitude)	Berryman, K.R., Review of Tsunami Hazard and Risk in New Zealand. Institute of Geological and Nuclear Sciences client report 2005/104. 2005, Institute of Geological and Nuclear Sciences.
	A pre-historic tsunami and record of sea-level change	Chague-Goff, C., S. Dawson, J.R. Goff, J. Zachariasen, K.R. Berryman, D.L. Garnett, H.M. Waldron, and D.C. Mildenhall, A tsunami (ca. 6300 years BP) and other Holocene environmental changes, northern Hawke's Bay, New Zealand. Sedimentary Geology, 2002. 150(1/2): p. 89-102.
	Estuarine environment	Chague-Goff, C., S. L. Nichol, et al. 2000. "Signatures of natural catastrophic events and anthropogenic impact in an estuarine environment, New Zealand." Marine Geology 167(3-4): 285-301.
	Holocene tsunami and storms	Cochran, U. A., K. R. Berryman, et al. 2005. "Towards a record of Holocene tsunami and storms for northern Hawke's Bay, New Zealand." New Zealand Journal of Geology and Geophysics 48(3): 507-515.
	NZ-wide return periods for tsunami, different sources, affect on ports	de Lange, W., and Fraser, R. 1999. Overview of tsunami hazard in New Zealand. Tephra. 17 (June): 3-9.
	Tsunami risk level for Sth Pacific Ocean using earthquake magnitude	de Lange, W., and Healy, T. 1999. Tsunami and tsunami hazard. Tephra. 17 (June): 13-20.

Hazard	Description of Data	Reference
	Historic Gisborne earthquakes and tsunami, magnitude, return period	Downes, G., Webb, T., McSaveny, M., Darby, D., Doser, D., Chague-Goff, C. and Barnett, A., 2000. The 26 March and 17 May 1947 Gisborne earthquakes and tsunami: Implication for tsunami hazard for East Cost, North Island, New Zealand. Proceedings of The International Workshop Tsunami Risk Assessment Beyond 2000: Theory, Practice and Plans. June 14-16, 2000. Russia, Moscow.
	Tsunami database	Fraser, R.J. 1998.Historican tsunami database for New Zealand. MSc theses. Waikato university.
	Tsunami evacuation	Fraser, S. 2013. Intended Evacuation Behaviour in a Local Earthquake and Tsunami at Napier, New Zealand GNS Science Report 2013/26.
	Tsunami inundation	Fraser, S.A.; Power, W.L.; Wang, X.; Wallace, L.M.; Mueller, C.; Johnston, D.M. 2014 Tsunami inundation in Napier, New Zealand, due to local earthquake sources. *Natural hazards, 70(1):* 415-445; doi: 10.1007/s11069-013-0820-x [January 2014]
	HB Tsunami hazard assessment	Goff, J. 2008. Tsunami Hazard Assessment for Hawke's Bay. NIWA Client Report CHC2008-021
	Tsunami hazard	Hawkes Bay. Facing the Risks: Chapter 8. Tsunami Hazard.
	Tsunami Hazard Maps	Hawke’s Bay Regional Council tsunami Hazard Maps
	Tsunami Inundation	Hawke’s Bay CDEM Group. Tsunami Inundation Mapping for Hawke’s Bay.
	Extent of wave at Hawke's Bay from displacement of a fault on the outer shelf of Hawke's Bay	Lewis, K., Collot, J-Y. and Goring, D. 1999. Huge submarine avalanches: is there a risk of giant waves, and if so where? Tephra. 17(October): 21-29.
	Hawke's Bay probabilities and return periods, extent of wave scenarios, effects	McSaveney, M. and Rattenbury, M. 2000. Tsunami Impact in Hawke's Bay. Institute of Geological and Nuclear Sciences client report 2000/77.
	Alerting options	Meldrum W. and Wright K. Public notification options within community response planning in Hastings District. See Decision tool www.mcdem.govt.nz
	Community understanding of tsunami risk	Pischief, K.S. 2007. Community Understanding and Preparedness for Tsunami Risk in the Eastern North Island, New Zealand. Unpublished thesis, University of Waikato.
	Tsunami modelling	W.L. Power. 2014. Tsunami hazard curves and deaggregation plots for 20km coastal section, derived from the 2013 National Tsunami Hazard Model. GNS Science Report 2013/59.
	3 Hawke's Bay scenarios, wave height, extent of run up and possible effects	Van Dissen, R.J., Lester, R. and Barnett, A.G. 1994. Tsunami hazard study for the Hawke's Bay Region. Institute of Geological & Nuclear Sciences client report 333901.20 prepared for the Hawke's Bay Regional Council.

Hazard	Description of Data	Reference
	Tsunamis experienced in NZ and damage done	Works and Development Services Corporation (NZ) Ltd, 1988. Report for New Zealand Earthquake and War Damages Commission on the effects of tsunamis in New Zealand. Works and Development Services Corporation (NZ) Ltd.
Coastal	Coastal hazard management	Andrews, C.; Reinen-Hamill, R.; Adye, M. 2003 Hawke's Bay coastal hazard management : strategy development and initial wave climate assessment. 9 p. IN: Kench, P.; Hume, T. (eds) *Coasts & ports Australasian Conference 2003 : 9-12 September 2003, Hyatt Regency, Auckland, New Zealand.* Barton, ACT: Institution of Engineers
	Coastal hazard zones	Baker, N., Ide, G., Reinen-Hamill, R. Implementing coastal hazard zones in planning policy: Living with dynamic shorelines. 2009. 19th Australasian Coastal and Ocean Engineering Conference 2009 and the 12th Australasian Port and Harbour Conference 2009, COASTS and PORTS 2009pp. 356-360
	Coastal property development	Collins, D. Contesting property development in coastal New Zealand: A case study of Ocean Beach, Hawke's Bay. 2009. International Journal of Urban and Regional Research. 33 (1), pp. 147-164
	Wainui Beach erosion hazard	Dawson, P.I. 1994. Wainui Beach erosion hazard: A case study. Proceedings of the Natural Hazards Management Workshop Wellington, 8-9 November 1994. Institute of Geological and Nuclear Sciences information series 31. Institute of Geological and Nuclear Sciences Limited.
	Coastal inundation	Ganev, K. 2000. Sea Inundation: Heavy Swells Wave Run-up. AM 0008 HBRC Plan No 2904
	Coastal hazard areas - Gisborne	Gibb, J.G. 1994. Defining coastal hazard areas and zones to control subdivision use and development. Proceedings of the Natural Hazards Management Workshop Wellington, 8-9 November 1994. Institute of Geological and Nuclear Sciences information series 31. Institute of Geological and Nuclear Sciences Limited.
	HB Coastal processes and erosion	Komar, P.D. 2007. Summary Report: The Coast of Hawkes Bay: Processes and Erosion Problems. AM 0702 HBRC Plan Number 3918
	Shoreline management	Komar, P.D. 2010. "Shoreline Evolution and Management of Hawke's Bay, New Zealand: Tectonics, Coastal Processes, and Human Impacts." Journal of Coastal Research 26(1): 143-156.
	Coastal erosion	Reinen-Hamill, R., Clode, G., Daykin, N. Coastal erosion of the Hawke Bay coastline from Napier to Cape Kidnappers. 2009. 19th Australasian Coastal and Ocean Engineering Conference 2009 and the 12th Australasian Port and Harbour Conference 2009, COASTS and PORTS 2009. pp. 97-
	Coastal cliff hazard zone	Tonkin and Taylor Limited, 2005a. Cliff Hazard Zone Delineation. HBRC Plan No. 3823 EMT 05/08

Hazard	Description of Data	Reference
	Coastal hazard southern beaches	Tonkin and Taylor Limited, 2005b. Summary Report on Site Specific Coastal Hazard Determination for Southern Beaches. HBRC Plan No. 3789 EMT 05/06
	Coastal hazard northern and southern beaches	Tonkin and Taylor Limited, 2006a. Revised Hazard Zone Determination for Northern and Southern Hawke's Bay Beaches. HBRC Plan No. 3824 AM 05/25
	Hardinge Road coastal hazard	Tonkin and Taylor Limited, 2006b. Coastal Hazard Assessment for Hardinge Road, Napier. HBRC Plan No. 3833.
	HB coastal hazards	Tonkin and Taylor Limited, 2008. Hawke's Bay Regional Coastal Environment Plan: Coastal Hazards - Additional Information. HBRC Plan No. 4043 EMT 08/07.
	Riverine fluxes – Waipaoa River	Phaedra Upton, Albert J. Kettner, Basil Gomez, Alan R. Orpin, Nicola Litchfield, Michael J. Page, 2012. Simulating post-LGM riverine fluxes to the coastal zone: The Waipaoa River System, New Zealand
	Estuary management	Yan, B., Y. Jia, et al. 2013. "Use of one-dimensional modelling in estuary management: entrance depth -- model calibration." Journal of Coastal Conservation 17(1): 191-196.
Flooding	Flood frequencies for Waiau River	Arnold, P.E., Field, L.B.S., and Reid, C.J. 1987. SH38 Waiau River Flooding Matai Bridge (RP 161/12.34) to Frasertown Bridge (RP 179/9.91). Report on flood level recurrence intervals in the Lower Waiau River. Soil and Water Directorate, MWD Napier.
	Wairoa floodplain, return periods of rainfall and peak discharges	Clode, G. 1994. Wairoa floodplain management. Progress report to July 1994. Hawke's Bay Regional Council.
	Flood investigation Taylors Bay, Mahia	Daykin, N. Taylors Bay, Mahia: Flood Investigation. AM 06/08 HBRC Plan No 3847
	Wharerangi Flood Risk	Daykin, N. and Goodier, C. 2007. Wharerangi Flood Risk Assessment. AM 0701 HBRC Plan No 3916
	Wairoa Flood report October 2005 event	Daykin, N. and Withey L. 2004. Wairoa Catchments Flood Report: Labour Weekend, 20-21 October 2005. AM 0603 HBRC Plan No 3836
	Historic flood records - Gisborne	From Civil Defence Office, Gisborne District Council
	Hill country runoff	Gillingham, A.G. and Gray, M.H. 2006. "Measurement and modelling of runoff and phosphate movement from seasonally dry hill-country pastures." New Zealand Journal of Agricultural Research 49(3): 233-245.
	Landslide-triggering rainstorm events	Glade, T. 1998. "Establishing the frequency and magnitude of landslide-triggering rainstorm events in New Zealand." Environmental Geology 35(2-3): 160-174.

Hazard	Description of Data	Reference
	Historic large magnitude rainfall events	Basil Gomez, Lionel Carter, Alan R. Orpin, Kim M. Cobb, Michael J. Page, Noel A. Trustrum and Alan S. Palmer. 2011. ENSO/SAM interactions during the middle and late Holocene. The Holocene 22(1) 23-30.
	Historic climate variability	Basil Gomez, Lionel Carter, Noel A Trustrum, Michael J Page and Alan R Orpin. 2013. Coherent rainfall response to middle- and late-Holocene climate variability across the mid-latitude South Pacific
	Central HB February 2004 Flood event report	Goodier, C. 2004. Flood Report Central Hawkes Bay February 15-16, 2004. AM 0417 HBRC Plan No 3389
	Soil moisture measures	Hawke, R. and McConchie, J. 2011. "In situ measurement of soil moisture and pore-water pressures in an 'incipient' landslide: Lake Tutira, New Zealand." Journal of Environmental Management 92(2): 266-274.
	Maps of areas floodable, cost and population affected	Hawke's Bay Region Civil Defence Organisation, 199?. Hawke's Bay Region flood hazard maps for Hastings District Council civil defence area. Hawke's Bay Region Civil Defence Organisation.
	HB June 1997 Flood event report	HBRC Asset Management & Hydrology Section. 1987. Flood Report 1-3 June 1997
	HB October 2004 Flood event report	Hawke’s ay Regional Council. 2007. Flood Report: Napier and Central Hawkes Bay, October 18, 2004.
	HB July 1982 Flood event report	McBryde, D.C. 2004 Flood Report 22-23 July, 1992. HBRC TS Report 92/15
	Waipaoa flood frequency plot	Ministry of Civil Defence, 1989. Cyclone Bola 7th-10th March 1988. Ministry of Civil defence
	Distribution of 24 hour 5 year rainfall, NZ wide.	ed. Mosley, P. and Pearson, C., 1997. Floods and Drought: the New Zealand experience. New Zealand Hydrological Society.
	Return periods for rainfall in Hawke's Bay	Porteous, A.S. and Burgess, S.M. 1999. Meteorological hazards to Hawke's Bay engineering lifelines. NIWA Client Report WLG99/78. National Institute of Water and Atmospheric Research Ltd. 55p.
	Revised flooding frequencies after Cyclone Bola (Waiau River)	Reid, C.J., 1989. SH38 Waiau River Flooding Addendum.
	February 2004 flood	Reid, P.; Brunsdon, D.; Fitzharris, P.; and Oughton, D. 2004. Review of the February 2004 Flood Event. Ministry of Civil Defence and Emergency Management.
	Record of floods in NZ 1920-1953	The Soil Conservation and Rivers Control Council, 1957. Floods in New Zealand 1920-1953. With notes on some earlier floods. The Soil Conservation and Rivers Control Council, Wellington. 239 p.
	Maximum rainfall return periods for specific durations	Thompson, C.S., 1987. The climate and weather of Hawke's Bay. New Zealand Meteorological Service, Wellington, New Zealand. 46p.

Hazard	Description of Data	Reference
	Rainfall frequencies for different durations	Tomlinson, A.I., 1980. The frequency of high intensity rainfalls in New Zealand. Water and Soil Technical Publication No. 19. Part 1. Water and Soil Division, Ministry of Works and Development, Christchurch.
	Design standards for Hawke's Bay stopbanks (eg.100 yr flood) & social priority rank, maps available also	Woodward Clyde (NZ) Ltd, 1999. Heretaunga Plains flood hazard study. Hawke's Bay Regional Council.
All hazards/ multi-hazard	Geological records of pre-historic tsunami and coastal inundation	Cochran, U.A., K.R. Berryman, D.C. Mildenhall, B.W. Hayward, K. Southall, and C.J. Hollis, Towards a record of Holocene tsunami and storms for northern Hawke's Bay, New Zealand. New Zealand Journal of Geology and Geophysics, 2005. 48(3): p. 507-515
	Logging effects on stream biota	Death, R. G., B. Baillie, et al. (2003). "Effect of Pinus radiata logging on stream invertebrate communities in Hawke's bay, New Zealand." New Zealand Journal of Marine and Freshwater Research 37(3): 507-520.
	Hazardous substances	ERMA. 2009. Hazardous Substances and New Organisms: Compliance and Enforcement. Report on activities for the year ended 30 June 2009 and intentions for the year ending 30 June 2010
	Climate change	Fowler, A.M., Aiken, S., Maree, K. Vulnerability of pastoral farming in Hawke's Bay to future climate change: Development of a pre-screening (bottom-up) methodology. 2013. New Zealand Geographer 69(2) 120-135
	Multi-hazard probability assessment	Johnston, D., J. Becker, and W. Smith, A review of natural hazard probability in the Hawke's Bay and Gisborne regions. Vol. 2001/04. 2001. 29 p.
	Hazards management; policy and planning	Johnston, D.M. and L.J. Pearse, Natural hazards in Hawke's Bay. Vol. AM99/03. 1999, Napier, N.Z.: Hawke's Bay Regional Council. 44 p.
	Coastal uplift and erosion	Litchfield, N.J., K.R. Berryman, J.L. Hoverd, and U.A. Cochran, Holocene coastal uplift and erosion in western Hawke Bay : evidence from fluvial terraces, in Geological Society of New Zealand / New Zealand Geophysical Society. Joint Conference (2006 : Massey University). 2006. p. 44-45.
	Fluvial uplift and response to coastal changes	Litchfield, N.J., K.R. Berryman, U.A. Cochran, and K.J. Wilson, Fluvial response to post-glacial sea level rise and coastal erosion in a tectonically uplifting setting, eastern North Island, New Zealand, in International Union for Quaternary Research. Congress (17th : 2007 : Cairns, Qld). 2007. p. 245 (abstract 0576)
	Hazardous substances facilities	Brendan Morris Consulting Limited. 2009. Hawke’s Bay High Risk Hazardous Substances Facilities. Report prepared for Hawke’s Bay Regional Council

Hazard	Description of Data	Reference
	Hazard information management	Brendan Morris Consulting Limited. 2012. Management of hazard information in the Hawke's Bay region. Report prepared for Hawke's Bay Regional Council.
	Mapping	Townsend, D.B.; Bland, K.J.; Lee, J.M.; Browne, G.H.; Begg, J.G.; Kamp, P.J.J. 2009 The QMAP 1:250,000 geological map of the Hawke's Bay area : new features and updates. p. 212 IN: Barrell, D.J.A.; Tulloch, A.J. (eds) *Geological Society of New Zealand & New Zealand Geophysical Society Joint Annual Conference, Oamaru, 23-27 November 2009 : programme and abstracts.* Wellington: Geological Society of New Zealand. *Geological Society of New Zealand miscellaneous publication 128A.*
	RiskScape	Schmidt, J., I. Matcham, et al. (2011). "Quantitative multi-risk analysis for natural hazards: a framework for multi-risk modelling." Natural Hazards 58(3): 1169-1192.
	Natural hazard investigations	Van Voorthuysen, R. (1994). Natural hazard investigations in Hawkes Bay. Natural Hazards Management Workshop (1994 : Wellington, NZ): 75-78.
	Natural disturbance in lowland podocarp	Wilmshurst, J. M., M. S. McGlone, et al. 1997. "A late Holocene history of natural disturbance in lowland podocarp/hardwood forest, Hawke's Bay, New Zealand." New Zealand Journal of Botany 35(1): 79-96.
	Hazard and risk	Wright, K.C.; Johnston, D.M.; Dellow, G.D. 2010 Hazard and risk in the Hawke's Bay : an update of the 2001 assessment. Lower Hutt: GNS Science. *GNS Science report 2010/06.* 42 p.
Planning and resilience	Improving resilience	Becker, J.S.; McBride, S.K.; Paton, D. 2013 Improving community resilience in the Hawke's Bay : a review of resilience research, and current public education, communication and resilience strategies. Lower Hutt: GNS Science. *GNS Science report 2012/38.* 72 p. [March 2013]
	Urban capability assessment	Eyies, G. O., J. H. Lawrence, et al. 1980. Hawke's Bay area planning study : urban capability assessment. Water and soil miscellaneous publication. 17.
	Engineering lifelines risk	Hawke's Bay Engineering Lifelines Steering Committee. 2001. HBRC Plan 3065
	CDEM	Hawke's Bay and Gisborne Civil Defence Emergency Management Hazards Research Review Workshop.29 May 2014
	Disaster Risk Reduction	Hill, M. and Gaillard, J.C. 2013. "Integrating disaster risk reduction into post-disaster reconstruction: A long-term perspective of the 1931 earthquake in Napier, New Zealand." New Zealand Geographer 69(2): 108-119.
	Natural hazards probability	Johnston, D.M.; Becker, J.S.; Smith, W.D. 2001. A review of natural hazard probability in the Hawke's Bay and Gisborne regions. *Institute of Geological & Nuclear Sciences client report 2001/04.* 29 p.

Hazard	Description of Data	Reference
	Sustainability	LeHeron, R. and Roche, M. 1996. "Globalization, sustainability, and apple orcharding, Hawke's Bay, New Zealand." Economic Geography 72(4): 416-432.
	Hazards management; policy and planning	Pearse, L., Johnston, D.M., and Becker, J. 2001. Managing natural hazards in the Hawke's Bay, New Zealand. Australian Journal of Emergency Management, 16(3): p. 37-39.
	Community resilience to earthquake hazard	Ronan, K.R., Johnston, D.M., and Paton, D. 2001. Communities' understanding of earthquake risk in the Hawke's Bay and Manawatu-Wanganui regions, New Zealand. 2001. p. 9 p.
	Regional policy statements TA plans and CDEM Group plans analysis	Saunders, W.S.A.; Beban, J.G.; Coomer, M.A. 2014. Analysis of natural hazard provisions in regional policy statements, territorial authority plans, and CDEM Group Plans, *GNS Science Report* 2014/28. 70 p.
	Community preparedness and tsunami hazard	Webb, T.H., Review of New Zealand's preparedness for tsunami hazard, comparison to risk and recommendations for treatment. Vol. Institute of Geological and Nuclear Sciences client report 2005/162. 104 p., appendices.

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A2.0 APPENDIX 2: HAWKE'S BAY CDEM GROUP HAZARD PRIORITIES

Description of hazards	Priority
Earthquake (includes liquefaction)	
Human pandemic / infectious diseases	
Flooding / heavy rainfall	
Fire involving hazardous substances	1
Electricity failure	
Pests or diseases affecting agriculture, forestry, or horticultural	
Local Tsunami	
Rural Wildfire	
Hazardous chemical incident (release of fumes)	
Coastal erosion	
Drought:- impacts on horticultural production	
Environmental pollution over unconfined aquifer	
Fire – urban (multiple)	
Hazardous chemical incident:- Spillage (including transport accident)	
Volcanic ash fall	2
Drought: - impacts on agricultural production	
Dam failure	
Snow storm	
Environmental pollution into waterway	
Engineering Lifelines utility failure: - Fresh water	
Telecommunications failure	
Serious soil erosion/landslide	
Coastal storm swell	
Hail strike	
Strong winds or Tornado	
Impact from space debris, meteorites, comets	
Water reservoir failure	
Sea level rise	
Distant Tsunami	
Computer systems failure	3
Gas utility failure	
Major air transport accident	
Waste water and sewage utility failure	
Major sea transport accident (including oil spill)	
Major road transport accident	
Soil Subsidence	

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A3.0 APPENDIX 3: SUMMARY OF THE 10 YEAR HAZARDS RESEARCH PLAN COMPLETED IN 2008

Showing projects proposed in November 2008 and projects completed to 2014.

	Projects	2008 Priority	Year Proposed	Completed work Uncompleted work (shaded in blue)
1	Creation of a HB hazardous substances database	High	2008/09**	Hawke's Bay High Risk Hazardous Substances Facilities Report December 2009 Brendan Morris Consulting Ltd. Copied to MfE, ERMA & MCDEM
2	Quantify risks from hazard events of different magnitude- initial liaison with lifeline utilities regarding RiskScape and inventory data	High	2008/09	Prototype provided June 2009 and user workshop hosted 13 May 2010. Requirement to collect lifeline data.
3	Sea-level rise projections and seismic land movement – feasibility investigation	High	2008/09	Sea level rise projections adjusted for vertical tectonic land movement along the Hawke's Bay coastline. June 2009. GNS Science Report 2009/128
4	Hawke's Bay regional hazards planning group – engage with existing regional forum on hazards issues	High	2008/09**	The HB/East Coast Planners Group and HB Planners Forum, as HB inter-council planning groups now annually discusses hazard planning issues.
5	Incorporating high consequence, low probability events into planning including update of Johnston et al (2001) report	High	2009/10 ongoing	Hazard and Risk in the Hawke's Bay; an update of the 2011 Assessment. June 2010. GNS Science Report 2010/06. This feed into the review of the Group Plan and its SMUG analysis. A 'Risk based tool for land use planning for natural hazards" was supported by HB and published by GNS Science in September 2013. GNS MS 67 www.gns.cri.nz/Home/RBP/Risk-based-planning/A-toolbox
6	Implementation of hazard information into planning	High	2009/10**	Hawke's Bay Joint Hazard Strategy for Local Authority Land Use Planning May 2011 Brendan Morris Consulting Ltd. and Implementation Plan August 2012, Opus. HBRC Plan 4397
7	Hazard information acquisition, storage and access – framework established	High	2009/10	Management of hazard information in the Hawke's Bay region, November 2012. Brendan Morris Consulting Ltd

	Projects	2008 Priority	Year Proposed	Completed work Uncompleted work (shaded in blue)
8	Fault trace mapping for Napier Wairoa area	High	2009/10	Fault Avoidance Zone Mapping for Wairoa District, Napier City and surrounds. May 2011 GNS Science. Active Fault Mapping & Fault Avoidance Zones for Central HB District. 2013 update. January 2014. GNS Science Report 2013/151
9	Sea-level rise projections and seismic land movement	High	2010/11	Global Climate Change and Barrier Responses Report, December 2013 Paul Komar. (Linked to 3) Network of GPS units to measure ongoing vertical ground deformation. Compare ground evaluation data with measured sea level gauge data to determine calibrated sea level rise projections.
10	Scientific information transfer system.	High	2010/11	*Implement a system for the transfer of information from the scientific community to end-users.* *Lead: GNS/NIWA*
11	Hazard information acquisition, storage and access – effective hazard and risk communication to HBRC staff	High	2010/11	*Determine all sources of natural hazard information held by Councils (PIMs, LIMs, GIS, event reports, resource database, planning maps, research reports. Create database (GIS based) that all can access.* *Lead: HBRC*
12	Tsunami inundation mapping – review latest modelling	High	2011/12	Tsunami Inundation Mapping Clifton, Te Awanga, & Haumoana 2010. HBRC Tsunami Inundation Mapping Wairoa, Napier and Hastings north of Cape Kidnappers. 2011/12. HBRC
13	Hazards and consequences modelling – primarily through RiskScape programme	High/Med	2011/12**	*To be conducted over several years. Stage 1: collect quality data particularly inventory/asset data. Lead: GNS/NIWA*
14	Create a system for geotechnical properties collection	Med/High	2012/13	Joint Project to review liquefaction risks and establish geotechnical database for HB commissioned June 2013. Project partners HBCDEM Group, Natural Hazards Research Platform, GNS, EQC, HDC & NCC. Work to be completed 2015.

	Projects	2008 Priority	Year Proposed	Completed work Uncompleted work (shaded in blue)
15	Overview of local source tsunami risk	Med/High	2012/13	Review of Tsunami Hazard in New Zealand (2013 Update) GNS Science Report 2013/131. Commissioned by MCDEM. www.civildefence.govt.nz/memwebsite.nsf/wpg_URL/For-the-CDEM-Sector-Publications-Review-of-Tsunami-Hazard-in-New-Zealand?OpenDocument
16	Geological properties of HB geological units updated	Med/High	2013/14	*Update ground shaking hazard maps for Hawke's Bay using geotechnical data collected* *Lead: GNS*
17	Landslide data collection system for national database	Medium	2013/14	*Maintain and improve landslide data collection by training regional staff to collect landslide information as part of regular duties to add to national database. The national landslide database catalogue needs to be available on-line for end users.* *Lead: GNS/HBRC*
18	Hazard information acquisition, storage and access – effective hazard and risk communication to HBRC public	Medium	2014/15	*Review effective hazard and risk communication to HB public. Surveys and focus groups of community members to determine what hazard information is required and how it is best delivered.* *Lead HB CDEM Group*
19	Wave inundation forecasting	Medium	2015/16	*Wave run-up and overtopping on gravel beaches needs to be better understood. Improved methodologies using short deployments of NIWA's mobile Camera system. Run-up would be linked to wave model forecasts. Lead: NIWA/HBRC*
20	Assess joint occurrence of high sea levels and high river flows	Medium/Low	2016/17	*Understanding the correlations between multiple hazards drivers in coastal and estuarine flooding. May benefit from a new 3-year project to develop a 40 year storm surge climate around the NZ coast.* *Lead: NIWA*
21	Establish tephra database	Medium/Low	2016/17	*Construct a tephra database to collect information on occurrences and thicknesses and to record geochemical characteristics of different tephra. Lead: GNS*

	Projects	2008 Priority	Year Proposed	Completed work Uncompleted work (shaded in blue)
22	Tephra fall magnitude frequency refined	Low	2017/18	*Refine the tephra-fall magnitude/frequency relationship based on the tephra isopach database. (NB: Tephra fall related research is a lower priority in HB as there is sufficient national studies to inform planning for tephra hazards)*
23	Extension of the severe weather database	Low	2017/18**	Augment and integrate information on historic sea weather events for HB from NIWA national weather event database. Undertake spatial and temporal analysis of past events providing context of weather related risk analysis and an educational resource. *Lead: NIWA* 'The Climate and Weather of Hawke's Bay' May 2014 PR Chappell NIWA provides a standard guide to patterns of rainfall, temperature, sunshine, etc. for HB.

A4.0 APPENDIX 4: SUMMARY OF NATIONAL AND INTERNATIONAL HIKURANGI MARGIN RESEARCH (AS OF END-2014)

This table was prepared by GNS Science staff to help understand what work was being undertaken around the Hikurangi Margin and by whom, to allow coordination of future science work programmes.

Key for "Focus"

1. Understanding the physical processes controlling short- and long-term deformation at the Hikurangi subduction zone
2. Understanding where and how often earthquakes occur
3. Understanding the role of slow slip vs. seismic slip in the accommodation of plate motion
4. Improved knowledge of the primary and secondary hazards that subduction earthquakes generate (e.g., ground shaking, liquefaction, tsunami).
5. Impacts and consequences for society.

Title	Agency	Institution	Lead PI	Status	Planned	Comment	Focus
IODP Proposals							
Multiphase Drilling Project: Unlocking the secrets of slow slip by drilling at the northern Hikurangi subduction margin, New Zealand	IODP	UTIG	L. Wallace	This is the umbrella proposal for 781A and 781B			1, 2, 3
Unlocking the secrets of slow slip by drilling at the northern Hikurangi subduction margin, New Zealand	IODP	Penn State	D. Saffer	Rated "excellent" by IODP proposal eval. Panel, and is awaiting scheduling	2016-2018	Riserless Drill Ship Proposal to drill 7 holes offshore Gisborne	1, 2, 3
Unlocking the secrets of slow slip by drilling at the northern Hikurangi subduction margin, New Zealand: Riser drilling to intersect the plate interface	IODP	UTIG	L Wallace	Rate "excellent" by IODP proposal eval. Panel but awaits additional site survey data	2020-2025	Riser Drill Ship Proposal to drill ~6km to plate interface	1, 2, 3

Title	Agency	Institution	Lead PI	Status	Planned	Comment	Focus
Creeping Gas Hydrate Slides: Slow Deformation of Submarine Landslides on the Hikurangi Margin	IODP	University of Auckland	I Pecher	Submitted	2016-2018	Ancillary Riserless Drill Ship Proposal to 781A-FULL	1, 4, 5
United States							
HOBITSS: Hikurangi Ocean Bottom Investigation of Tremor and Slow Slip	NSF	UTIG	L. Wallace	Funded	2014-2016	Marine deployment of seafloor observatory: complimentary science to IODP 781A-FULL	1, 2, 3, 4
Unlocking the secrets of slow slip at the Northern Hikurangi Subduction margin, New Zealand: CORK observatory development and installation	NSF	UTIG	L. Wallace	submitted	2016-2018	Borehole observery: complimentary science to IODP proposals	1, 2, 3, 4
The Thermal Regime of the Hikurangi Subduction Zone and Shallow Slow Slip Events, New Zealand.	NSF	Oregon State University	R. Harris	submitted	2015	Marine seafloor observations and seismic surveys: complimentary science to IODP 781A-Full	1, 2, 3
A community 3D seismic investigation of fault property controls on slow-slip along the Hikurangi megathrust	NSF	UTIG	N. Bangs	submitted	2016-2018	Complimentary science to IODP 781A-Full and 781B-FULL	1, 3
Controls on along-strike variations in locked and creeping megathrust behavior at the Hikurangi convergent margin: SHIRE (includes Hikurangi earthquakes and tsunami records: onshore-offshore)	NSF	UTIG, Rutgers University	K. McIntosh, J. Pilarczyk	submitted		Marine and land geophysical surveys: complimentary science to IODP 781A-Full and 781B-FULL	1, 2, 3, 4, 5

Title	Agency	Institution	Lead PI	Status	Planned	Comment	Focus
German							
SlamZ -Slide activity on the Hikurangi margin, New Zealand	BMBF	Univ of Bremmen	K. Kuhn	Funded	2015	Marine MeBo shallow drilling related to IODP 841-APL	1, 4, 5
Past, Present, Future Fluid Flow at the Hikurangi Margin; New Zealand	BMBF	GEOMAR	J. Greinert	submitted	2016-2018	Marine MeBo shallow drilling	1, 4, 5
Capturing and comparing slow slip events in Cascadia and New Zealand using a novel, physics-based approach	NSF	UTIG	L. Wallace	Funded			1,3
New Zealand							
Subductions Slippery Slope	Marsden	GNS Science	S. Henrys	Funded	2009-2013	Recently completed with published results	1, 2, 3
How do tectonic plates lock together?	Marsden	GNS Science	M. Reyners	Completed	2009-2013	Recently completed, with published results	1, 2, 4
Uncorking the Hydrate Bottle	Marsden	University of Auckland	I. Pecher	Funded	2010-2014		1, 4, 5
Sticky or Creepy? What causes abrupt variations in seismic behavior along subduction margins	Marsden	GNS Science	S. Ellis	Funded	2013-2016	Testing the idea that fluid pressure variations along the subduction margin control sticking vs. creeping behaviour, by combining estimates for fluid sources and sinks with rock mechanics in a coupled fluid-mechanical model	1, 2, 3
Capturing the gurgling and chatter from slow slip deformation: Unlocking the role of fluids with magnetotellurics and seismology.	Marsden	GNS Science	S. Bannister and G. Caldwell	Funded	2012-2015	Onshore broadband seismic array and broadband MT array, targeting shallow tremor and LFEs associated with SSEs, recording since Nov 2011.	1, 2, 3, 4
Does the southern edge of the	Marsden	GNS	M. Reyners	Funded	2013-2016	Seismic tomography of southern	1

Title	Agency	Institution	Lead PI	Status	Planned	Comment	Focus
Hikurangi Plateau control Otago tectonics?		Science				Canterbury-Otago region	
Harnessing New Zealand Gas Hydrate Resources	MBIE	GNS Science	I. Pecher	Funded	2012-2018		1, 4, 5
TSZ Seismology – (seismic tomography, earthquake relocations, seismic tremor)	GNS CORE	GNS Science	M. Reyners	Funded	2011-2020	Detailed seismic tomography studies of the Hikurangi subduction zone, with tectonic interpretation	1
GHZ Seismology – rupture and attenuation	GNS CORE	GNS Science	S. Bannister	Funded	2011-2020	Earthquake rupture scenario modeling ; ground motion prediction, rupture kinematic and dynamic modeling ; attenuation model development ; earthquake source studies of large subduction events	2, 3, 4, 5
TSZ Subduction earthquake geology	GNS CORE	GNS Science	U. Cochran	Funded	2011-2020	Earthquake geology to obtain timing and locations of past Hikurangi subduction earthquakes and tsunami	1, 2, 3, 4, 5
TSZ Subduction Locking	GNS CORE	GNS Science	S. Ellis	Funded	2011-2020		1, 2, 3, 4, 5
TSZ Subduction MT Studies	GNS CORE	GNS Science	G. Caldwell	Funded	2011-2020		1, 3
EEZ Offshore Pate Boundary Structure	GNS CORE	GNS Science	S. Henrys	Funded	2011-2020		1, 2, 3, 4, 5
OBP/APG processing approaches	GNS SDF	GNS Science	B. Fry	Funded	2013 only		2, 3, 4
Slow-rupture earthquakes	GNS SDF	GNS Science	C. Mueller	Funded	2013 only	Examining classification of slow-rupture tsunamigenic events	2,3,4,5
GHZ Tsunami Hazard	GNS CORE	GNS Science	W. Power	Funded	2011-2020	Including: subduction zone tsunami source models; 1947 tsunamigenic	2, 4, 5

Title	Agency	Institution	Lead PI	Status	Planned	Comment	Focus
						earthquakes; geological characterisation of paleotsunami deposits on the Hikurangi Margin	
Wairarapa Fault investigations	GNS CORE & EQC	GNS Science	P. Villamor	Funded		Estimation of slip rates and paleoearthquake history of the Wairarapa Fault - has it always ruptured together with the subduction zone?	1, 4
Geothermal - Fault analysis project	GNS CORE	GNS Science	P. Villamor	Planning		Volcano-tectonic interactions: what is the influence of the subduction zone earthquake in the volcanism in the volcanic arc?	1
"It's Our Fault" – defining earthquake risk in Wellington	GNS Applied	GNS Science	K. Clark	Funded	2012-14	Timing of recent rupture: earthquake geology investigations	1, 4
Gisborne seismic and tsunami hazard: constraints from marine terraces at Puatai Beach	EQC	GNS Science	N. Litchfield	submitted	2014-16	Trenching Hikurangi marine terraces for evidence of paleoearthquakes and paleotsunami	1, 2, 3, 4, 5
Great Megathrust earthquake hazard in New Zealand	NHRP	Geomarine Research	B. Hayward	Funded	2013-14	Assessing evidence for a margin-wide subduction earthquake ~600 years BP	1, 2, 3, 4, 5
Earthquake histories from Hikurangi turbidite sequences		NIWA	P. Barnes	Planning			1, 2, 3, 4, 5
Social Science Project 1: Policy and Planning	GNS CORE	GNS Science	W. Saunders	Funded		Research explores how to improve the preparation and implementation of plans and policies addressing tsunami hazards within district, regional and central government (eg. District, Regional and CDEM plans etc).	5
Social Science Project 2: Community Resilience	GNS CORE	GNS Science	D. Johnston	Funded		Research explores resilient attributes and indicators at individual, community and	5

Title	Agency	Institution	Lead PI	Status	Planned	Comment	Focus
						societal levels, the role of formal and informal social networks, community engagement, empowerment, and strategies for motivating and sustaining community participation in at-risk communities. The role of education in schools and community groups in preparing for hazard events is also a focus. New phase of work on iwi-based EM planning.	
Social Science Project 3: Effective warnings and emergency management	GNS CORE	GNS Science	G. Leonard	Funded		Research on societal perceptions of hazards and warning messages, and develop strategies that motivate and maintain appropriate social responses. These studies focus on emergency management training the role of exercising in EoCs for building effective capacity and capability. Research also has evaluated the effectiveness of emergency management response to recent events, with respect to community response needs, organisational effectiveness and the monitoring and evaluation process.	5
Japan							
Hikurangi slow slip monitoring and modeling	JSPS	DPRI, Kyoto Univ.	Y. Ito	submitted	2014-2018	Related to slow slip drilling project and HOBBITSS	1,2,3

A5.0 APPENDIX 5: AGENDA FOR WORKSHOP

INVITATION

Thursday, 29 May 2014

Please join the Hawke's Bay and Gisborne Civil Defence Emergency Management Groups at the

Hazards Research Review Workshop

held at the Hawke's Bay Regional Council Chambers, 159 Dalton Street, Napier.

Considerable research has been undertaken into some hazards and risk topics on the East Coast, while other topics have been addressed to a lesser degree due to either lack of data or technology, lower priorities, or budget constraints. Following the completion of its CDEM Group Plan, Hawke's Bay is reviewing its 10-year hazard research plan, which provides opportunities to evaluate international research initiatives in our region and consider opportunities for collaborative research with scientists and our neighbouring Gisborne Group. A two-part workshop will be hosted.

Program

9.30 am Morning Coffee

Part One: Joint with HB CDEM & Gisborne CDEM Groups

10.00 Start (Introduction, outline of workshop, introductions)

10.20 Natural Hazards research in NZ and Internationally (David Johnston, Professor of Disaster Management Massey/GNS & Dr Richard Smith, Manager- Research & Education EQC)

11.00 Subduction plate boundary zone research (Ursula Cochran, Paleoecologist /Earthquake Geologist, GNS Science)

11.20 It's Our Fault – the successful Wellington regional branded study – how it was done (Russ Van Dissen, Earthquake Geologist GNS Science)

11.40 Weather and coastal research (Rob Bell, Principal Scientist - Coastal and Estuarine Physical Processes, NIWA)

12.00 Fire, Technological and Hazardous Substances. (TBC)

12.15 Workshop discussion: Opportunities which might be leveraged from the international and national work, some of it collaborative, including the concept of a East Coast regional branded study e.g. "East Coast LAB (Life at the Boundary)".

1.00 Lunch

Part Two: HB CDEM Group representatives (including planning, regulatory, hazards and emergency management)

1.30 Hazards Research Plan Discussion

a. Recent and current Hawke's Bay hazards research;
b. Priorities for future hazards research in the Hawke's Bay
c. Revision of 10-year plan including projects, priorities and timelines.

4.30 Finish of workshop. *Thereafter a report will be produced by October 2014 which summarises the findings of the review and workshop, and presents an updated 10-year plan for Hawke's Bay Hazards research.*

A6.0 APPENDIX 6: SUMMARY OF THE 10 YEAR HAZARDS RESEARCH PLAN COMPLETED IN 2014

2014 Ranking	Projects in progress (from 2008) plan	Priority*	Year/s project will be undertaken	Prior Project No. Reference 2008 (Appx 3)
1	Review liquefaction risk and establish geotechnical database.	In progress	2013-15	14
2	Hazard information acquisition, storage and access, via a GIS portal.	In progress	2014-15	11
3	Fault-line mapping review work - Hastings and Wairoa.	In progress	2015-17	-
4	Re-assess the locations, rates and role of earthquake fault sources in the National Seismic Hazard Model for Hawke's Bay.	In progress	2015-17	-

2014 Ranking	Ranked future projects	Workshop Priority	Year/s project will be undertaken	Prior Project No. Reference 2008 (Appx 3)
5	RiskScape hazards and impacts/consequences modelling –focus on earthquake and tsunami.	High (3)	2015-2019	13
6	Flood mitigation and warning for Wairoa, including developing a Draft Action Plan that considers flood impacts, consequences, and agency roles and responsibilities.	-	2015-16	-
7	Review of effective hazard and risk communication to Hawke's Bay public, via surveys and focus groups.	High (2)	2015-16	18
8	Develop and update earthquake ground motion model for Hawke's Bay, based on the National Seismic Hazard Model.	Med/ High(1)	2014-15	16
9	An update of earthquake ground shaking behaviours, presented as loading code soil types on maps.	-	2016-17	-
10	Identify vertical land deformation from a subduction plate boundary earthquake event (i.e., identify potential areas in Hawke's Bay that may experience subsidence, versus those that may experience uplift).	-	2018-19	-
11	Develop a regional-level assessment tool to assess the level of risk to life property and businesses from rockfall and cliff collapse hazards.	**-**	2019-20	**--**
12	Further assess past tsunami frequency, using the record of past large earthquakes from Ahuriri Lagoon, Napier to better determine future estimates for Hawke's Bay tsunami hazard.	Medium(1)	2019-20	-

2014 Ranking	Ranked future projects	Workshop Priority	Year/s project will be undertaken	Prior Project No. Reference 2008 (Appx 3)
13	Research the re-mobilisation of volcanic ash post-eruption, which includes the impacts of depositing ash into river and stream catchments.	High(1)	202-/21	-
14	Investigate climate change implications for other hazards (50 years) – including extreme weather events, coastal hazards, and tsunami.	Med(2)/ High(1)	2021-22	-
15	Undertake wave inundation forecasting (to feed into the proposed Coastal Strategy) in light of the predicted impacts of climate change. Includes understanding the correlations between multiple hazards drivers in coastal and estuarine flooding.	Med(2)/ High(1)	2022-23	20
16	Assess joint occurrence of high sea levels and high river flows at the river sea interface – interactions and hazards posed (esp. for Wairoa).	Med(1)/ High(1)	2023-24	19
17	Undertake 'loss modelling' of coastal hazards and support of NIWA core research on probabilistic approaches to predicting future coastal erosion (including climate change) for both sandy and gravel coastlines.	-	2023-24	-
18	Undertake research to better understand river-coastal transitions systems. This may include joint AEP combined water levels and morphological modelling, connecting river sediment to coast, and understanding the connection with hazards impacts.	-	2024-25	-
19	Undertake further research on maximum credible weather events for wind. Update and assess the wind gusts for Hawke's Bay climate and identify whether wind strengths have changed – updating AEP values for different wind quadrants.	Medium (1)	2024-25	-
20	Update Hawke's Bay severe weather database to understand hazardscape from past events. Undertake spatial and temporal analysis of past events providing context of weather related risk analysis. Produce educational materials to raise awareness and contribute to CDEM exercise scenarios.	Low	2025-26	23
21	Develop managed retreat scenarios. Research conducted into the viability and implementation of managed coastal retreat in the Hawke's Bay. Could a recovery plan include strategies for how retreat might be managed after a major storm or tsunami event?	Low(1)	2025-26	10a

* "High", "Medium", "Low" priority refers to the workshop prioritisations that were assigned. The rank order was then decided upon based on the workshop prioritisation and post-workshop feedback.

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