User Requirements of RiskScape 2.0 Software and Opportunities for Disaster Risk Research in Aotearoa-New Zealand

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GNS Science Report 2020/10
June 2020

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BIBLIOGRAPHIC REFERENCE

Thomas K-L, Woods RJ, Garlick R, Scheele FR, Coomer MA, Paulik R, Clarke LB. 2020. User requirements of RiskScape 2.0 software and opportunities for disaster risk research in Aotearoa-New Zealand. Lower Hutt (NZ): GNS Science. 83 p. (GNS Science report; 2020/10). doi:10.21420/10.21420/RVDT-8R62.

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ISSN 2350-3424 (online)
ISBN 978-1-99-001030-9 (online)
http://dx.doi.org/10.21420/RVDT-8R62

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ABSTRACT

RiskScape is open-access risk modelling software jointly developed by NIWA and GNS Science, funded through their respective Strategic Science Investments Funds (SSIF) research programmes since 2004. The first versions of the RiskScape software have served as a proof of concept in Aotearoa-New Zealand and the Pacific to demonstrate how risk science can be used through a software tool to effectively model natural hazard losses and quantitively evaluate the benefits of implementing planning and mitigation options.

In early 2017, the RiskScape governance group commissioned an external review of RiskScape. Challenges identified resulted in a programme of work to out-source the re-development of RiskScape's core engine, using open source technologies with a focus on workflow functionality, optimisation and performance enhancements, as well as to build a new RiskScape 2.0 user interface. This provides an opportunity to develop user experiences for RiskScape informed by end-user requirements and needs.

To assess user requirements of a risk modelling tool, an online survey was carried out and workshops were held in the four main centres of Auckland, Wellington, Christchurch and Dunedin. Seventy-six workshop participants and 153 survey respondents from a range of sectors and disciplines shared:

- tools and services currently being used in Aotearoa-New Zealand to undertake risk assessment/modelling
- current challenges and opportunities around current methodologies and tools
- requirements of RiskScape 2.0 functionality and desired risk modelling outputs, and
- requirements of a new user interface.

The results indicated that a range of approaches are taken to assess 'risk' in Aotearoa-New Zealand, but holistic risk-based assessments seem to be seldom undertaken. Data gaps, access and best-practice standards are a major limitation; participants highlighted the need for a central risk data repository and 69% of survey respondents indicated the need for data to be provided with RiskScape in order to operate it. Overall, RiskScape 2.0 will need to be inter-operable, open-access, transparent, intuitive, flexible, collaborative, reliable, expert-supported, secure, open-sourced, fast and visual to cater for differing needs across and within sectors.

Success of the RiskScape software is dependent on the availability of risk data and collaboration across research institutes to fulfil the needs outlined here by the study's participants, as well as the capability of the software to be compatible and support risk modelling methodologies. This report will help guide future development and investment decisions for RiskScape and will be useful for the wider risk community. There remains to be more engagement going forward to further define types of risk analysis (e.g. style of loss curves, etc.) in order to engage wider representation from sectors and from sectors that were under-represented here, including Pacific partners and the wider international community. As participants noted, user input will be integral in designing RiskScape 2.0 to be useful, usable and used. User requirements will change over time, so continued communication is vital.

KEYWORDS

RiskScape, risk tools, end-user engagement, user requirements

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1.0 INTRODUCTION

1.1 Disaster Risk Reduction in Aotearoa-New Zealand

Disaster risk is:

> *"the potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability and capacity … Disaster risk reduction is aimed at preventing new and reducing existing disaster risk and managing residual risk, all of which contribute to strengthening resilience and therefore to the achievement of sustainable development"* (UNDRR 2016).

In March 2015, the Government of Aotearoa-New Zealand made a commitment to the International Sendai Framework for Disaster Risk Reduction, committing also to the Paris Agreement and the achievement of the Sustainable Development Goals. More recently, the New Zealand Treasury has focused on using a Living Standards Framework (LSF) to assess the impact of government policies on the wellbeing of New Zealanders and that contribute to disaster risk reduction (DRR) and positive climate-change mitigation and adaptation initiatives.

Effective DRR in Aotearoa-New Zealand is dependent on the interplay between a range of legislative tools implemented by diverse groups responsible for disaster risk management (DRM) –

> *"the application of disaster risk reduction policies and strategies to prevent new disaster risk, reduce existing disaster risk and manage residual risk, contributing to the strengthening of resilience and reduction of disaster losses."* (UNDRR 2016).

Legislation governing DRR and DRM in Aotearoa-New Zealand includes and is not limited to the following:

- Civil Defence Emergency Management Act 2002 (encompasses the National Disaster Resilience Strategy, National CDEM Plan and CDEM group plans)
- Resource Management Act 1991
- Building Act 2004
- Local Government Official Information and Meetings Act 1987
- Local Government Act 2002
- Soil Conservation and Rivers Control Act 1941 (Willis 2014).

DRM and DRR are also supported by a range of other legislative tools and regulations that contribute to the wellbeing of people and the environment. Specific DRM initiatives, research and resources are implemented by a diverse group of players, including the National Emergency Management Agency (NEMA); the Ministry for the Environment (MfE); the Ministry for Business Innovation & Employment (MBIE); the Department of Conservation (DoC); the Earthquake Commission (EQC); the National Infrastructure Unit (within Treasury); regional councils, territorial authorities; Crown Research Institutes (CRIs); universities; the National Science Challenges, including the Resilience to Nature's Challenges challenge (RNC2); CDEM groups; infrastructure lifelines groups; commercial players, such as insurance companies; re-insurers; and banks (adapted from Willis 2014). Iwi, hapū and Māori

businesses, other businesses, community groups, households and individuals are also vital implementors of DRR and DRM.

Priorities for action to understand risk (Priority 1 of the Sendai Framework) include:

> *"to enhance the development and dissemination of science-based methodologies and tools to record and share disaster losses and relevant disaggregated data and statistics, as well as to strengthen disaster risk modelling, assessment, mapping, monitoring and multi-hazard early warning systems"* (p. 16).

The National Disaster Resilience Strategy's priority of managing risks includes "ensuring everyone has the information and tools they need to make informed decisions about resilience" (p. 27).

1.2 What is RiskScape?

RiskScape is open-access risk modelling software jointly developed by NIWA and GNS Science (GNS), funded through their respective Strategic Science Investments Funds (SSIF) research programmes since 2004. RiskScape provides a generic framework for multi-hazard impact modelling to support DRR and DRM decision making (thus can be applied for natural hazards, climate change and non-natural hazards). It generates information about the risk of impacts from natural hazard events using hazard, exposure and vulnerability data (i.e. risk data). Over the last decade, the NIWA and GNS research programmes, alongside national research programmes (e.g. RNC and QuakeCoRE), university academics and students, have developed a base of research to support RiskScape and contribute to natural hazards impact modelling in Aotearoa-New Zealand (e.g. King et al. 2009; Schmidt et al. 2011; Cousins 2015; Kwok 2016; Deligne et al. 2017; Crawford et al. 2018a, 2018b; Grace et al. 2017; Thomas et al. 2018; Williams 2019; Paulik et al. 2020 and Scheele 2020, among others).

1.2.1 RiskScape Version 1.0.3

Software development for RiskScape began in 2004, with the first release of the software being shared with local government end-users in 2006. RiskScape was designed to perform complex calculations simply and quickly without needing specialist modelling knowledge, enabling users to assess risk to buildings, infrastructure and people (in buildings) from natural hazards and inform evidence-based decision making.[1] The first versions of the RiskScape software have been adopted as a proof of concept in Aotearoa-New Zealand and the Pacific to demonstrate how risk science can be used through a software tool to effectively model natural hazard losses and quantitively evaluate the benefits of implementing land-use planning and mitigation options. Many RiskScape users have shared the outcomes they have experienced in using the first software versions and provided the RiskScape team with valuable feedback around the challenges involved (Crawford et al. 2018a, 2018b).

1 See https://www.youtube.com/watch?v=7YsiDk2dguw

1.2.2 RiskScape 2.0

In early 2017, the RiskScape governance group commissioned an external review of RiskScape 1.0.3. The scope of the review included an assessment of the existing system code and architecture, as well as the composition of the software development team. As a result, some challenges were identified if software development was to continue building on the existing release 1.0.3 of RiskScape. These included:

- The underpinning architecture of the system, which was built using software development principles from around 13 years prior and resulted in data and models being hardcoded into RiskScape.
- The hardcoding of data and models, which added to the complexity of updating the software for future releases.

On consideration of the review findings, the RiskScape governance group approved the decision to cease software development and support for RiskScape 1.0.3 and rebuild the software. The governance group approved a programme of work that out-sourced the development of the RiskScape 2.0 engine, using open-source technologies, to an external software development vendor. The work programme for RiskScape 2.0 includes continuing to develop its core engine, with a focus on workflow functionality, optimisation and performance enhancements, as well as to build a new user interface. This provides an opportunity to develop user experiences for RiskScape informed by end-user requirements and needs.

To support the development of RiskScape, the project has a strategy that was first approved in May 2018. RiskScape's vision is to reduce the impacts of natural hazards through evidence- and risk-based decision making. RiskScape 2.0 is a multi-hazard risk assessment tool built to assist its users in:

- understanding disaster risk [2]
- identifying and understanding risk scenarios (including the components of hazard, exposure, vulnerability and capacity) [3], and
- effectively implementing natural hazards clauses of New Zealand's legislation.[4]

Figure 1.1 Principles of RiskScape.

2 The first priority of the Sendai Framework for Disaster Risk Reduction 2015–2030.

3 To inform decision making – Objective 1 of Chapter 5: Managing Risks in the National Disaster Resilience Strategy.

4 Including Section 6 of the Resource Management Act 1991, Local Government Act 2002, Building Act 2004 and Civil Defence and Emergency Management Act 2002.

RiskScape 2.0's principles (Figure 1.1) will help focus its strategic outcomes: to deliver tools for partners and users to evaluate natural hazard impacts, to assist the New Zealand Government in being more informed on the possible impacts from natural hazards and to help New Zealanders be more resilient to natural hazards though a range of programme activities, including tools and services through the risk modelling software, engagement and training, data and models, as well as applied research.

1.3 Users of RiskScape

DRR and DRM requires an understanding of risk and an interplay of sectors, across disciplines, to implement mitigation measures. RiskScape is a tool to understand risk and evaluate beneficial mitigation options. Therefore, a wide range of users with a variety of risk modelling expertise and experience could benefit from using RiskScape or its outputs. In the original development of RiskScape, training and engagement was targeted toward researchers and local government. RiskScape may also be used by sectors and disciplines such as lifeline and asset management, insurance, policy and planning, engineering and hazard and risk science. It is important to understand their risk modelling needs and how they would like to (or not like to) interact with risk modelling tools and RiskScape 2.0.

Crawford et al. 2018a undertook research to understand motivations, challenges, ethos and need for risk modelling in local government emergency management through focus groups (of between 6–15 people) with five CDEM Groups. Crawford et al. (2018a) found "there is definite interest and engagement in the use of risk modelling from CDEM and other natural hazard risk management practitioners within local government" (p. 615). Three key themes emerged from their analysis:

- 'CDEM within and across councils', which highlighted the complexity of which functions within local government are responsible for addressing the 4 'R's of disaster risk reduction.
- 'Drivers and needs for risk modelling', which identified a range of activities that would benefit from risk modelling: communication to the public and decision makers; real-time event response; exercise development; contingency planning; generic plans, such as land-use and civil defence plans; and policy development, such as Regional Policy Statements. Risk communication and real-time event response were the two most frequently discussed topics. Uncertainty involved in risk modelling, as well as external influences and personal experiences, was also discussed.
- 'Risk data sources and pathways', which highlighted that emergency managers mostly gather data from other sources but raised several challenges around lack of data, knowledge of what data exists, data consistency, cost of data collection management and sharing.

In 2018, a range of user personas were developed by Catalyst IT, GNS and NIWA to guide software development and capture the range of competencies RiskScape end-users may have with risk modelling tools (Appendix 1). Personas were informed based on the experience and assumptions of the RiskScape team. However, further research was required to understand user needs across other sectors/disciplines and user skill levels to refine the personas and inform software development. These user needs include both 'functional' and 'non-functional' requirements for RiskScape 2.0 software. Functional requirements include software capability needs, e.g. reading in specific data formats, whereas non-functional requirements include outside variables required to operate the tool, e.g. availability of risk data.

1.4 Aims and Objectives

The aim of this project was to identify RiskScape user needs across different sectors/disciplines that hold responsibility for or contribute to DRM and DRR in Aotearoa-New Zealand in order to inform RiskScape Governance Group decisions around software capability and user interface development. This information will determine how RiskScape 2.0 could best serve the needs of its users.

The objectives of the project were to:

1. Identify data systems, methods and software applications and platforms that are currently being used to determine natural hazard impacts and risk hazards in Aotearoa-New Zealand.
2. Identify current challenges with using existing risk tools (including previous experiences using RiskScape) and in assessing natural hazard risk and impact.
3. Identify sector/discipline-based (e.g. government, private, non-governmental organisation [NGO], university, emergency management, insurance, lifelines, planning and/or policy) needs and priorities for risk assessment and modelling, including:
    a. What types of analysis and outputs are needed, in what temporal and spatial contexts, and if users have any specific priorities.
    b. How users want to interact with a risk modelling software.
    c. Specific functionality requirements of software.
    d. Specific functionality requirements of a user interface.
4. Evaluate opportunities and areas for future investment in both software development and research to support risk modelling.

2.0 METHODS

The cross-CRI research team, comprised of representatives from GNS Science, NIWA and consultants from Catalyst IT, selected methods from social research and agile software development to capture user needs from a wide variety of users across different sectors, disciplines and geographical reach.

An online survey and six workshops in four regions were used to capture user needs. This section details the engagement and data analysis methods, the team's positionality and influence and the ethical considerations.

2.1 Online Survey

An online survey was developed, with eighteen questions framed around the objectives of this research. It included mostly closed questions, with some open-ended questions.

Several questions were asked to determine which sector/discipline the respondent belonged to, as well as to understand the demographics of survey respondents, including:

- Question 1: Are you completing this survey as a representative from an organisation or as an individual?
- Question 2: Please indicate which category applies best to you/your organisation (sectors).
- Question 16: Which gender do you most identify with?
- Question 17: Which age bracket are you in?

A set of questions were asked to understand what tools and services people and organisations in Aotearoa-New Zealand use to undertake risk assessment and modelling:

- Question 4: Do you currently use software applications to create or assess natural hazard risk information?
- Question 5: If you do use software applications to assess/model risk, what do you currently use?
- Question 6: Please write here which risk tools / scripting language you use.
- Question 7: If you do not use software tools to create or assess natural hazard risk information, why not?

Questions were asked to understand desired risk modelling outputs:

- Question 8: Which risk outputs would you use to carry out your work?
- Question 9: In what context do you need risk outputs?
- Question 10: What scale do you prefer the risk outputs to be in?
- Question 11: What format do you prefer risk outputs in?
- Question 12: How do you currently use risk outputs?
- Question 13: How would you like to interact with a risk tool?
- Question 15: How do you/your organisation want to visualise outputs from RiskScape 2.0?

Other RiskScape-specific questions were asked to inform future branding decisions and functionality for the new user interface, as well as to provide further opportunity for comments and suggestions:

- Question 3: How did you first hear about RiskScape?
- Question 14: What is important to include in the RiskScape 2.0 interface?

The online survey was distributed via the RiskScape newsletter subscription list, the RiskScape website, GNS and NIWA social media accounts (Facebook, Twitter, LinkedIn) and was included as an optional workshop activity and emailed to people who indicated interest in attending the workshop but who could not attend. Therefore, some survey participants were self-selected; others were invited to respond to the survey through the workshop.

2.1.1 Ethical Considerations

The survey was evaluated through GNS ethics procedures and deemed low risk (Appendix 2).

2.1.2 Data Capture and Analysis

Survey data contained in the 153 responses were captured via Survey Monkey. Data was processed using SPSS software and responses were analysed based on their sector (Question 2). Data was graphed using Microsoft Excel.

2.2 Workshops

Workshops were held in Aotearoa-New Zealand's main city centres of Auckland, Wellington, Christchurch and Dunedin to capture more in-depth discussion from a range of targeted professionals. Invitees were identified through RiskScape team member's professional networks, targeted to represent a range of industry sectors and disciplines. Some invitees were asked to snowball the invitation to others, allowing for a maximum capacity of 30 at each workshop. In Wellington and Christchurch, a larger number of participants were identified (due to professional networks in these locations, as well as university departments and risk organisations located in these cities). Therefore, two workshops were held in these locations; these were split into a practitioner workshop and a researcher/science-based workshop to draw out deeper discussion amongst practitioners and scientists alike.

The workshops utilised agile software development methodologies to capture end-user requirements. These methods were considered most appropriate due to their collaborative, flexible and adaptable nature, while seeking to achieve high end-user satisfaction by embracing higher rates of change in software requirements and end-user expectations (Williams 2010; Roden and Williams 2015; Lipmanowicz and McCandless 2014). Workshop activities were guided by principles of liberating structures and practices, which are used in agile development (Derby et al. 2006). These are structures and practices that facilitate effective participation, collaboration and innovation and were refined during the first few workshops. Workshop facilitators were from GNS, NIWA and Catalyst IT; three facilitators were consistent across the workshops.

Following a presentation on RiskScape and the risk modelling framework that underpins the software (Figure 2.1), participants were asked to self-organise into the following disciplines (anticipated based on those who RSVP'd):

- local government emergency management
- planning and policy

- lifeline infrastructure and engineering
- insurance
- researcher (social science, communications, early warning, planners), and
- researcher (risk engineers or hazard/risk science)

Figure 2.1 Workshop participants in Dunedin listening to the presentation on RiskScape.

2.2.1 Activity One: Risk Scene Setting

The purpose of this exercise was three-fold:

1. To break the ice and get people into workshop mode by participating in and completing an activity, as well as for the participants to determine for themselves if this workshop was for them (participants were free to leave at any stage of the workshop).
2. For facilitators to gauge the level of knowledge and experience in the room regarding risk modelling and RiskScape so as appropriately tailor engagement with the different audiences.
3. To determine what risk tools/methods sectors were using, current challenges and future research priorities to achieve objectives 1–4.

Participants were asked to think about what they currently use / how they currently undertake risk assessment and risk modelling; what was working well; any challenges; and what research, tools or investment they would like to see in the future. These four aspects were written on flipchart paper as a quadrant (Appendix 4). Using sticky notes, participants were given five minutes to individually write their ideas and encouraged not to discuss them with peers at their table (Figure 2.2). This facilitation technique aimed to encourage active participation and ensure power relationships had less influence over what comments were written.

Participants were then asked to share their points with the group, one at a time, and place them on the quadrant. This ensured discussion stayed on topic and allowed all voices to be heard. Participants were asked to organise/theme their points (place similar ones together). Then participants were given three sticky notes each to vote on which items were very important to them. Finally, the participants were asked to analyse what they had in front of them and to summarise the sticky notes in three points to share back with the rest of the group. Setting a limit of three required the participants to work together to come to a consensus about what was important and provided insight into the prioritisation of these items. Feeding back to the other groups allowed both the facilitators and potentially the participants to better understand each other's priorities.

Following the first session debrief, the facilitators determined that participants were conflating views on risk modelling generally and RiskScape (Version 1.0.3). For subsequent workshops, we provided two quadrants – one for RiskScape specific feedback and one for risk assessment and modelling in general.

Figure 2.2 Workshop participants in Wellington undertaking Activity 1.

2.2.2 Activity Two: User Interface Prototype Testing

This activity began with a presentation on the re-development of RiskScape and the current state of RiskScape 2.0, highlighting the difference between the old and new version. The presentation gave a high-level overview of basic functionality using a hypothetical example. The hypothetical example (a kaiju/monster attack) allowed the facilitators to present the functionality without:

a. initiating off-topic discussion about scientific details of the hazard or scenario used, or

b. generating assumptions that it can only model one specific hazard, instead demonstrating flexibility in modelling any type of peril, if the underlying hazard data and vulnerability functions exist and can be made available to the system.

Following the presentation, participants were asked to try and navigate a draft, static prototype of a user interface for RiskScape, user testing designed by Catalyst IT (Figure 2.3). Static prototypes are called wire-frames, a low-fidelity layout of an application interface. Wire-frames show the key elements on various screens of an interface and how the elements relate to each other in terms of priority and hierarchy on the page rather than showing a complete visual design. By stripping the visual design elements of colour, shape and formatting from the design, wire-frames can be developed, and also revised, quickly.

The Chalkmark [5] online 'first click' testing tool was recommended by Catalyst IT for this type of testing. Participants were given a scenario and asked to navigate the screen and click buttons to achieve a task. During this exercise, the Chalkmark software records the participants response including timing and location of their clicks/navigation. This is used to produce
hot spot maps to indicate whether the design was intuitive. Chalkmark also has the capacity to design a survey to collect information about the user tester. Users were asked:

- what their role was;
- their requirements of a software tool like RiskScape;
- what tools they were already comfortable using, whether they would interact with the tool themselves and how often their organisation would use RiskScape;

5 https://www.optimalworkshop.com/chalkmark/

- their specific preferences for data preview formats, post-data analysis and data storage; and
- to review the wire-frames and tasks they were asked to undertake (see Appendix 5 for more detail).

These questions helped to provide more information on participant's responses and distinguish between direct users (analysts/researchers interacting with the software) and indirect users (e.g. managers who make decisions based on the results).

Participants then gathered in their sector-based groups to evaluate what they liked and disliked about the draft interface, ranking these from 1 (disliked) to 5 (liked).

Figure 2.3 Workshop participants in Christchurch undertaking Activity 2.

2.2.3 Ethical Considerations

The workshops were evaluated through GNS ethics procedures and deemed low risk (Appendix 2).

2.2.3.1 Research Team Positionality

Researcher positionality and bias has influence on engagement, qualitative data capture and analysis and reporting. This research team consisted of interdisciplinary scientists and software development specialists from three institutions: GNS Science, NIWA and Catalyst IT. GNS Science and NIWA researchers specialise in DRR and DRM and have a range of backgrounds, some having worked for emergency management and in local and central government sectors in relation to planning and policy processes. Most of the team are actively involved in the development of RiskScape 2.0.

The positionality of the researchers influenced the participant's engagement with the facilitators during the workshops and also the interpretation of results. To reduce bias, the data analysis was shared with the wider RiskScape team (including researchers who had not contributed to this research and non-researchers, such as communications advisors) for review.

2.2.4 Data Capture and Analysis

Qualitative data captured via sticky notes and flip chart paper from the workshop activities 1 and 2 were transcribed; coded by workshop, location and sector; and analysed for key themes in Microsoft Excel. These themes were then visualised using word-clouds or summaries. Quantitative data collected during Activity 2 was captured and analysed by Chalkmark software.

3.0 RESULTS

153 people responded to the survey from a range of disciplines and demographics (Figure 3.1; Appendix 3). Seventy-six people attended the workshops.

Figure 3.1 Disciplines that participated in the survey (left) derived from Question 2, and those that participated in the workshops / user interface testing (right) based on those who participated in the Chalkmark activity. 'Other' included agencies such as GeoNet and Central Government but with an undefined discipline.

The results of both the workshop and survey data are presented together. The workshop data provided insight at a high level of how different sectors and disciplines in Aotearoa-New Zealand assess risk or contribute to risk analysis (probability x consequence) and their current challenges and opportunities, as well as what the participants would like to see in a risk tool user interface. The survey questions then supplemented this information with greater detail regarding their preferred interaction with risk tools, their functionality and output requirements.

Firstly, the results are presented generically across all workshop participants to evaluate the current risk modelling situation and user needs of RiskScape across sectors and disciplines in Aotearoa-New Zealand. Then we provide summaries for specific disciplines that participated in the workshops or responded to the survey.

3.1 Risk Assessment and Modelling in Aotearoa-New Zealand

Activity 1 of the workshop and the online survey provided valuable insight into the status of the risk assessment and modelling scene of Aotearoa-New Zealand (Objectives 1 and 2). The following sub-sections summarise common themes across sectors/disciplines that attended the workshops and participated in the survey.

3.1.1 How is Risk Assessed/Modelled?

While we anticipated workshop participants to list risk assessment approaches/methods, it became apparent that some of our participants only contribute to parts of the risk analysis (or its application) or only undertake parts of a risk assessment, whether it be hazard, exposure, vulnerability, impact or risk, across a range of contexts. Participants who attended the workshops:

- use scripting languages, Excel or GIS to build their own risk models;
- undertake lab experimentation to develop vulnerability models;

- use field observations and empirical evidence around hazard and impact to build vulnerability models or inform future impact;
- use social science approaches, including participatory action and expert elicitation, to evaluate potential impacts;
- use risk matrices;
- use risk tools such as RiskScape; or
- contract external consultants to undertake hazard, exposure, impact and/or risk assessment for them.

For future workshops, it may be useful to ask participants what kind of work they do in the risk and resilience space and whether they contribute to parts of risk analysis, undertake end-to-end risk assessments or just use the results. These aspects were covered in the survey but may help narrow workshop discussion and data analysis.

Seventy-one percent of all survey respondents indicated that they themselves, or people in their organisation, are currently using software applications to assess natural hazard risk. Across disciplines in Aotearoa-New Zealand, at least 50% of participants indicated that they are currently using software, except for iwi, hapū or iwi-owned companies, for which there were two respondents (Figure 3.2).

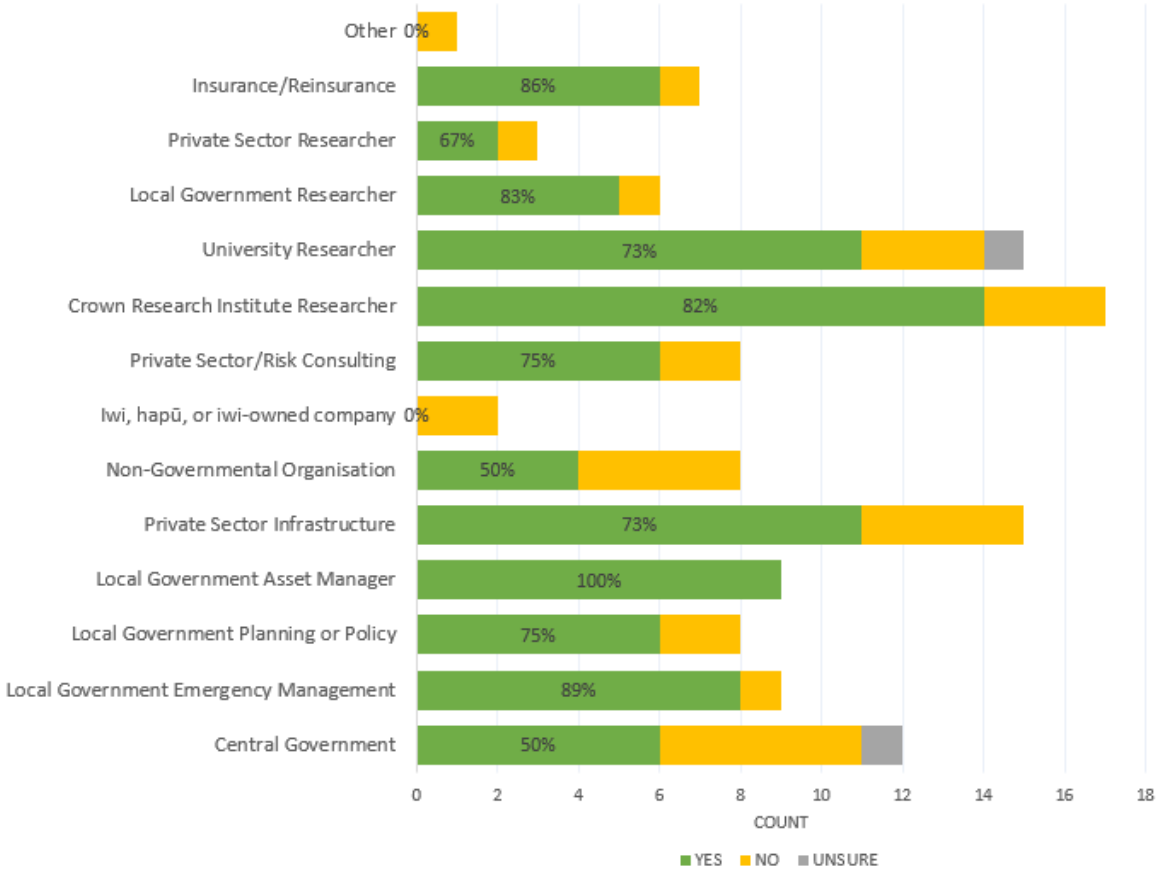

Figure 3.2 Responses to Question 4: Do you currently use software applications to create or assess natural hazard risk information?

GIS was the most popular software to assess risk, receiving 41% of the total responses to Question 5 (the question asked to tick all that apply) (Figure 3.3). Excel received 26% of total responses, followed by scripting (12%), risk tools (11%) and RiskScape (10%) (Figure 3.3).

GIS and Excel are used across sectors and disciplines to undertake risk assessment, whereas scripting appears not to be used by local government (Figure 3.4; Appendix 3). It also appears that risk tools (including RiskScape and others) are not yet being used by researchers in local government, iwi/hapū/Māori business or NGOs.

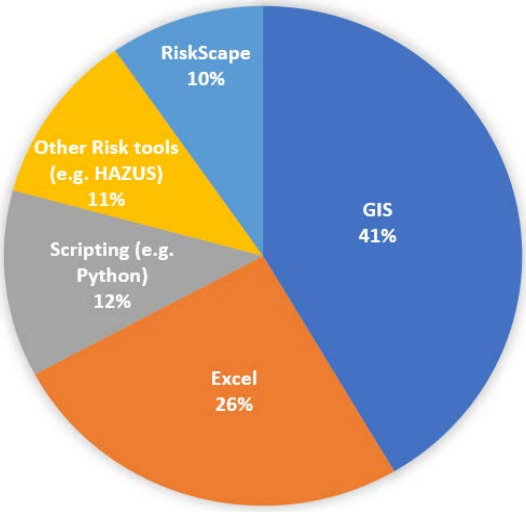

Figure 3.3 Responses to Question 5: What software applications do you use? The question asked to tick all that applied, as some respondents use multiple software.

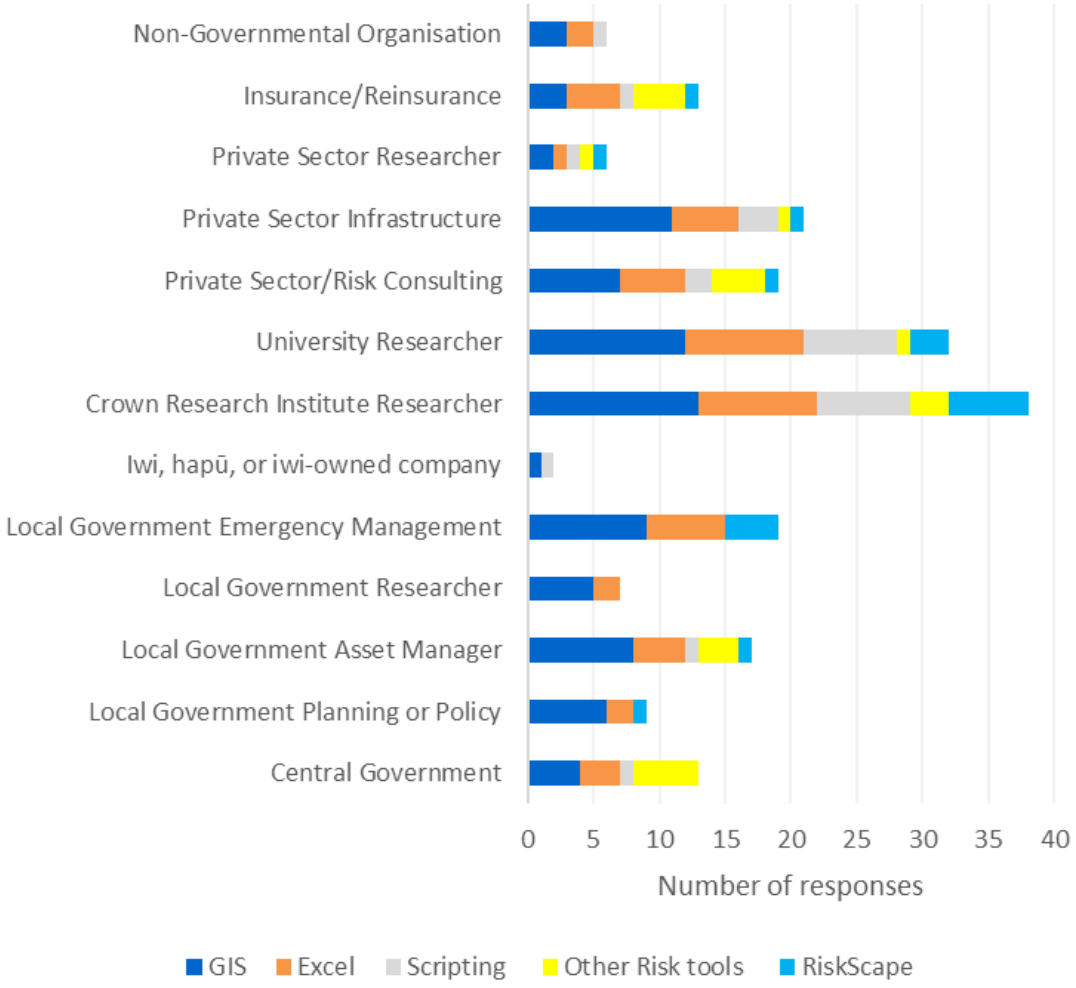

Figure 3.4 Sector/discipline-based responses to Question 5: What software applications do you use?

A range of scripting languages and software packages are used including: Python, C++, Java, R, MATLAB, Vensim, SALib, Stata, Bash, VBA, SQL, ArcPy, Arcade and EMA Workbench. Other tools and models being used to assess natural hazard risk and/or impact include: the ESRI ArcGIS Platform, including QGIS, loss_mm (GNS Science in-house-developed script), Minerva (EQC), MERIT, Hazus, CAPRA, RMS, inaRISK, Global Perils Diagnostic (GPD), Banco BOCOM BBM, cat vendor applications, third-party catastrophe models and in-house developed tools. People also mentioned hazard software such as OpenQuake, InfoWorks ICM and waterRIDE software.

RiskScape had been used by a few of the workshop participants to evaluate risk from scenarios for readiness, response and recovery and, although it was not clear whether they had used the tool once, or consistently, they commented that the available asset data was useful. Ten percent of survey respondents had used RiskScape; they belonged to the following sectors:

- researchers at Crown Research Institutes (6), universities (3) and in the private sector (1);
- local government planning and policy (1), emergency management (4) and lifelines (1);
- insurance/re-insurance (1);
- private sector lifelines (1) and risk consulting (1); and
- overseas Government (1).

Table 3.1 outlines reasons selected by respondents as to why some individuals/organisations are not currently using software to assess risk; 40% of these indicated that they use expert opinion or desktop assessments rather than in-depth modelling. Other reasons for not using software included that:

- others in the organisation would typically undertake the risk assessment for them, or
- they were 'about to start' or currently seeking affordable and easy-to-use software.

Table 3.1 Reasons for not using any software applications to assess risk.

Reasons	Count	% of 'Other'	Participant's Sector/Discipline
I / Our organisation undertakes risk assessments that are desktop or expert-based and are not delivered using software applications	28	40%	Emergency management, planning and policy, NGOs, researchers, risk consulting, private sector infrastructure
I / Our organisation contract consultants or partner with other organisations to deliver risk assessment capability	18	26%	1–2 responses from most sectors (except iwi/hapū/iwi-owned company, private sector risk consulting and researchers) and 4 responses for private sector infrastructure
I / Our organisation does not currently have the capability/capacity	15	21%	NGOs, planning and policy, iwi/hapū/ iwi-owned company, private sector infrastructure and emergency management
I / Our organisation does not assess risk (e.g. a consumer of risk information or a producer of input data for risk assessment)	6	9%	Central Government, planning and policy, researchers (e.g. hazard modellers)
Other	3	4%	NGOs

Survey respondents indicated that they undertake risk assessments for a range of contexts but do so mostly before an event occurs for scenario-based and probabilistic analysis rather than in response to an event/post-event (Figure 3.5). However, this response may be influenced by high representation from researchers, rather than event responders. For sector-based responses, see Appendix 3.

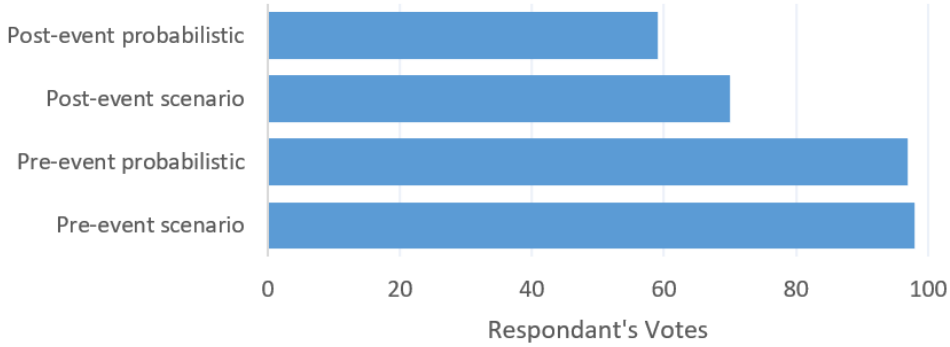

Figure 3.5 Responses to Question 9: In what context do you need risk outputs?

Survey respondents also indicated that they use risk assessment outputs for a range of purposes (Figure 3.6). Exposure to risk, likely costs to be incurred and evaluating cost-effective risk reduction options were voted as the top three uses (although, as above, these may be influenced by high representation from researchers; see Appendix 3). Risk modelling outputs are currently used less to inform public education. Other uses include:

- to engage government ministers in dialogue on disaster risk management and fiscal budgeting for resilience / disaster risk financing and insurance
- to better understand base data requirements to enact and encourage improvements
- to support cross-sectoral programme design
- to determine asset/component vulnerability, and
- to determine expected annual loss.

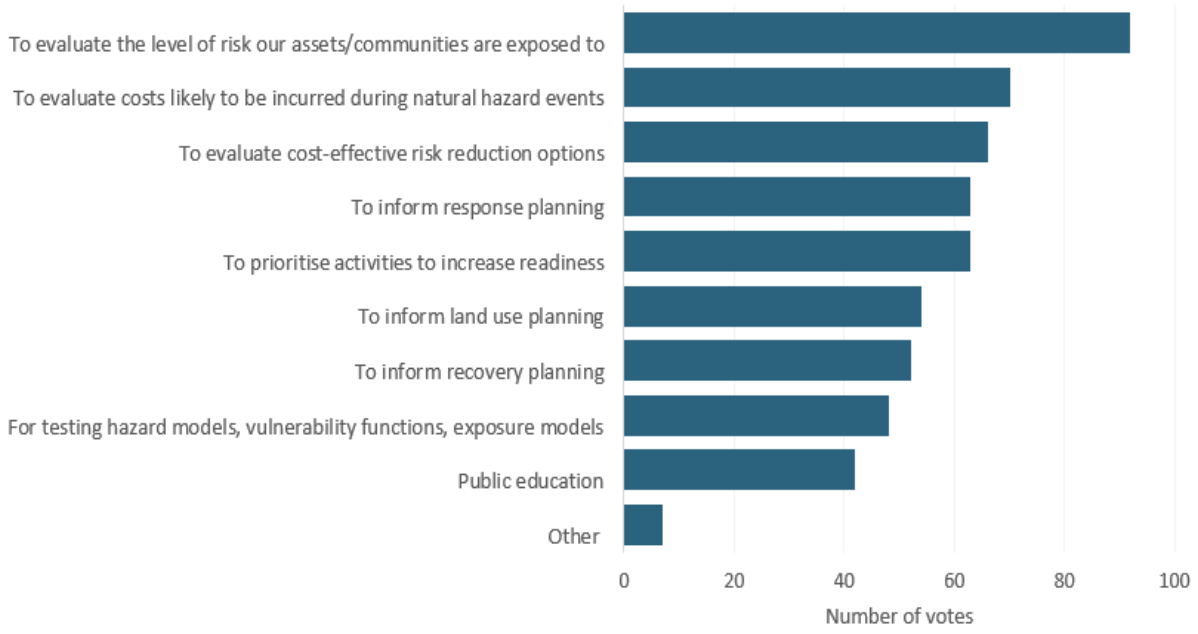

Figure 3.6 Responses to Question 12: Current use of risk outputs.

In summary, the workshop and survey results demonstrated that a range of approaches, from using expert judgement to risk modelling via python scripts, are used to assess risk in Aotearoa-New Zealand, each with their own limitations and benefits and, presumably, selected based on context, capability/capacity and budget. Across the sectors, individuals and organisations who participated in the workshops and surveys also contribute to various parts of risk analysis, e.g. producing the data or models that risk assessments use, undertaking end-to-end assessments or only using the risk outputs. These results highlight the diversity of risk modelling needs, experience and capacity within sectors and disciplines. Most respondents (71%) indicated that they are using software tools to assess risk (Figure 3.2), the most popular being GIS and Microsoft Excel, with risk tools, including RiskScape, and scripting their own models less popular among respondents (Figures 3.3 and 3.4). Table 3.1 outlined the reasons why some respondents do not use software to assess risk, highlighting opportunities for risk modelling software such as RiskScape 2.0. Survey responses suggest iwi/hapū and Māori businesses, Central Government and NGOs may not be using software to assess risk, or perhaps using software less than others, for some of these reasons. These results also show that risk assessments are undertaken for a range of contexts, most commonly for pre-event analysis (Figure 3.5) and to produce outputs for a range of purposes (Figure 3.6).

3.1.2 What is Working Well

Participants of the workshop were asked which aspects of risk assessment were working relatively well. Themes common across the 35 sticky notes from across the groups included:

- hazard characterisation;
- local government natural hazard databases;
- LINZ data initiatives;
- open data, e.g. open street map;
- flexibility and control over which models risk modellers can use or build;
- production of scenarios using a mix of qualitative and quantitative data;
- multi-agency risk engagement for major or significant hazards, i.e. AF8, Hikurangi, Taranaki;
- workshops and expert elicitation;
- risk matrices;
- wide range of applications for assessments;
- some standards, such as the Building Standard; and
- a general philosophy of public good.

It is worth noting that during the workshop activities there were generally fewer sticky notes ‘posted’ under this theme compared to challenges and wish list items.

3.1.3 Challenges and Opportunities of Risk Assessment

Challenges and wish list risk assessment items were compiled to analyse risk assessment challenges and opportunities experienced across Aotearoa-New Zealand relating to Objectives 2 and 3. Two hundred and five sticky notes were coded to key themes presented in Figure 3.7, where the frequency of the theme mentioned is represented by the size of the text in the word cloud. Large topics occurred 25 times across workshops, and the smallest topics only occurred twice across all workshops.

Figure 3.7 Risk modelling challenges and opportunities. Small text reads: RiskScape-Merit, business interruption, decision support, liquefaction, network analysis, open source, and buildings database.

Data gaps and access to data were central themes of this conversation. Many participants alluded to datasets being incomplete, inaccessible, unmaintained, not at suitable resolutions, not standardised, not fit for purpose for 'data hungry' risk models and/or unable to represent a dynamic, or real-time, risk environment. There was a call for more empirical data, open-access data and national data standards, as well as more collaboration in order to avoid duplication and create better integrated and inter-operable systems, including between risk tools such as RiskScape 2.0 and socio-economic models such as MERIT [6]. Participants noted more support or resourcing was required to maintain current databases and to undertake auditing/testing of current datasets and models.

The need for an expert-supported central repository or 'risk data pool', a collaborative space where accessible risk data (including those mentioned in Figure 3.7) can be shared securely and peer-reviewed, including national datasets, hazard data, asset data, vulnerability models and damage surveys/empirical data, was frequently mentioned.

Twelve percent of sticky notes in the challenges and wish list activities mentioned vulnerability models (including fragility functions and damage functions), and some were voted as important compared to other ideas (red-dotted sticky notes in Figure 3.8). This included:

6 https://www.merit.org.nz/

- transparent, open and accessible vulnerability models;
- vulnerability models for volcanic hazards and impacts;
- vulnerability models for multi- and cascading hazard impacts;
- vulnerability models for infrastructure components and systems in order to understand outage and disruption;
- psycho-social and business-interruption vulnerability models;
- uncertainty in vulnerability models; and
- access to empirical data and resourcing damage surveys to develop vulnerability models.

Figure 3.8 Sticky notes documenting the challenges and opportunities of vulnerability models.

Risk communication was also frequently 'posted'. Across the sectors, better means of communicating risk are desired, including engagement tools, visual outputs and infographics for use in multi-agency stakeholder and community/public engagement (including schools) to engender action/response; "the science is not always easily understood or taken up." Related to this theme was 'risk literacy' and a shared understanding of risk terminology, assessment and modelling.

Another key theme was impact forecasting for early warning and real-time impact assessments dependent on communication, collaboration, inter-operable systems and artificial intelligence. Weather, rainfall, landslides and immediate assessments following disaster were mentioned.

More investment and research is sought to build and refine risk modelling methodologies that:

- intertwine qualitative and quantitative data;
- model cascading hazards and impact;
- incorporate complex cascading, multi- and episodic hazards and impacts, e.g. in volcanic eruptions;
- model systemic and cascading failure of interdependent infrastructure networks (network analysis) to inform damage, outage and restoration times;

- model psycho-social impacts;
- consider temporal impacts over different scales, e.g. what to expect during longer response and recovery phases and at the local, regional and national levels;
- model impact and interruption to businesses; and
- allow intervention scenarios and adaptive pathways.

Other challenges and opportunities included:

- National databases and datasets for flood, tsunami, storm surge, sea-level rise, earthquake, elevation (LiDAR), buildings and infrastructure, and resourcing to support existing databases (e.g. active faults database and tsunami database) and maintain these datasets/databases.
- Consistent approaches, national data standards and "a national ecosystem of best practice" with comparable outputs to target resources and action.
- Population models, incorporating behavioural data, movements diurnally and seasonally and urban, rural and transient populations for use in evacuation modelling and forecasting of injuries and fatalities, as well as displacement.
- Datasets for social vulnerability, cultural data, rural asset data, infrastructure components and systems, and buildings with good metadata.
- Scenario and probabilistic hazard data and risk modelling methods for fire, landslide, liquefaction, tsunami, high-impact weather and climate change. Climate change scenarios should include the local level and be compatible with the National Climate Change Risk Assessment and NEMA's Risk Assessment Guideline.
- Auditing and review of models and tools following events and/or more data to make sure models are up-to-date and forecasting as accurately as they can.
- Risk governance.
- Quantification of uncertainty in risk analysis.

This section summarises current challenges of risk modelling in Aotearoa-New Zealand and highlights opportunities and areas of research that research funders, Crown Research Institutes, universities, research centres and the private sector could invest in and collaborate on to contribute towards priorities of the Sendai Framework and National Disaster Resilience Strategy. This section also highlights the perceived challenges of RiskScape 2.0 for users, particularly around data gaps and access to data to operate the tool.

3.2 RiskScape Software User Requirements

This section documents specific user requirements of a risk assessment software tool. General user requirements are first outlined before summarising sector-based needs of RiskScape 2.0 based on the results of the workshops and survey.

3.2.1 General User Requirements for Risk Modelling Software

During Activity 1 of the workshops, participants noted their current 'wish list' items for risk modelling tools in Aotearoa-New Zealand. Figure 3.9 shows the key themes from analysing 120 sticky notes specific to tool capability across the sectors. Themes that occurred across workshops and sectors show that users desire decision support tools that are: inter-operable (17 sticky notes), open-access (14), transparent (14), intuitive (12), flexible (12), collaborative (4), reliable (4), expert-supported (3), secure (3), open-sourced (2), fast (2) and visual (2).

Figure 3.9 Key themes from RiskScape-specific wish list.

Participants also discussed tool functionality that they would find useful, including (in no particular order):

- model run history with templated information to fill (author, date, purpose);
- the ability to run in real-time, read in real-time data and perform impact-forecasting;
- the ability to undertake network analysis;
- cascading hazard risk modelling and temporal impact modelling;
- the inclusion of probabilistic capability;
- a map view of data and models;
- the ability to easily re-run models with updated data;
- automated reporting of risk/impact results and the uncertainty involved in each component of the run / each dataset;
- templated map outputs that need little post-editing for community engagement (although there was concern about full context of results);
- good user support, including training, easy licencing and a collaborative wiki with multilingual capacity;
- case studies and customer reviews, as well as auditing/testing to make sure the tool is doing what it should do;
- inclusion of qualitative data; and
- continued user input.

Both the workshops and the survey indicated that, for users to use RiskScape, they will need access to data, including assets and vulnerability models, potentially from a ‘pool’ or ‘portal’ of risk data. Only 13% of survey respondents (15 people) indicated that they would be able to use RiskScape without provided data, whereas 69% (82 people) indicated that they need

access to data before they can operate RiskScape (Figure 3.10). Also of interest was the proportion of survey respondents who would request others to use the tool for them. Themes around data access and gaps from the workshops are consistent with these survey findings.

Workshop participants noted that they would like transparency in these datasets and within the software itself so that models/runs are repeatable and traceable. Having good metadata associated with these datasets was identified as a general challenge by workshop participants and thus would be a good opportunity for improvement (Figure 3.7).

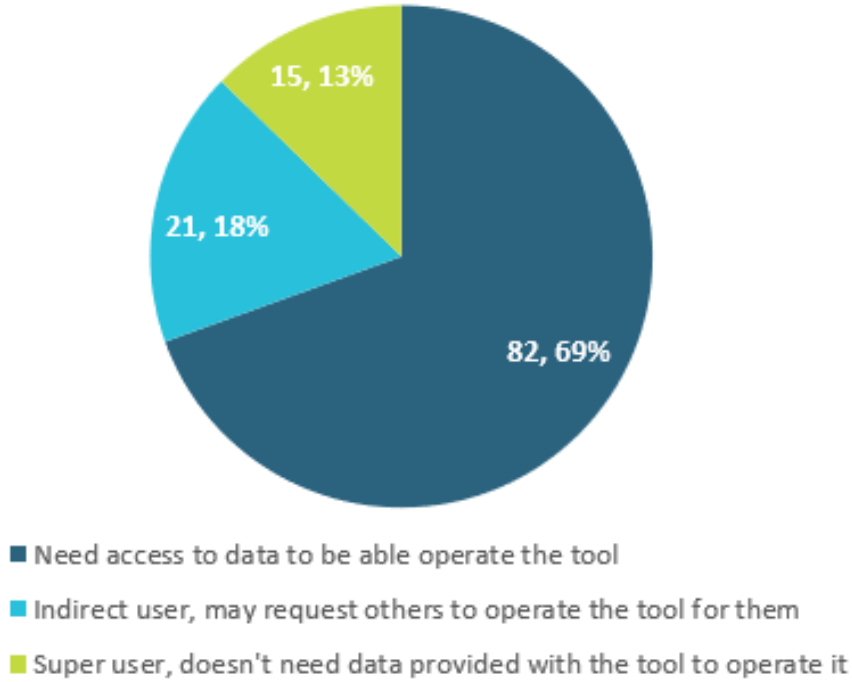

Figure 3.10 Responses to Question 13: How would you like to interact with a risk tool? The first number is the number of respondents, followed by the percentage.

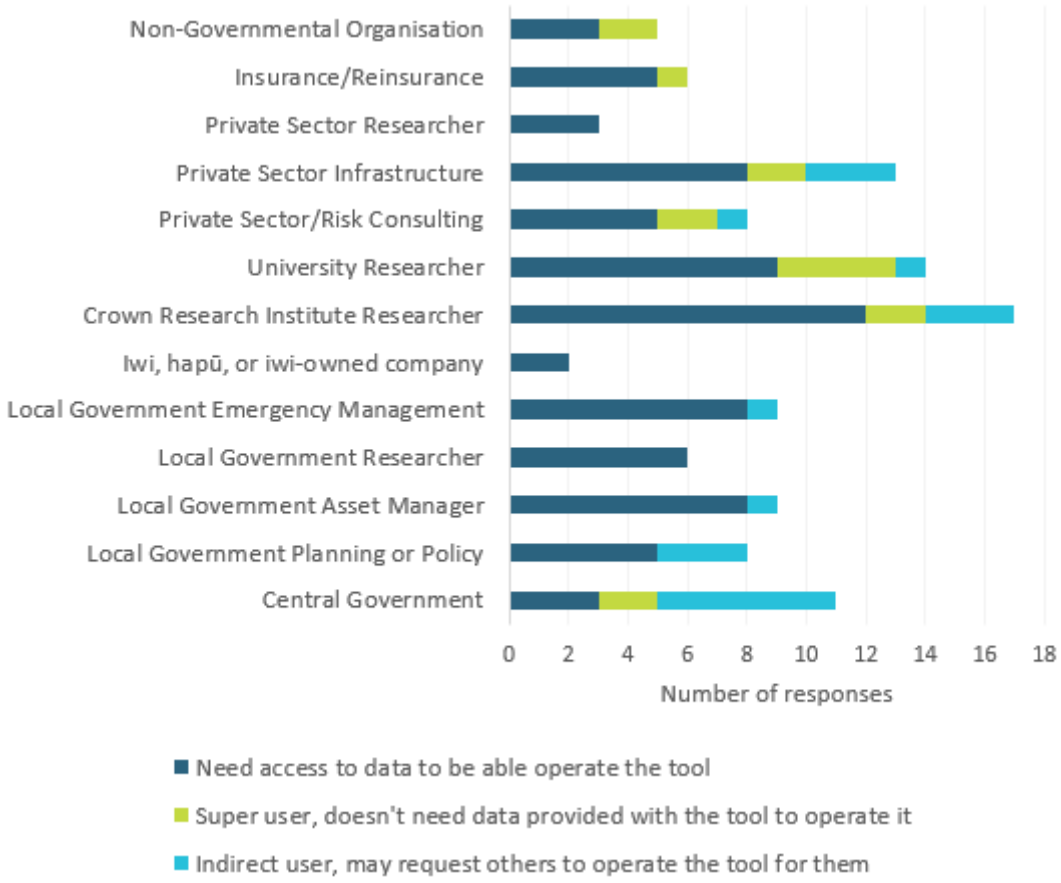

Figure 3.11 Sector-based responses to Question 13.

Survey responses indicated that RiskScape 2.0 will need to output results in various formats, as within each sector different individuals/roles use different output formats (Figure 3.12). Workshop participants also requested that outputs are flexible, spatial, comparable, can be exported into other programmes, have map templates and have easy to understand visuals, and well-reported results.

Survey respondents indicated that the RiskScape 2.0 software would need to be flexible around options for output aggregation and scales (Figure 3.13). Respondents ticked multiple scales that were applicable to them; specific/asset component levels of results received one third of responses. Meshblock, territorial authority and per region were also popular spatial scales of interest. Other options and comments included:

- that scale depends on the context of the project or study, so needs to be flexible;
- catchment areas;
- statistical areas;
- by demographic;
- by own defined geographic extent; and
- non-spatial categories.

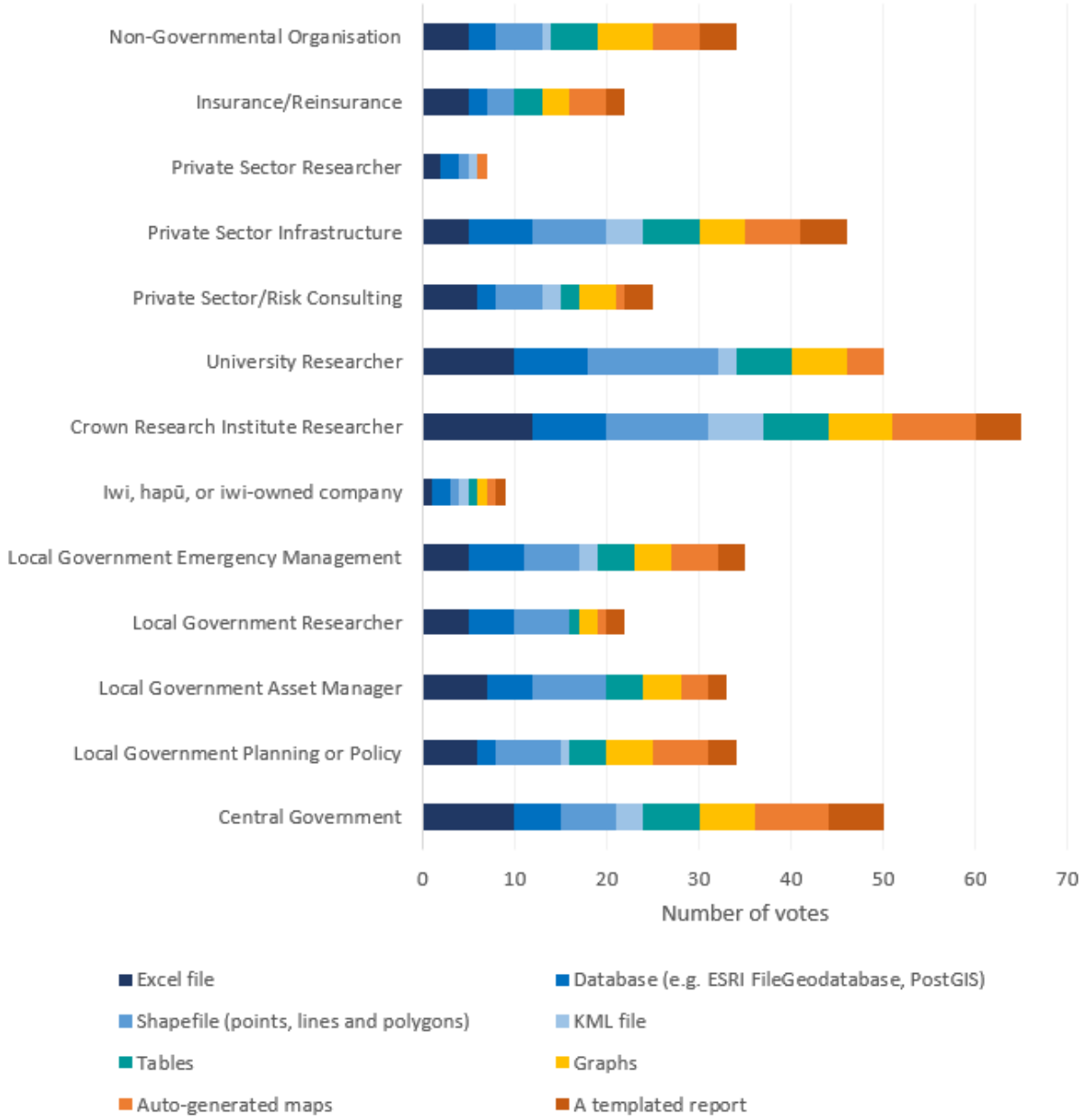

Figure 3.12 Sector-based responses to Question 11: What format do you prefer risk outputs in?

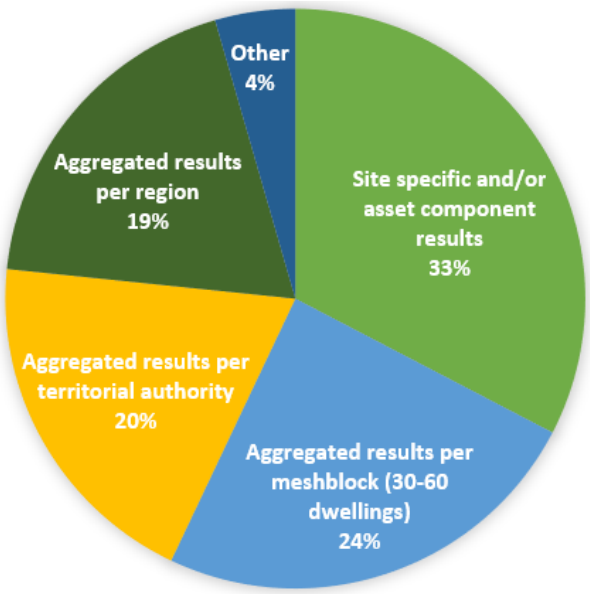

Figure 3.13 Responses to Question 10: What scale do you prefer the risk outputs to be in? The percentage is of total responses received.

Survey respondents were also asked how they would like to visualise outputs from RiskScape. Web and local desktop interfaces were most popular, followed by interactive interfaces and mobile phone applications (Figure 3.14). Included in 'Other' was GIS viewer/map. Other suggestions included Software as a service (SAAS), use of widgets and access to a representational state transfer (REST API) so users can build integrations to drive and query RiskScape from their own software packages.

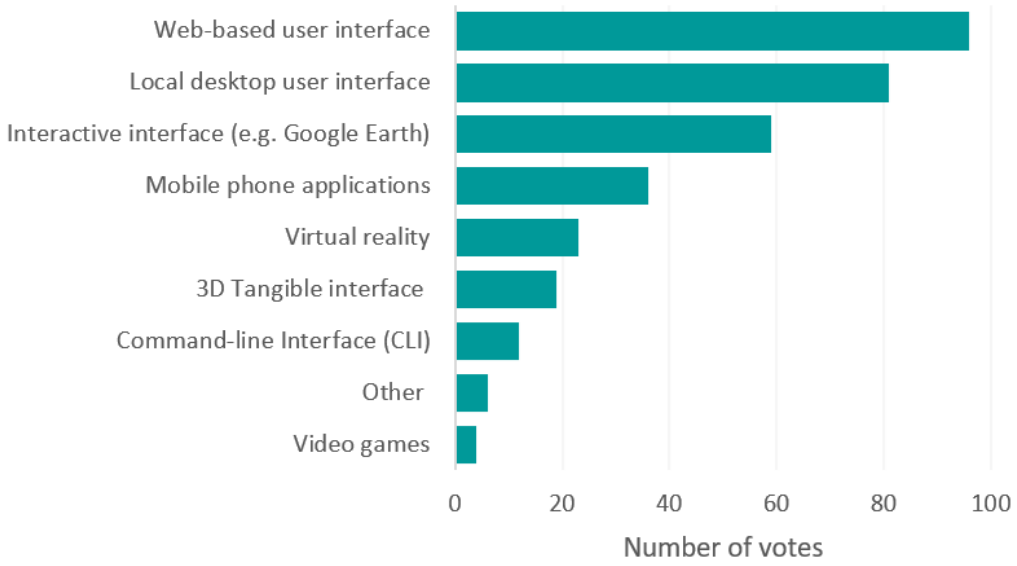

Figure 3.14 Responses to Question 15: How do you / your organisation want to visualise outputs from RiskScape?

In summary, this section highlights general user needs for RiskScape 2.0. Participants suggested that the tool will need to be inter-operable, open-access, transparent, intuitive and flexible, and they have provided suggestions for useful functionality. The results from the workshops and survey have found that access to data will need to be provided with the tool for RiskScape to be useful to most users. RiskScape will need to be flexible in the format, scale and visualisation of outputs to accommodate the diversity of users both across the sectors and within sectors. The following sections detail the results from each sector.

3.2.2 Local Government Users

Workshop participants from fields within local government indicated that, currently, local government emergency management, hazard analysts and planners and policy makers (engaged in local government processes) undertake risk assessment primarily in relation to CDEM group plans or Resource Management Act plan-making processes (identifying land-use types and resource management and setting policy requirements for mitigations or adaptive responses), long-term planning or infrastructure planning. These processes usually involve a larger project every 5–10 years.

To assess risk, local government commonly follow the AS/NZ ISO 31:000 and NEMA Risk Assessment Guideline to assess a range of hazards and rank their actual and potential impacts in order to inform and prioritise actions and resources. Regional Council users identified that they generally focus on hazard mapping rather than the risk or impacts. Several methods are used to evaluate likelihood, consequences and costs versus benefits, including:

- expert opinion and multi-agency engagement through workshops,
- GIS overlays of modelled and historic hazard data with societal assets to assess exposure (no vulnerability or loss),
- application of a risk matrix (e.g. Saunders et al. 2013),
- contracting of consultants to model risk, or
- a combination of the above.

3.2.2.1 What is Working Well

According to workshop participants from these sectors, obtaining scenario-based hazard data and creating qualitative impact scenarios through multi-agency collaboration and the use of guidelines and matrices to inform prioritisation and decision making is currently working well. However, it was apparent that ‘data gaps and inconsistency’ is a major limitation for these sectors – “rubbish in equals rubbish out”. Other challenges included ‘limitations of risk modelling tools and methods’ and ‘how to communicate risk’. Some key points (sticky notes that had one or more red dot) regarding current challenges included:

- There is a lack of national datasets for natural hazard risk assessment.
- Databases and datasets need to be supported and maintained, including existing national databases, and extra resourcing is needed for maintaining and updating local government databases.
- There is a lack of data standards nationally and locally to improve inconsistency of data and issues with data coverage.
- Access to some data, including vulnerability models, is difficult; public-funded research needs to be publicly available.
- There are gaps around how to assess social impacts, risk reception/acceptance, psychological impacts and longer-term impacts.
- Current risk modelling tools are excessively ‘data hungry’; it is difficult to deal with key data gaps (e.g. fragility functions) and to generate quantitative impact and loss values.
- Who is making sure risk tools are fit for purpose, maintained and inter-operable?
- Risk literacy is poor, including among those making decisions. The science is not always easily understood or taken up.

Emergency managers, hazard analysts and planners who attended the workshops sought better ‘data access and inter-operability’, ‘understanding [of] complex and cascading hazards, slow-onset hazards, vulnerability and societal impact’, ‘real-time data and impact forecasting’ and ‘risk communication’.

3.2.2.2 Risk Wish List

Some key points for future investment and research as voted by participants (sticky notes with one or more red dot) included:

- complete, accurate, consistent, well-maintained and open national datasets for infrastructure, buildings, hazard models and vulnerability models that are reliable for effective decision making;
- the establishment of an agreed standard and methodology that everyone understands;
- cascading and secondary hazard modelling;
- climate change hazard scenarios and impact science that is compatible with the National Climate Change Risk Assessment and NEMA Risk Assessment Guideline;
- more vulnerability models for complex hazards and volcanoes;
- the ability to include qualitative risk modelling, as well as for other threats, e.g. terrorism and cyber;
- infrastructure outage and delays;
- population movement module (e.g. day versus night evacuation) and displacement model;
- social vulnerability impacts and consequences;
- flagging of potential issues through phases of recovery (social and economic impacts in the short-, immediate- and long-term);
- impact science for different land-use and intervention scenarios and uses for dynamic adaptive pathways for planning processes;
- quantification of resilience based on risk, impact, consequence, loss;
- the ability to generate immediate assessments based on real-time data and to forecast impact; and
- engagement tools for communicating risk across agencies, to stakeholders and to secondary schools – use risk experts, then translate for the public using simple outputs.

3.2.2.3 Prioritisation of Risk Modelling Outputs and the Use of RiskScape

Survey respondents provided insight into the risk outputs that local government emergency management and policy and planning users would find useful. The risk output options included in Question 8 were all considered important to the participants from local government emergency management (10) (Figure 3.15). However, the top three output options considered ‘very to extremely’ important were habitability, infrastructure outage and physical damage, followed closely by social and cultural impact, as well as exposure.

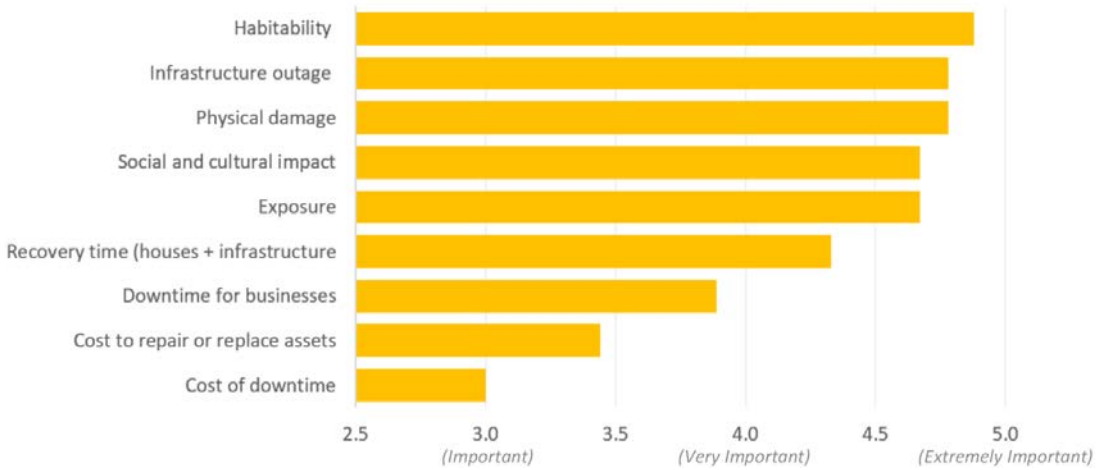

Figure 3.15 Averaged responses from emergency management professionals to Question 8: Which risk outputs would you use to carry out your work?

Planning and policy survey participants (11) also considered all the suggested risk outputs as important, but indicated physical damage and exposure were very important (Figure 3.16).

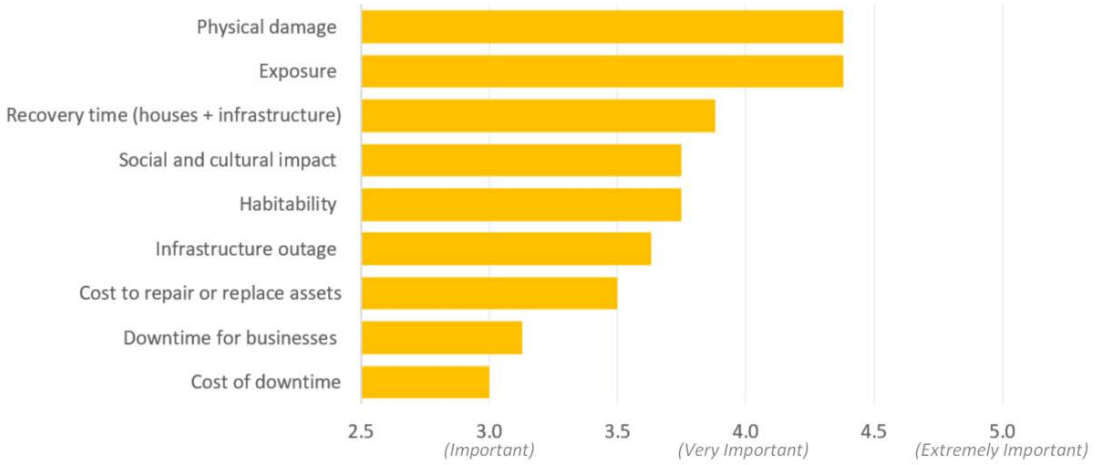

Figure 3.16 Averaged responses from policy and planning professionals to Question 8: Which risk outputs would you use to carry out your work?

Workshop participants from these sectors provided useful information on how RiskScape could be useful for them. To be useful and usable by these users, RiskScape needs:

- to be robust, credible and easy to use, with minimal interface training required (so they do not need to use IT or a GIS team), as well as easy to use for small-scale projects but also with the speed and analytic ability for larger jobs.
- to be able to incorporate the user's own data. as well as access a data pool with vulnerability models.
- outputs to be in formats that are easily imported into Excel or other spreadsheet software, as well compatible with GIS and other open-source formats, ideally including spatial data outputs and good maps that require minimal editing for risk communication and public engagement. Outputs need to be able to be compared for prioritisation.
- to be transparent, including how probabilities are calculated and impact the result, and have a clear display of limitations, assumptions and uncertainty (it would be great to have an automated disclaimer with each model run) to provide an evidence base for decisions and be able to stand up in court.

Survey respondents also indicated interface features that emergency management and policy and planning sectors may find useful. All suggested features were deemed important to emergency management respondents, but a feature to keep track of model runs and a model builder were considered very important (Figure 3.17). All suggested features were also deemed important to planning and policy respondents, but the most important were features to display results and output report templates (Figure 3.18).

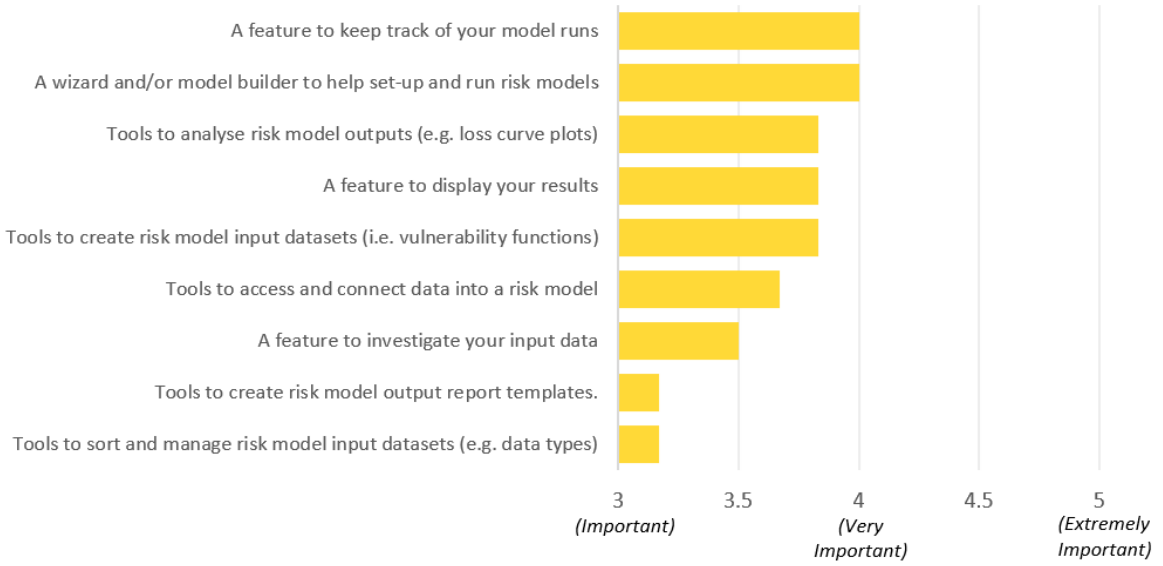

Figure 3.17 Averaged responses from emergency managers to Question 14: What is important to include in the RiskScape 2.0 interface?

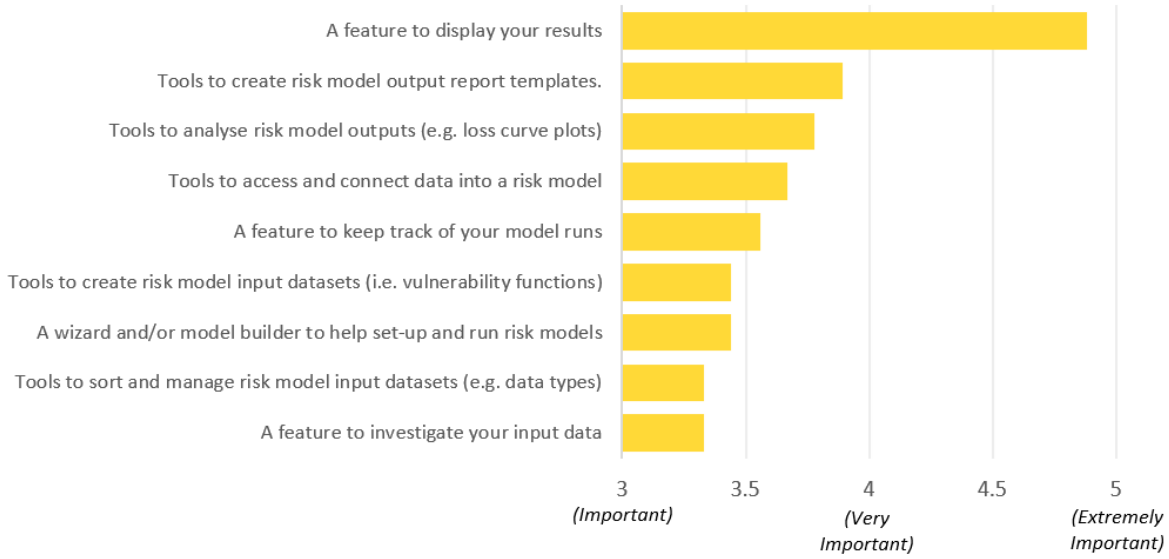

Figure 3.18 Averaged responses from policy and planning professionals to Question 14: What is important to include in the RiskScape 2.0 interface?

3.2.3 Lifelines Infrastructure

Workshop participants working in lifelines infrastructure and engineering across local government and private sectors indicated that they generally obtain hazard data from Councils or CRIs or undertake their own hazard modelling to assess exposure and risk. They use a range of frameworks and models, including the Dam BRTAIL model, business continuity planning and business impact assessment tools, lifelines criticality models and annual fatality risk methods (AFR), as well as discussions with universities and CRIs. They undertake (deterministic and probabilistic) risk assessment to assess resilience of their network in order to inform business case development for intervention options.

3.2.3.1 What is Working Well

Obtaining data from local government is working well, as is the use of building standards, but there are significant gaps around data accessibility, inter-operability and consistent approaches that are limiting this sector. Participants from this sector identified some key challenges, including that:

- hazard and asset data sources are hard to assemble and can be aged, inaccurate, incomplete, low resolution (local government relies on national/regional assessments that are not detailed enough at the local level) or irrelevant (local impact);
- there is an inability to model changing/dynamic hazards due to the non-availability of climate change and cascading hazard scenarios;
- there is uncertainty in hazard and vulnerability models and lack of transparency in vulnerability models, including how they are made and access to insurance data to develop functions; and
- there are not currently consistent approaches and data standards, shared understanding of risk modelling methods, integrated information systems and ways to communicate risk.

3.2.3.2 Risk Wish List

Wish list risk modelling capabilities for this sector were based around understanding complex hazards, vulnerability and societal impact, including:

- multi-, cascading and climate change hazard data, including rainfall and landslide forecasts (also at the local level);
- having more vulnerability models and understanding their uncertainty, plus collection of more damage data from past events;
- understanding of interdependencies, outage time, loss and disruption;
- the ability to assess qualitative data; and
- behavioural models to inform injury and fatality, as well as social vulnerability and impact.

3.2.3.3 Prioritisation of Risk Modelling Outputs and the Use of RiskScape

Twenty-four participants from the lifelines, across both public and private sectors, also indicated the risk outputs that are important to this sector. All outputs suggested were considered as important (Figure 3.19). However, the top three outputs considered ‘very important’ were exposure, physical damage and infrastructure outage.

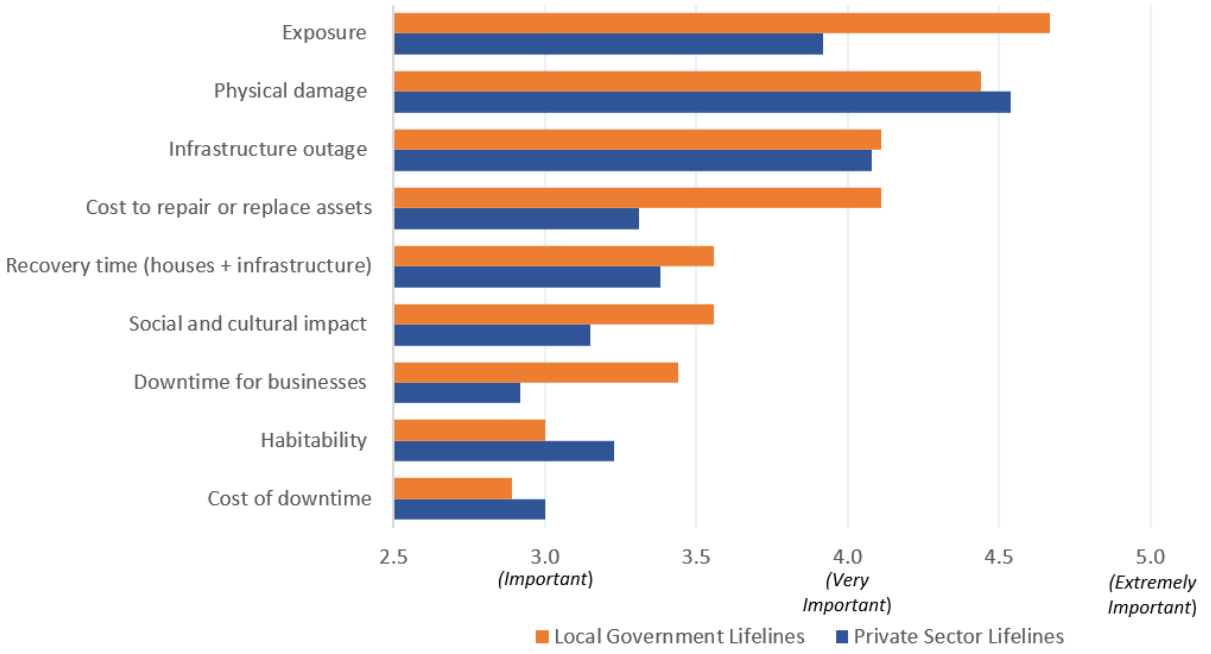

Figure 3.19 Averaged responses from lifelines professionals to Question 8: Which risk outputs would you use to carry out your work?

RiskScape may be useful to produce these outputs for the lifelines sector. Workshop participants indicated that, for RiskScape to be useful, it needs to be:

- transparent, easy to use, based on common principles agreed with end-users and be accountable to these, as well as flexible to fit in with current procedures (e.g. proxy settings);
- able to read-in data from sources (inter-operable with asset management systems, age and condition of components), as well as have access to a pool of agreed hazard, asset and vulnerability data and be able to contribute to it;
- able to undertake probabilistic analysis and model outage across all lifeline sectors; and
- able to produce inter-operable formats for input into other programmes such as GIS and MERIT, as well as be able to export visual formats.

While all suggested interface features were considered to be important to all lifelines survey respondents, the most important features to local government lifelines were: display results, access and the ability to connect data to the tool and a model builder. Features most important to private sector respondents included: tools to manage input data, tools to access and input data, and a model builder (Figure 3.20).

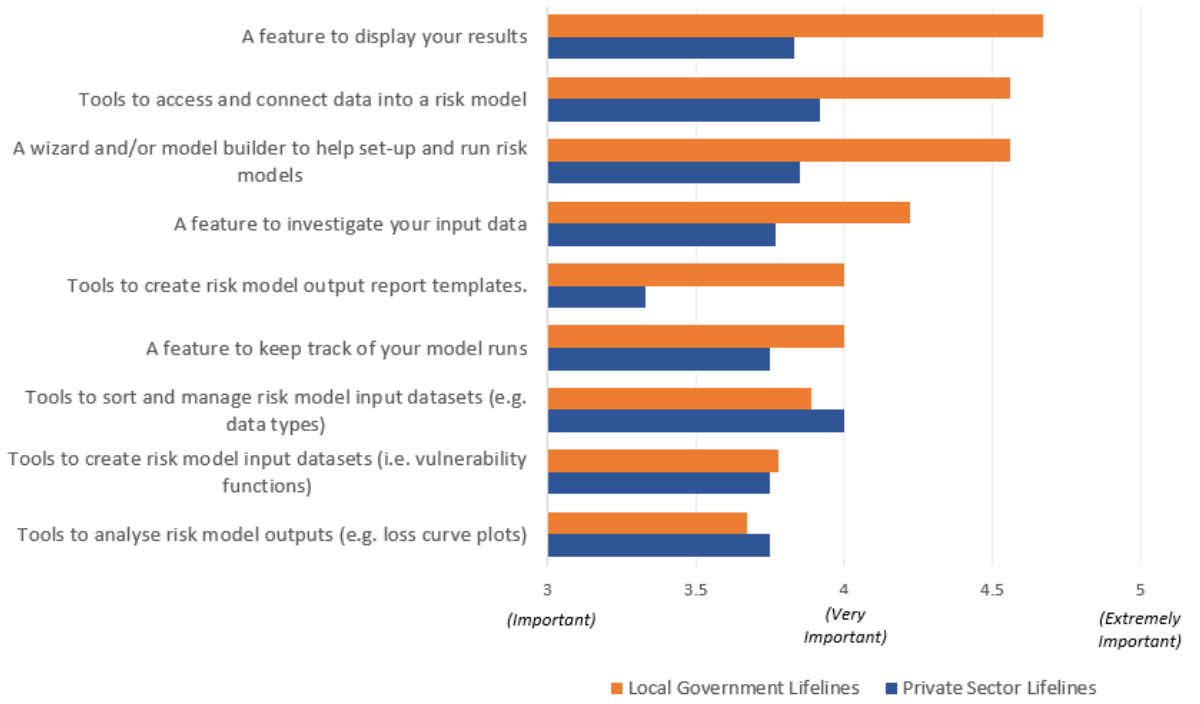

Figure 3.20 Averaged responses from lifeline professionals to Question 14: What is important to include in the RiskScape 2.0 interface?

3.2.4 Insurance

Insurance users typically use risk models from the market or tools they have built themselves, as well as contract consultants to undertake risk assessments for them. Risk information is used to inform re-insurance negotiations, to support asset management strategies and to support risk appetite discussions.

3.2.4.1 What is Working Well

These methods are considered to be working well in some respects, the methods they use are trusted and free and can undertake scenario and probabilistic analysis and reduce uncertainty.

3.2.4.2 Risk Wish List

However, the insurance sector also experiences challenges, including:

- obtaining clear, consistent, understandable and sharable inputs;
- access to underpinning hazard data, as there is no central repository;
- the lack of national standards (hazard, asset, field and metadata standards), sharing of libraries and an ecosystem for best practice;
- key person risk, where only a small number of experts can operate the models or tools (particularly in-house developed tools);
- sensitivity analysis;
- loss modelling for probabilistic tsunami hazard, multi-hazard and asset system dependencies and interdependencies; and
- the ability to drive decisions on climate change adaptation.

3.2.4.3 *Prioritisation of Risk Modelling Outputs and the Use of RiskScape*

The eight survey respondents from the insurance sector considered all outputs listed in Figure 3.21 as important. However, 'cost to repair or replace assets' and 'physical damage' were considered very important.

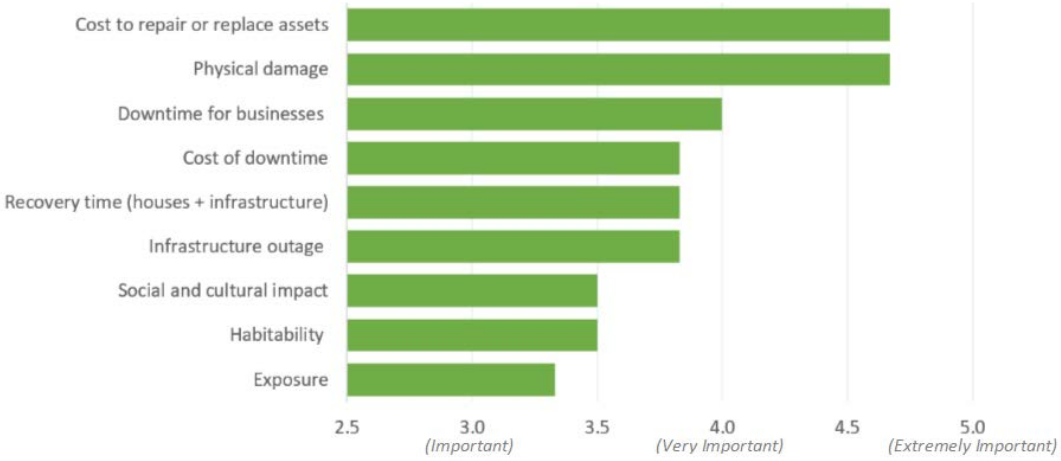

Figure 3.21 Averaged responses from insurance professionals to Question 8: Which risk outputs would you use to carry out your work?

RiskScape may be useful to produce these risk outputs for the insurance sector. For RiskScape to be useful for insurance users, workshop participants stated that it needs to:

- be supported with state-of-the-art science that is supported by multiple experts
- have a drag and drop function for data inputs
- provide a map view with investigative function, and
- have a pre-automated reporting module with plain-English report outcomes.

RiskScape features suggested in the survey (Figure 3.22) were all considered important, with the exception of a feature to investigate input data. A tool to access and connect data was considered the most important, followed by a tool to analyse risk outputs and to create datasets such as vulnerability functions.

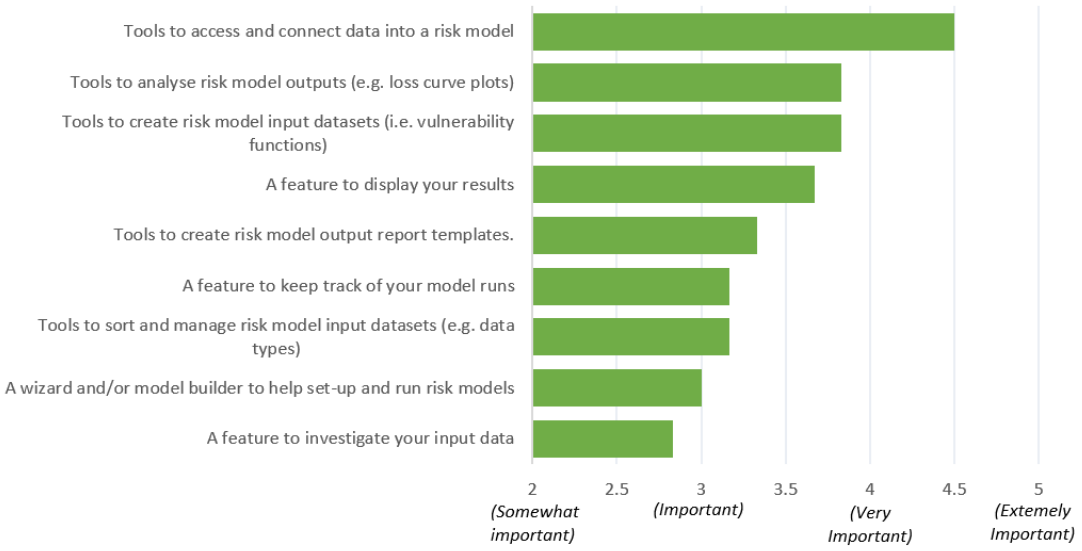

Figure 3.22 Averaged responses from lifeline professionals to Question 14: What is important to include in the RiskScape 2.0 interface?

Key risk assessment priorities for the insurance sector are:

- quality, consistent and understandable data, in
- current, maintained and updated systems that are supported by experts, and is
- easy to use, secure, reliable/available, accessible and a clear communication tool for decisions.

Data that encompasses all of these qualities equals “TRUSTED”.

3.2.5 Researchers

Researchers were the highest-represented group in both the workshops and the survey (Figure 3.1). Forty-nine researchers responded to the survey and 38 participated in the workshops. While the survey did not differentiate research fields, during the workshops the risk engineer researchers / academics, risk scientists/researchers and social scientists were asked to form their own groups to undertake activities. Due to the similarity in the risk engineers’ and risk scientists’ contributions, these participants results are compiled into one category.

3.2.5.1 Risk Engineers and Hazard and Risk Scientists

Risk engineers and scientists who participated in the workshops indicate that they use a range of tools to model and assess risk, including:

- building their own models through scripting in MATLAB, R or Python packages or manual calculations in Excel, using vulnerability models from literature, or generating their own models (through lab experimentation and/or empirical data collection);
- risk tools such as RiskScape;
- GIS map overlays;
- collating information from reports and expert elicitation workshops; and
- a mix of quantitative and qualitative methods.

What is Working Well

Generally, using mixed and flexible qualitative and quantitative methods works well – impacts can be quantified and aggregated, scenarios are easy to produce and there is control over datasets and models (selecting or creating fit-for-purpose rather than prescribed). There is also currently access to open data and packages that are consistent, reproducible and have a wide range of applications. However, there are several challenges involved in risk assessment and modelling, mostly relating to data. Hazard and asset data can be labour intensive to obtain, may need formatting to be compatible with models, may not have full coverage or may be incomplete, thus some analysis is potentially based on poor data. There is also a lack of empirical datasets or limited access to these datasets to develop and refine vulnerability models.

Risk Wish List

Future investment and research priorities identified by workshop participants aligned to three key themes: ‘data access and inter-operability’, ‘real-time impact forecasting and better decision support’ and ‘understanding complex hazards, vulnerability and societal impact’. Participant feedback included:

- less development and more collaboration – a development zone for vulnerability functions with standards for better metadata would be useful;
- an open data source for hazard, assets (infrastructure and buildings), land-use and vulnerability functions, with data standards (protection and privacy) and metadata published so others can peer review;
- national hazard models and hazard models for concurring, cascading, multi-hazards (hot topics included volcanoes, wildfires, landslides and forestry slash);
- rural asset data and vulnerability;
- cascading and multi-hazard vulnerability functions, including volcanic impact to buildings'
- understanding of fragility of infrastructure components, restoration times and disruption;
- understanding and quantification of social vulnerability and impact – more people vulnerability models;
- understanding economic impacts;
- population movement model (e.g. day versus night evacuation);
- quantification of uncertainty; and
- impact forecasting using real-time data and good integration/communication across all agencies after an event, i.e. NGMC-GEONET-NEMA-CDEM-RiskScape.

3.2.5.2 Social Science

Social scientists use a range of methodologies and tools to assess risk. This includes qualitative risk assessment based on expert opinion, exploring perceptions of risk through social science approaches, participatory community-based action research and analysis, workshops to share knowledge between scientists and end-users and open-source tools, such as the Quantitative Microbial Risk Analysis (QMRA). Social scientists also obtain information through technical reports, empirical evidence and field-based observations. Workshops and sharing knowledge appears to be working well.

Risk Wish List

Future investment and research priorities align to three key themes: 'data access and inter-operability', 'risk communication' and 'real-time impact forecasting'. Priorities also included:

- rapid, near real-time impact assessments and forecasts using real hazard data for early warning systems and making use of AI technologies to predict based on empirical data;
- access to comprehensive information for researchers, end-users and communities to understand cascading risks and respond appropriately;
- a focus not only on high value or urban assets but also on lower-value distributed rural infrastructure;
- expansion of results to impacts such as social impact assessments, e.g. service outage, evacuation, transient populations, traffic delays; and
- communication of cascading hazard impacts and risk and linking of information to potential actions and responses.

3.2.5.3 Prioritisation of Risk Modelling Outputs and the Use of RiskScape

Risk engineers and scientists that had used RiskScape previously commented that the tool was useful for evaluating scenario-based quantitative consequences to inform readiness, response and recovery activities. Asset data provided with RiskScape 1.0.3 was relatively clean and well-documented. However, the user interface was old and looked untrustworthy, it was hard to keep track of single realisations when looking at multiple outputs and the software was unstable, slow, locked down or hidden and did not deal with line or polygon asset data. There is opportunity for the new standalone RiskScape 2.0 software to include the following:

- Users require easy sign-up, licencing (similar licence for engine and other tools like RiACT) and support systems, including a collaborative wiki for the user community.
- A 'model expert' interface was considered valuable to select many different inputs and outputs options and to keep track of runs and uncertainties for reporting (traceable and reproducible history).
- An expert user interface for scientists who cannot code was also suggested, available in multiple languages and able to be applied in developing countries. Having quality control, e.g. student runs versus expert coding, would be beneficial.
- RiskScape could provide access to datasets, including hazard, asset and vulnerability functions, with the ability to read in open, local and international data (WFS service) as well as mix and match data. However, any pooled open data should be linked with their respective publications and any sensitive data needs to be able to be encrypted.
- The new software could be built to be fast and efficient, including in-built analytics. It would be useful to be able to connect to local servers to run larger jobs.
- Probabilistic / Monte Carlo functionality.
- Inter-operability with network models.
- Geoprocessing functions for line and polygon geometries.
- Functionality to support concurrent, cascading and multi-hazard data, as well as prolonged episodic hazard dataset, would also be useful.
- RiskScape will need to output open source data files and import and export data at different resolutions, as well as output spatial data and good maps for decision support.
- The tool could also include functionality for real-time/interactive modelling, e.g. read-in GeoNet, MetService or NIWA data to forecast impacts.

RiskScape 1.0.3 was limited by its lack of geospatial support, and the interface was slow, clunky and unclear. For RiskScape 2.0 to be useful for social science use, it needs:

- to be user-friendly for people without coding skills or so that social scientists could build their own interface to suit their needs;
- to access data and data repositories directly (or only access data, not the models), e.g. exposure, vulnerability, impacts (post-damage survey results, impact assessment results), as well as the ability to bring in a user's own quantitative and qualitative data, with ensured security around private data, and requiring minimal data formatting for input.
- to have transparency behind data sources, vulnerability functions and data processing;
- to have the functionality to read-in real-time data during real events to support decision making and early warning;

- to output understandable information for end-users to translate and communicate to communities to lead change in actions and behaviours; and
- to have developers keep listening and communicating, as user needs will be emergent and iterative.

Researchers (across disciplines and sectors) also desired the ability to carry out sensitivity analysis and test robustness. The user community could validate models from real events as they occur. Researchers who participated in the survey indicated the risk outputs they considered important (Figure 3.23) and features of RiskScape 2.0 software that would be useful (Figure 3.24). Opinions varied between researchers from each sector (university/ tertiary, CRI, local government and the private sector). For researchers at universities, physical damage, infrastructure outage, exposure and recovery time were considered most important. For CRI researchers, physical damage, exposure and the cost to repair/replace assets were considered very important, whereas local government researchers considered exposure, social and cultural impact and the cost to repair/replace assets very important. Private sector researcher participants considered infrastructure outage and exposure very important. This demonstrates the varied range of potential RiskScape 2.0 applications.

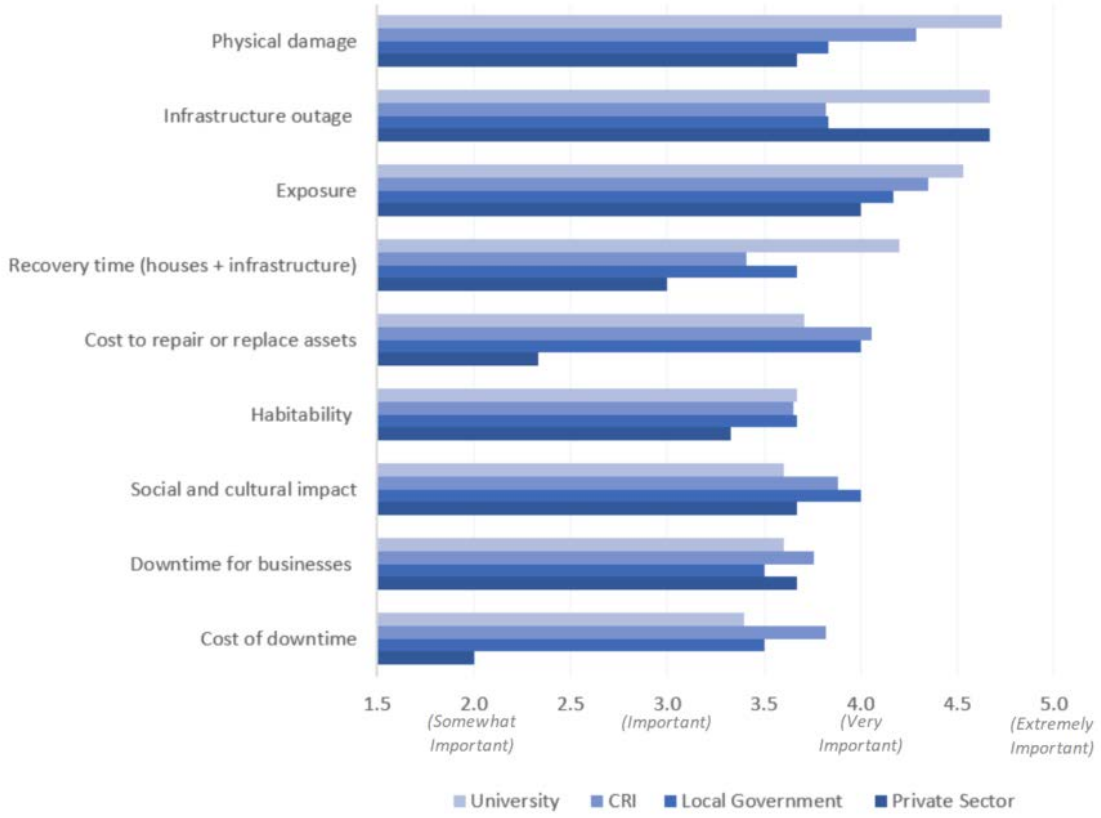

Figure 3.23 Averaged responses from researchers to Question 8: Which risk outputs would you use to carry out your work?

All researchers considered a tool to access and connect data to the risk software very important and tools that involved managing input and output data less important (Figure 3.24). For researchers at universities, tools to create input data (e.g. vulnerability functions) and to keep track of model runs and display results were also considered very important. For CRI researchers, tools to display results and access/connect data to the software were considered very important, whereas local government researchers considered a model builder and a tool to access/connect data very important. Private sector researcher participants considered tools to keep track of model runs and to access data very important.

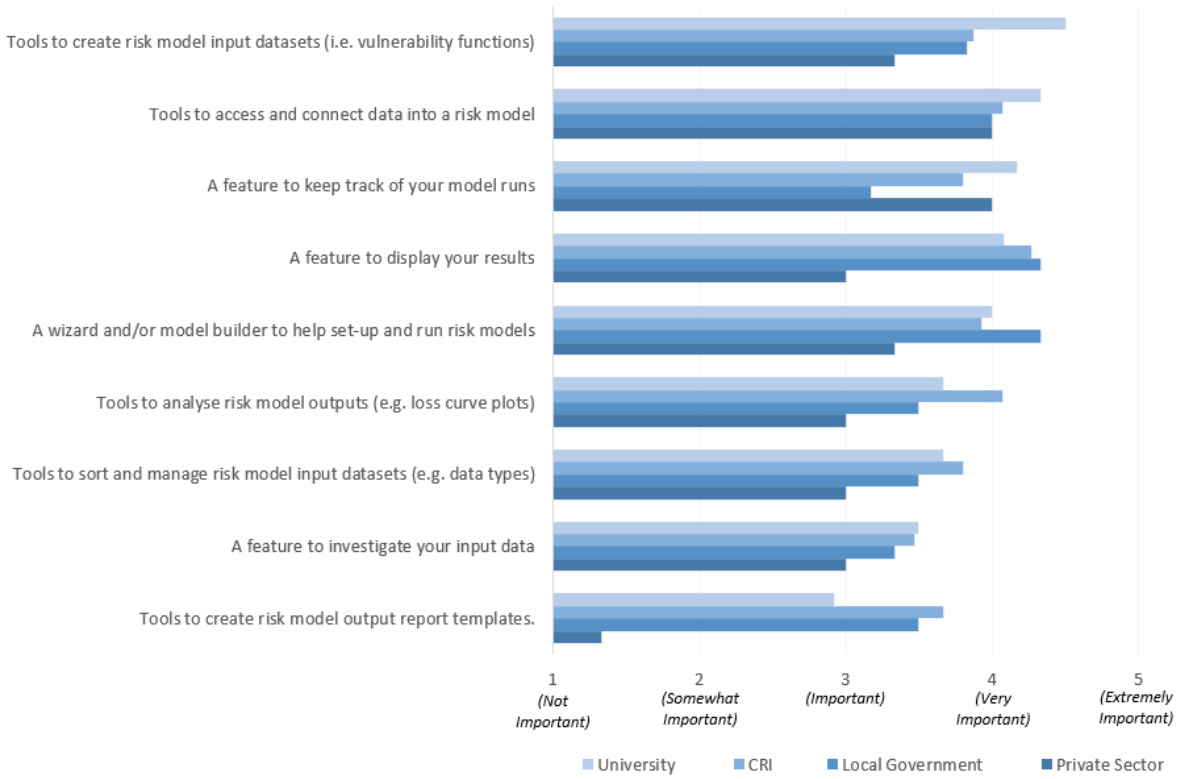

Figure 3.24 Averaged responses from researchers to Question 14: What is important to include in the RiskScape 2.0 interface?

3.2.6 Central Government

Data from Central Government participants were limited to survey results, as during the workshops representatives from this sector participated in their respective sectors, e.g. insurance, emergency management, lifelines.

The risk output options included in Question 8 were mostly considered important to the 14 participants from Central Government (Figure 3.25). The top three output options considered very to extremely important were exposure, physical damage and habitability.

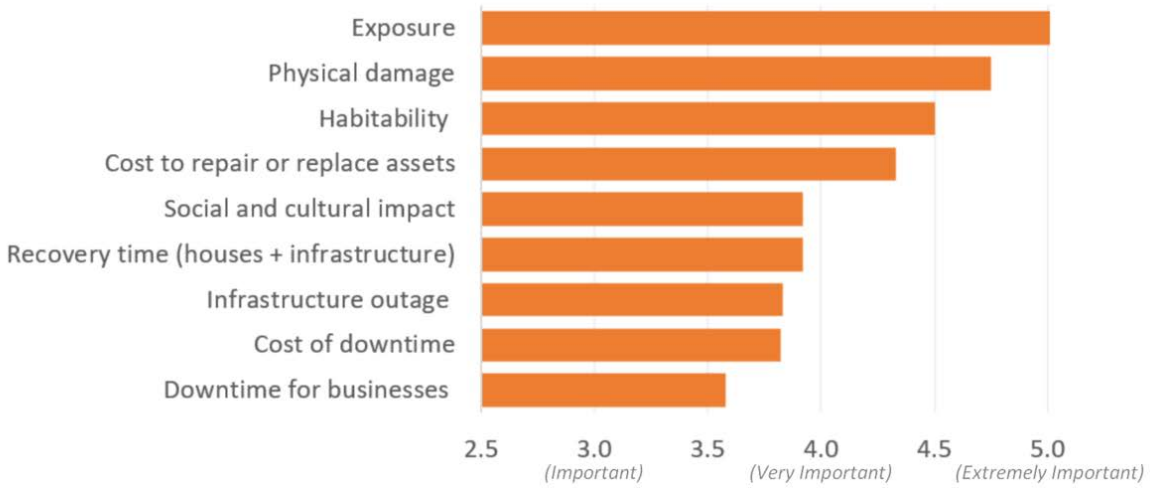

Figure 3.25 Averaged responses from Central Government representatives to Question 8: Which risk outputs would you use to carry out your work?

Tools and features provided in Question 14 were all considered important to Central Government representatives; the top three were tools to display risk modelling results, access and connect data to the tool and to analyse outputs (Figure 3.26).

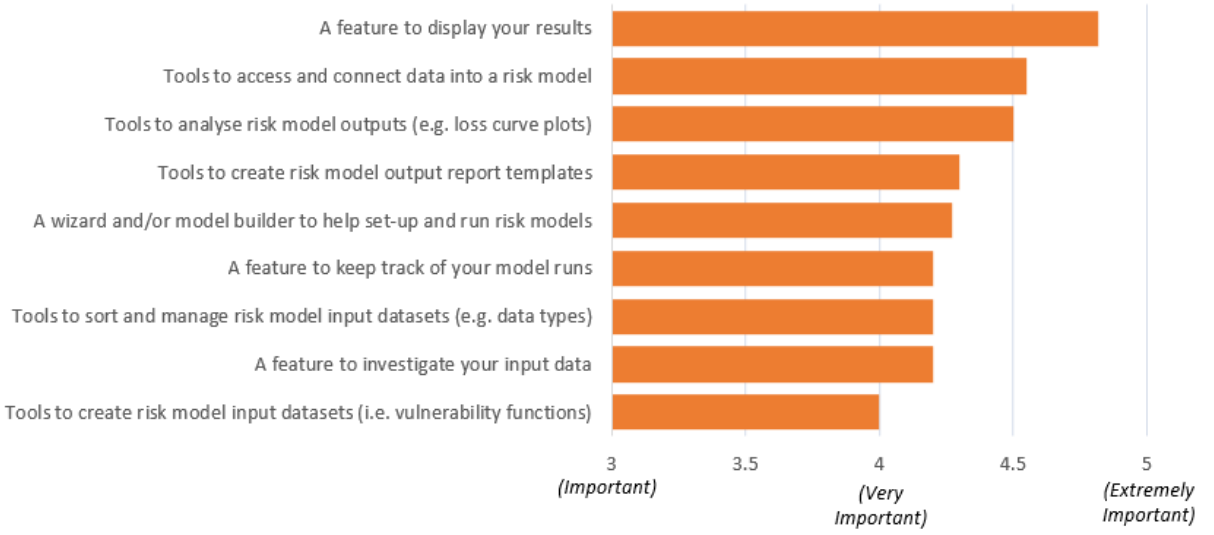

Figure 3.26 Averaged responses from Central Government representatives to Question 14: What is important to include in the RiskScape 2.0 interface?

3.2.7 Iwi, Hapū or Māori Business

Two representatives from this sector responded to the survey. The legacy RiskScape programme has not previously engaged with iwi, hapū and Māori businesses, but engagement is recognised as a priority going forward in the RiskScape 2.0 development programme. RiskScape seeks to partner with iwi, hapū and Māori businesses to evaluate their interest in a tool such as RiskScape, whether they would like to interact with the tool and, if so, their requirements of tool features and interface requirements in the coming years through culturally appropriate methods. At this time, RiskScape 2.0 will be in a better position to demonstrate its capabilities and the services it can provide.

Neither of the respondents indicated that they were currently using software to assess risk (Figure 3.3) and that this was because their organisation does not currently have the capability/capacity. However, both indicated that they were using GIS systems. All risk outputs provided in the survey options were deemed important to the two representatives; the top three outputs deemed very important were social and cultural impact, recovery time (defined as restoring functionality of houses and infrastructure) and infrastructure outage. Both respondents also indicated that they would like to interact with a risk modelling tool to do the analysis themselves, using their own hazard and exposure data and with the capability to generate their own vulnerability functions.

Both respondents indicated that they need risk outputs in the context of pre-event probabilistic analysis. Pre-event scenario and post-event probabilistic were also of interest.

All interface features provided in Question 14 were deemed important to the two representatives, but the most important were:

- a feature to investigate a user's own input data
- tools to create risk model output report templates
- a feature to display results

- tools to create risk model input datasets (i.e. vulnerability functions), and
- tools to analyse risk model outputs (e.g. loss curve plots).

In the survey, this category was described as 'iwi/hapū and iwi-owned company'. In future, this category should also be inclusive of not only iwi-owned companies but also Māori businesses.

3.2.8 Non-Government Organisations

Historically, the RiskScape team has not engaged with NGOs to a large extent. However, 10 representatives from this sector responded to the survey and highlight future opportunities for engagement with this sector.

Respondents indicated that some from the sector are using software applications to assess risk (Figure 3.3). This included Microsoft Excel, GIS and R. Those who indicated that they were not using software indicated that they either: undertake assessments based on expert elicitation, contracted others to undertake risk modelling for them, currently do not have the capacity/capability or they were currently searching for appropriate software to use.

The risk output options provided in Question 8 were mostly considered important to the 10 participants from NGOs (Figure 3.27). The top three, considered 'very important', were: social and cultural impact, habitability and exposure.

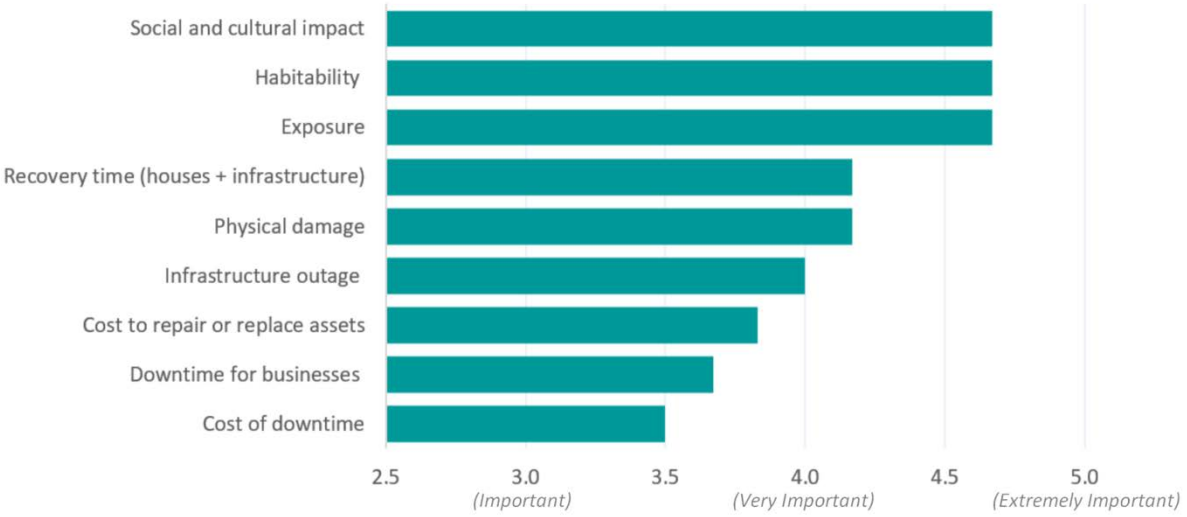

Figure 3.27 Averaged responses from NGO representatives to Question 8: Which risk outputs would you use to carry out your work?

NGO representatives considered all interface features suggested in Question 14 as important. The top three (considered very important) were tools to display results, access and connect to data and a model builder (Figure 3.28).

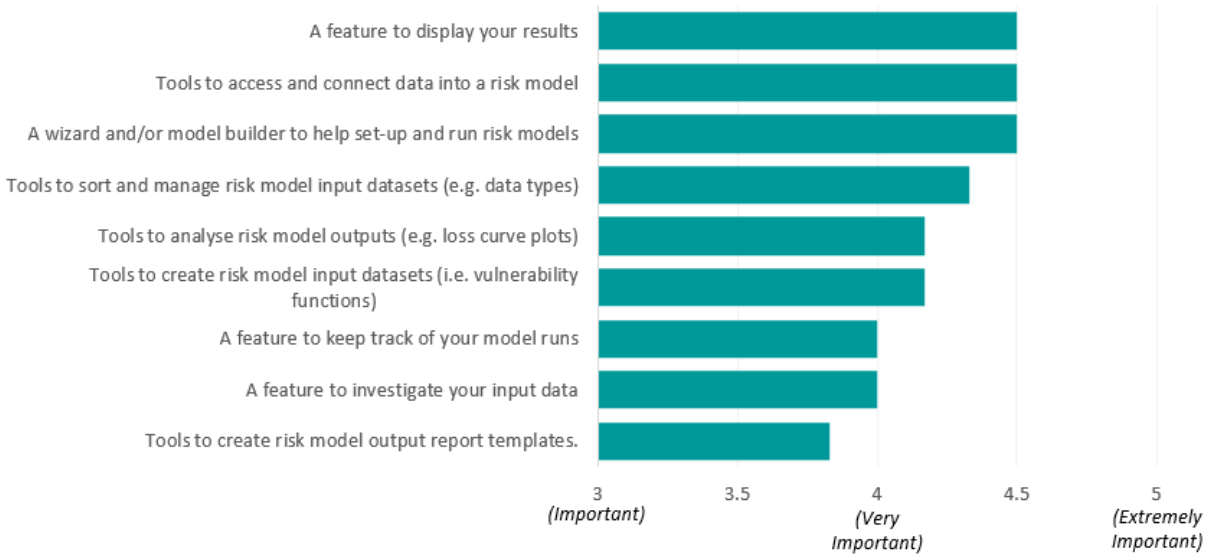

Figure 3.28 Averaged responses from NGO representatives to Question 14: What is important to include in the RiskScape 2.0 interface?

3.2.9 Private Sector Risk Consultants

Some private sector representatives attended the workshops and chose to participate in their respected fields of expertise (e.g. insurance, lifelines/engineering, emergency management, research). The nine survey respondents from this sector indicated that they currently use Microsoft Excel, GIS, scripting and risk software tools to undertake risk assessments or undertake expert-based assessments. The risk output options included in Question 8 were mostly considered important to the nine risk consultants (Figure 3.29). The top three, considered very to extremely important, were physical damage, habitability and recovery time. One respondent also commented that being able to specify insurance and re-insurance excesses, limits and re-insurance layers would be useful.

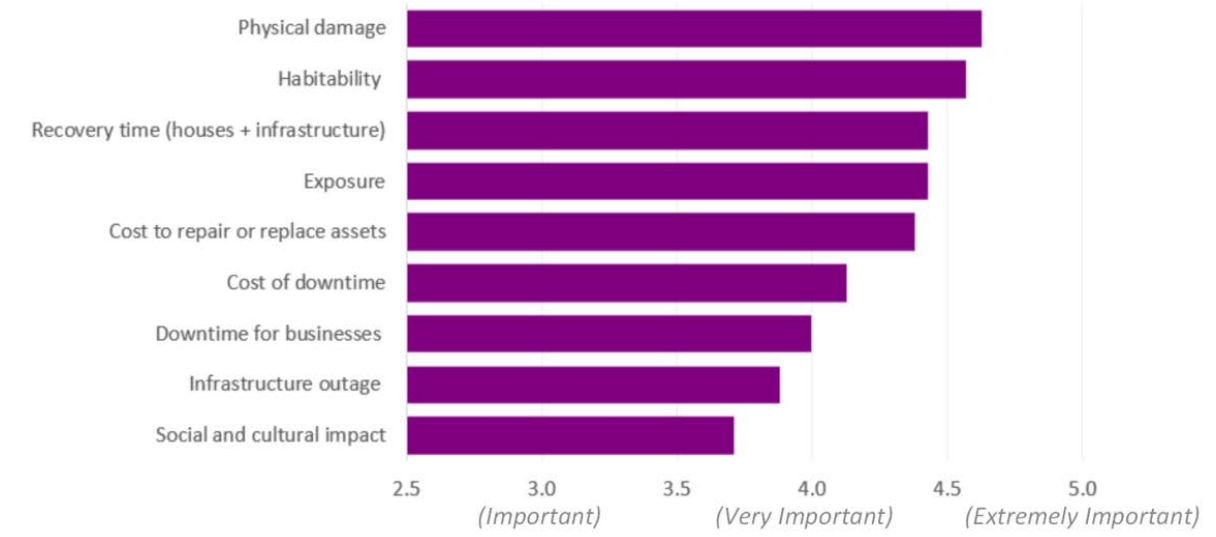

Figure 3.29 Averaged responses from risk consultants to Question 8: Which risk outputs would you use to carry out your work?

Private sector risk consultants considered all interface features suggested in Question 14 as important. The top four (considered very important) were tools to analyse results, display results, create input data and to investigate input data (Figure 3.30).

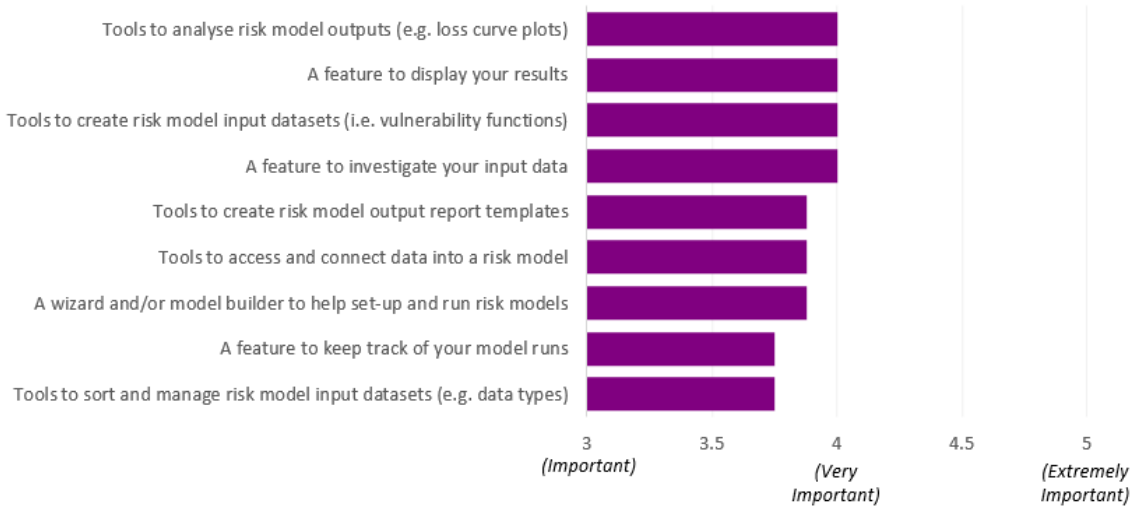

Figure 3.30 Averaged responses from risk consultants to Question 14: What is important to include in the RiskScape 2.0 interface?

3.3 Feedback of Draft RiskScape 2.0 Interface

This section reports the results from Activity 2 (described in Section 2.2.2) of the workshop, where participants tested a draft user interface and provided their input on desired interface features.

Feedback on the draft user interface was collected through individual testing using the 'Chalkmark' user testing software. In this section, the results of the Chalkmark testing are outlined first, then results of sector-based collective review and discussion are presented. This information will support software developers in designing the RiskScape 2.0 user interface.

3.3.1 Individual User Testing of Interface Wire-Frames

Seventy-six participants tested the user interface wire-frames during the workshops (Section 2.2.2). Participants were from a variety of sectors (Figure 3.1 right, Table 3.1), with a high representation from researchers and low representation from risk consultants, the insurance sector and Central Government.

Heatmaps and success rates from the Chalkmark tasks showed that most of the wire-frames were intuitive to the participants (Figure 3.31). All tasks (except Task 6) had a success rate of 79% or greater for all participants (Appendix 5). The draft design (apart from Task 6) also proved intuitive for most of the 'direct users' (people who self-identified as someone who would be directly interacting with the software), with a success rate of 86% or higher.

The task with the poorest response for all participants was Task 6, where they were asked *'You are now in the map preview for your asset data. You now want to look at the vulnerability function used to calculate the loss. Where do you click?'* (Figure 3.32). Comments in the Chalkmark questions and collective feedback in the section below provided good feedback for user interface developers to adapt this and other wire-frames for subsequent workshops. The testing was also carried out for two RiskScape 1.0 user interface screens for comparison.

On both RiskScape 1.0 screens, there was no success in clicking the correct button (Figures A5.7 and A5.8 in Appendix 5).

Of the 43 participants who self-identified as a direct user:

- 54% had used RiskScape before
- After seeing both the old user interface and new draft design, 79% preferred RiskScape version 2.0 over RiskScape 1.0
- 67% would like to preview data in a map view, 12% preferred a table preview and the remaining 21% had no preference (or presumably may like to see both).

Within the Chalkmark tasks (Table A5.1, Appendix 5), participants were asked about estimated frequency of use and preferences for where they would like to analyse outputs and for where data is stored (Table 3.2). Overall, as with the results of Activity 1 in the workshops and the survey, RiskScape 2.0 will need to be flexible to cater for the different needs both across sectors and within sectors. All sectors indicated that they would like the option to be able to analyse results within the RiskScape software.

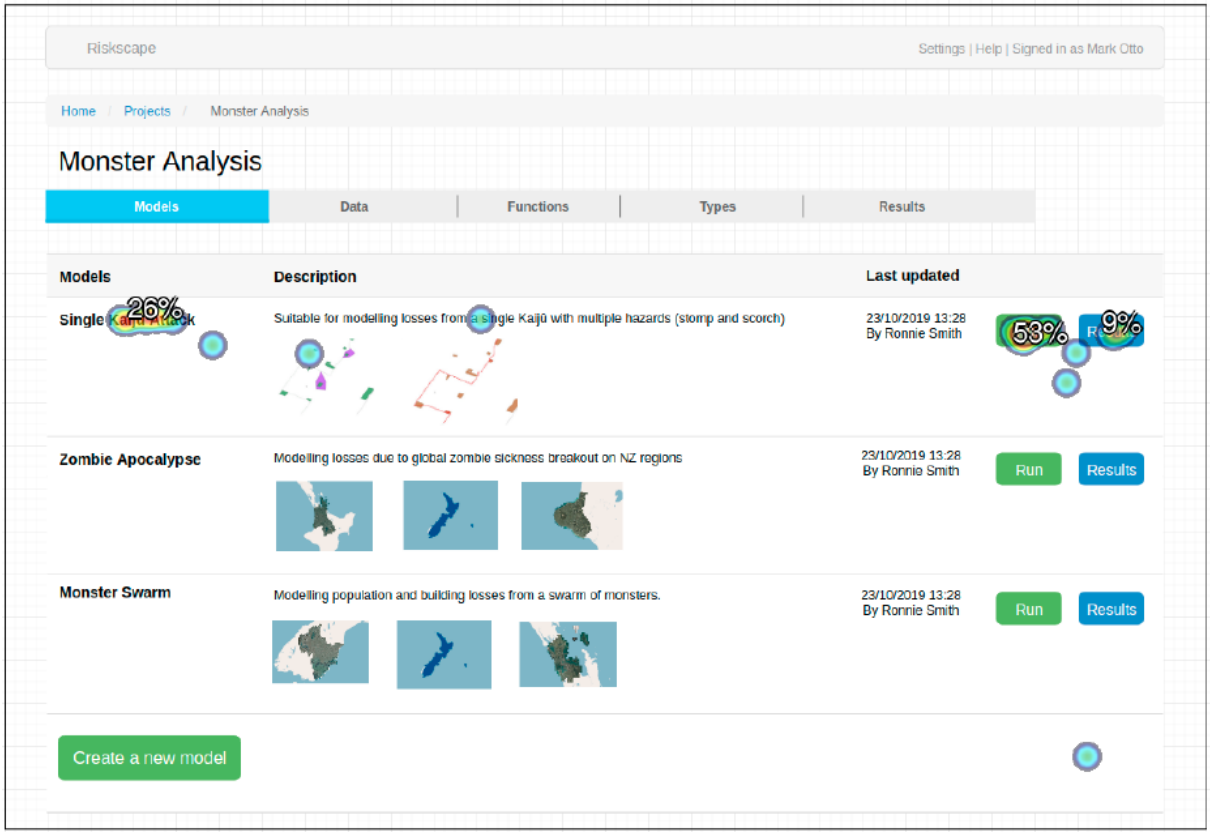

Figure 3.31 Direct user responses to Task 2, where participants were asked to work with their 'Single Kaijū Attack' model. Only one click was unsuccessful (bottom right), the rest would have been successful.

Table 3.2 Sectors that participated in user interface testing. Direct users are those who self-identified as someone who would directly interact with a user interface, and indirect users are those who self-identified as someone who would get someone else in their organisation to run it for them.

Participants	Direct Users	Indirect Users	Total	Frequency of RiskScape Use	Results Analysis Preference	Preferred RiskScape Run Data Storage
Central Government	Undefined (3)	Emergency management (1), undefined (1)	5	A couple of times a month to a couple of times a year	Within RiskScape, Excel or GIS	On a C: drive or within RiskScape
Emergency Management	4	4	8	A couple of times a fortnight, a couple of times a year and during response	Within RiskScape, Excel or GIS	Shared file system, organisation repository or within RiskScape
Planning and Policy	Local government (2)	Local government (3), private sector (2), CRI (1)	8	A couple of times a year and during response	Within RiskScape or GIS	Within RiskScape, on a shared file system or organisation repository
Researcher	CRI (9), university (14), local government (4)	CRI (5), university (4), local government (1) private sector (1)	38	Wide range from weekly to a couple of times a year and during response	Flexibility – Excel, GIS, R, Python, within RiskScape	Flexibility
Lifelines	Private sector (3), local government (2)	Private sector (4), local government (1)	10	Wide range from weekly to a couple of times a year and during response	Within RiskScape, Excel, R or GIS	Flexibility
Risk Consultant	1	2	3	A couple of times a month	Within RiskScape or secured cloud space	Within RiskScape or a shared file system
Insurance and re-insurance	1	1	2	A couple of times a month to a couple of times a year	Within RiskScape	Within RiskScape
Other	0	Geonet (1), Other (1)	2	In response only	Within RiskScape	Within RiskScape
Total	43	33	76			

Figure 3.32 Responses from all participants to Task 6, where they were asked where they would click to look at the vulnerability function used to calculate losses.

3.3.2 Collective Feedback on the Draft Interface Design

Following the individual tasks on navigating the draft interface, sector-based groups discussed their experience and ranked the items that people liked and disliked, on a scale from 1–5, and voted for the most important points (Figure 3.33). The groups across all sectors had similar opinions regarding which items they liked and disliked. The only variation was that emergency management and policy and planning participants highlighted that maps and visuals were important more than other sectors.

Participants across the sectors liked (ranked 4 or 5) and voted for:

- the simplicity and flexibility of the wire-frames (which participants commented were much more intuitive than RiskScape 1.0)
- the concept of following a workflow/pipeline
- visuals with text for navigation
- maps and visuals (maps and tables with preview of the data)
- being able to view history of runs and metadata about these, and
- the option to work in command line rather than the suggested interface.

Other aspects participants liked (ranked 4 or 5 but were not voted) included:

- map thumbnails at each step to view input data;
- simple terminology, e.g. ‘run’;
- intuitive parameter input and the ability to change/swap parameters in the pipeline;

- transparency of the modelling process – being able to see data input and separate data from the models;
- the option to show different interfaces for different levels of users, e.g. communications versus analyst; and
- being asked for feedback.

Participants across the sectors disliked (ranked 1 or 2, voted and unvoted):

- Not being able to see the map and table at the same time, suggested that pop-up screens may be useful.
- the terminology used in the wire-frame, e.g. project versus model, types, functions, parameter, sample, test and history. A comment was made that 'natural hazards' language may not represent an 'all-hazards' future.
- The absence of 'hazard layer' and 'vulnerability models' from the pipeline.
- Draft choices of colour – there were suggestions to avoid red versus green for colour blindness and that red was perceived as 'cancel' or 'wrong'.
- The lack of help functions, as the current workflow assumes some modelling knowledge.
- Any unnecessary information – it could be simpler.

Questions and suggestions for RiskScape engine and interface functionality were organically provided by participants during this activity (were not specific likes or dislikes about the interface), mostly posted under 3 (neutral). Suggestions included:

- providing datasets or links to open data to run analysis with RiskScape;
- drag and drop for data input;
- tool tips (visual and text explanations) and definitions for terms in the pipeline;
- start-up wizard/tips for starter's page/folder;
- addition of a search function;
- using green for action buttons/prompts;
- the ability to change the pipeline for more complex modelling;
- the ability to run multiple models at the same time;
- analysis status / estimated time for run completion;
- some dynamic/exciting visuals, e.g. when waiting for analysis, at completion of analysis;
- the ability to view map and table simultaneously;
- map functions, including layer view (click on and off, such as in GIS), basemap selection, zoom/scroll and crop function (to crop analysis to an area) and time slider;
- clear steps to generate automated report template with input layers used, uncertainty information and outputs selected;
- sorting system for projects, name / date / person working on it and template for what to include in 'Read Me' project description (encourage people to include references, etc.); and
- add an 'open/view' and 'edit' button to the projects screen so that users can view a previous project without re-running it or use the previous project as a template.

Queries included:

- Risk engineers asked if the pipeline could accommodate complex data (e.g. asset files and attributes) and complex modelling, including stochastic, AI input and multi-/cascading hazard. Relatedly, risk scientists asked about the option to add building blocks or change the structure of the building blocks in the pipeline – “How do I feed my model in?”
- How does the pipeline model consider social impacts, cascading hazards and impacts analysis?
- Is there flexibility in what people can export – crop to an area or only part of the process, e.g. exposure?

Other comments:

- Participants from local government did not like the assumption that they are able to produce or possess their own vulnerability models.
- There was concern that, if there were automated map templates, a less-expert user could produce something they did not understand.

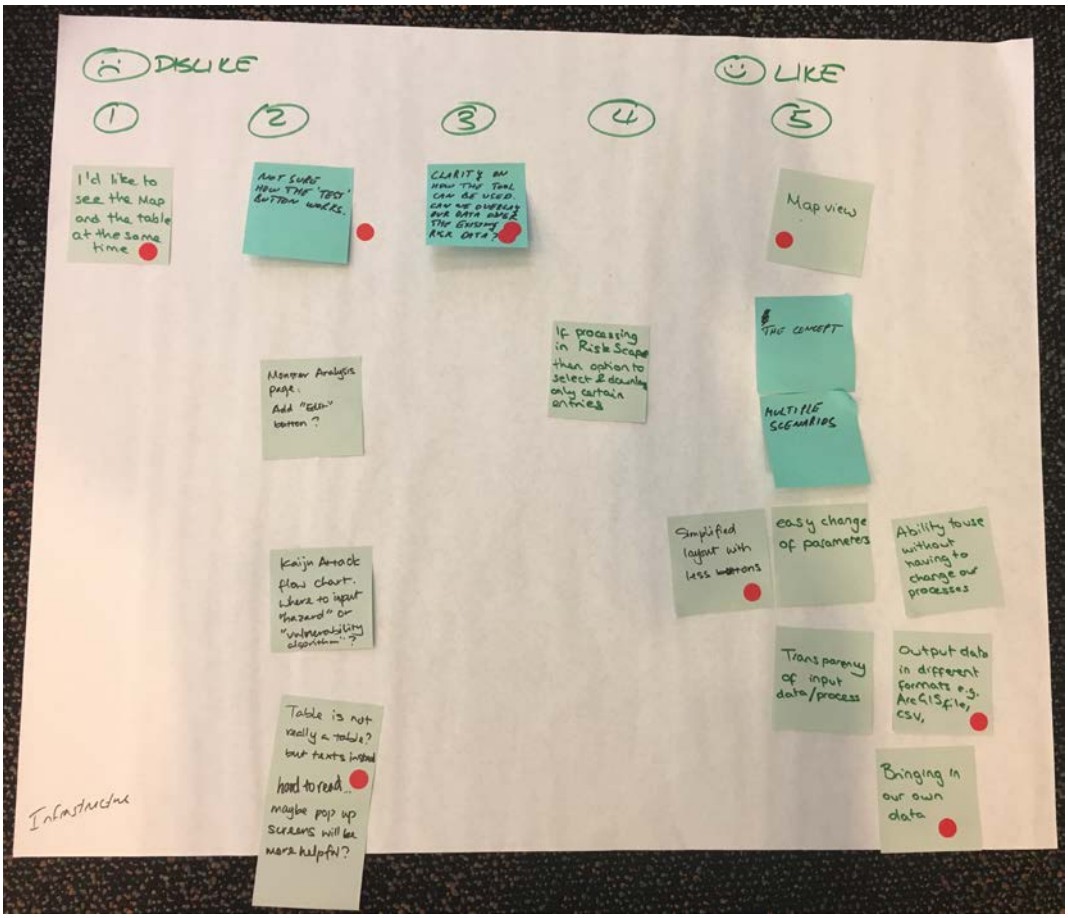

Figure 3.33 Items of the wire-frame that people in the infrastructure group in Dunedin liked and disliked.

4.0 DISCUSSION

4.1 Methods Evaluation

Workshop activities and facilitation techniques that were designed based on agile software development methodologies and guided by principles of liberating structures and practices, as well as social science methods, were effective in achieving research objectives. Current risk assessment and modelling methods used by participants and their challenges were identified, as were sector-based needs and priorities and opportunities, both for risk research and tool development. Results show a variety in risk modelling needs across and within sectors. In future, it would be useful to not only differentiate by sector but also to differentiate by various contributions to risk assessment and modelling. For example, do users only require outputs compared with running the risk tool themselves or contributing to only part of the risk model workflow (e.g. vulnerability model development)? It would also be useful to ask why participants use their preferred risk modelling methodologies to support software development.

The survey provided good information around appetite for a risk modelling tool and some specific and preferred functionality. It may have been useful to include more open-ended questions in the survey around specific requirements, e.g. kinds of result analysis and specific outputs required additional to the examples provided. More questions around participants' specific role within organisations would also have been useful to better define use cases and reasoning for responses. It may be useful to define both whether the participant worked for the private (consultancies, NGOs, tertiary sector) or public sector (Central or Local Government, CRI) and their area of work (emergency management, lifelines, insurance, etc.), as well as their role (e.g. manager versus risk modeller).

Both the workshops and online survey had high representation from researchers. This, and the representation of other sectors shown in Figure 3.1, is to be considered when using the results derived from all participants. High participation from researchers may be due to legacy RiskScape programme efforts to engage with researchers/scientists previously through conferences and university trainings. Of the researchers, there was a higher representation from volcanic risk scientists, and Christchurch had the highest number of researcher attendance. The insurance workshop participants had high representation from EQC and this may have influenced insurance results.

Workshop invitation methods influenced the representation of sectors and bias in the results. To reduce this bias, sections were written specifically on the results from each sector, sectors were clearly defined in graphs such as Figures 3.2, 3.11 and 3.12, where all sectors were represented, and participation was evident through the number of votes placed. For future engagement, it would be useful to snowball invitations to wider audiences.

4.2 Results

4.2.1 Risk Assessment in Aotearoa-New Zealand

Globally, risk assessment methods and models have rapidly developed over the last decade as science and policy communities recognise the need to push toward achieving priorities of the Sendai Framework to reduce natural hazard risk (Ward et al. 2020). Aotearoa-New Zealand researchers and practitioners have already contributed significantly to these advancements, e.g. Magill and Blong (2005), King and Bell (2005), Seville and Metcalfe (2005), Wilson et al. (2012), Saunders et al. (2013), Massey et al. (2014) Jenkins et al. (2014),

Davies et al. (2015), Rovins et al. (2015), Blake et al. (201), Orchiston et al. (2018), Brown et al. (2019), Williams et al. (2019) and many others.

The results of this study show that a variety of methods are used across the sectors to assess risk and impact, selected based on context, capacity/capability, timeframe and budget, where practice varies between regions and within regions. Some uptake of the research mentioned above was evident (e.g. specific mentions of risk matrices, lifelines criticality ranking, AF8 programme and Wellington Resilience Project). However, across the workshops, reference to 'likelihood and consequence', 'end-to-end risk assessments' and the AS/NZ ISO 31000 Risk Management Framework was rare. Participants also identified a key challenge around risk literacy in Aotearoa-New Zealand. This is consistent with the findings of Willis (2014), where a range of approaches are currently being taken to 'risk assessment' in Aotearoa-New Zealand, but expert-supported, genuine risk-based assessments are seldom undertaken:

> *"Most people managing hazards would probably argue they take a risk-based approach. There are, however, very significant differences of view about what a risk-based approach entails"* (p. 40).

This study's participants generally contributed to specific parts of risk analysis (e.g. hazard modellers, developing vulnerability functions or assessing impacts through social science methods and economic modelling) or were risk evaluators, information consumers or decision makers. It is evident that a wide range of software applications are being used to assess exposure, vulnerability and risk, the most popular being GIS and Microsoft Excel, with some scripting and lesser-used risk modelling tools. Workshop participants considered that hazard data and characterisation, multi-agency collaboration to undertake risk assessments using a mixture of qualitative and quantitative methods, expert elicitation workshops and risk matrices are currently working well. Risk modellers were the only group that identified risk analysis as working well. Participants identified a lack of expert-supported, best-practice guidance and standards as a key challenge also identified by Willis (2014). Since the LGNZ review, NEMA have released a draft Risk Assessment Guideline based on the AS/NZ ISO 31000 Framework. However, the draft guideline does not specifically provide guidance on best-practice risk analysis methodologies to derive likelihood and consequences, suggesting that risk modelling tools such as RiskScape provide these standardised methods.

This highlights a gap where risk modelling tools such as RiskScape 2.0 could bridge innovative and best-practice risk assessment methodologies being developed by the risk modelling community and practitioners to support more end-to-end risk-based approaches and multi-agency collaborations, which evidently are working well.

4.2.2 Challenges and Opportunities across Sectors and Disciplines

The results of the workshops are consistent with the findings of Crawford et al. 2018a (which were specific to local government emergency management) but find that the challenge around data is common among all sectors and disciplines. There are also synergies with the challenges identified in Willis (2014) in relation to information availability, comprehensibility and disclosure and the need for a single natural hazards information portal. The key challenges and opportunities for all users are represented in Table 4.1.

Table 4.1 Challenges and opportunities common to all sectors/disciplines.

Challenges	Opportunities
• Datasets are often incomplete, inaccessible, unmaintained, not at suitable resolutions, not standardised, not fit for purpose and unable to represent a dynamic or real-time risk environment • Knowledge of what data exists • Data consistency • Cost of data • Data collection, management and sharing • 'Data hungry' risk models • Quantification and communication of uncertainty • Risk communication • Real-time and impact-based forecasting capabilities • Methodologies to support probabilistic analysis, multi- and cascading hazards, climate change, complex dynamic systems and infrastructure and assess social vulnerability and phyco-social impacts.	• A single natural hazards information portal, a collaborative space where accessible risk data (including those mentioned in Figure 3.7) can be shared securely and peer-reviewed, including national datasets, hazard data, asset data, vulnerability models and damage surveys / empirical data • Open-access data • Collection of more empirical data • National data standards, best-practice guidelines and datasets • More collaboration to avoid duplication and create better integrated and inter-operable systems, including between risk tools • Transparent, open and accessible vulnerability functions (including damage functions and fragility curves) were identified as a key gap and may be inhibiting sector capability to undertake risk analysis • Innovative risk methodologies and technology.

Unique to the emergency management and planning policy sector, participants wished to include qualitative risk modelling and, for non-natural hazard threats (e.g. terrorism and cyber), modelling phases of recovery (social and economic impacts in the short-, immediate- and long-term), impact science for different land-use or intervention scenarios and dynamic adaptive pathways, as well as quantifying resilience.

The lifelines sector would like collaboration and inter-operability around probabilistic outage modelling, as their systems are often interdependent on each other. Unique to the insurance sector was a lack of trained risk model operators where only a small number of experts can operate the models or tools.

4.2.3 User Requirements of a Risk Modelling Tool

A significant finding of this study is that RiskScape 2.0 will need to provide data or access to data for users (from across the sectors and disciplines) to be able to operate it (Section 3.2.1, Figure 3.10). Good metadata will need to be provided with these datasets. It was clear that sectors do not often have access to vulnerability functions and this access will be a limiting factor of using RiskScape 2.0. Participants provided feedback that publicly funded research needs to be publicly available. A user interface feature to access and connect data to the tool was deemed very important across all sectors (Section 3.2).

Requirements of RiskScape vary across sectors and within sectors. Overall, RiskScape will need to be inter-operable, open-access, transparent, intuitive and flexible to suit user needs across and within sectors. An important message from participants was that continued user input is integral in the future development of RiskScape 2.0 if it is to be useful, useable and used and that user needs will change over time.

Emergency management professionals were most interested in disaster impact risk modelling outputs such as habitability, infrastructure outage, physical damage, social cultural impacts and direct exposure (Figure 3.15). These were also of interest to planning and policy, Central Government and NGO participants (Figures 3.16, 3.25, 3.27). Those from the insurance sector were interested in economic outputs such as damage and the cost to repair or replace assets, duration and cost of business downtime and recovery timeframes. Lifelines, researchers and risk consultants indicated that they require a range of direct and indirect impacts/outputs from risk modelling (Figures 3.19, 3.23, 3.29).

Interface features selected by planning and policy and Central Government participants suggest that they are more interested in results of RiskScape analysis and templated reports than in building risk models within the tool themselves, whereas emergency management, lifelines, insurance, researchers, NGOs and risk consultants were interested in interface features to build their own risk models and analyse outputs (Section 3.2).

Forty-one percent of survey respondents indicated that they used GIS to undertake risk assessment, whereas only 12% used scripting languages. This suggests that the user interface should be built to reflect user capability in GIS and Microsoft Excel. The draft user interface wire-frames used in this engagement appeared to reflect this capability; success rates of participants who self-identified as someone who would be directly using the tool were 86% or higher. Participants also identified areas for improvement and specific functionality that would be useful. Interestingly, all sectors had similar opinions around likes and dislikes of the draft design. However, emergency management, policy and planning participants placed more emphasis on the importance of maps and visuals.

4.3 Future User Requirement Engagement

This research has provided insight into sector-based risk modelling needs and priorities of DRR and DRM professionals in Aotearoa-New Zealand to inform the development of the RiskScape 2.0 engine and GUI. Future user requirement evaluation should include further engagement with sectors and disciplines under-represented in the workshops and survey, including:

- Māori iwi and hapū around their risk modelling needs, if or how they would like to interact with RiskScape 2.0 and how the tool may best support their aspirations.
- NGOs and their potential interaction with and desired functionality of RiskScape 2.0.
- Multi-disciplinary consultancies and consultancies across disciplines
- Aotearoa-New Zealand's Pacific partners who have been integral in the development of the legacy RiskScape versions through the Partner Project.
- International users, including government, emergency management, science and NGOs.
- Non-natural hazard disciplines (e.g. public health, security) that may benefit from a risk modelling tool.
- Identification of and engagement with other sectors or user groups interested in RiskScape.

Some participants indicated that they would like to analyse the results within RiskScape, so future engagement could further evaluate specific types of outputs desired (e.g. kinds of loss curves, statistical outputs). Future work could use the survey data collected to evaluate gender-based preferences for risk modelling outputs and user interface design features. As GIS is currently the most popular tool for risk assessment, it would also be useful to evaluate what types of analysis and output creation (e.g. maps) users would prefer to do in GIS and

what they would prefer to do in RiskScape. As participants stated in the workshops, user needs will change; therefore, we will need to be flexible and continued engagement and user input is required to ensure that RiskScape 2.0 is useful, usable and used to support Aotearoa-New Zealand's commitments to DRR.

5.0 CONCLUSION

The aim of this research was to identify RiskScape user needs across DRR and DRM fields of practice in Aotearoa-New Zealand in order to inform software capability and user interface development. This involved an online survey, which received 153 responses, and six workshops that engaged with 76 participants to understand the methods and context for which they are undertaking risk assessments (Objective 1), their current challenges, opportunities (Objective 2) and specific user requirements of a risk modelling tool and user interface (Objective 3), which evaluated potential areas for future investment (Objective 4). Workshop participants provided high-level insight of how the risk sectors in Aotearoa-New Zealand assess risk and contribute to risk analysis, their current challenges and opportunities and testing of a draft user interface, providing useful feedback. The survey questions then supplemented this information with specifics around preferred interactivity with a risk tool and functionality and output requirements.

Currently, a range of approaches are taken to assess 'risk' in Aotearoa-New Zealand. Participants noted that current hazard characterisation, some open-data sources, scenario development, expert elicitation, risk matrices and multi-agency collaboration to undertake risk assessments are working well. However, across the workshops, reference to 'likelihood and consequence' and to the AS/NZ ISO 31000 Risk Management Framework were rare. In general, risk literacy is inconsistent across DRR sectors in Aotearoa-New Zealand and there is no national standard for best-practice risk-based approaches or risk analysis methods. Thus, holistic risk-based assessments seem to be seldom undertaken. The participants in this study generally contribute to parts of the risk assessment process and follow unique approaches depending on their context. GIS, Excel and scripting are the most common software tools used to assess risk or contribute to understanding risk. Participants who were not using software tools either undertake assessments based on qualitative expert judgement, contract others to undertake the assessments for them, currently do not have the capability/capacity to model risk or are the consumers of risk information.

There were several risk modelling challenges and opportunities experienced across Aotearoa-New Zealand. Data gaps and access to data is a key challenge for using risk tools and software to assess risk. This included access to and gaps in asset, hazard and vulnerability data, as well as climate change, multi- and cascading hazards data or data to represent dynamic and complex systems (including temporal impacts such as slow-onset disasters and long-term recovery). Data gaps and access to data is likely to limit users in using RiskScape, with 69% of survey respondents indicating that they would need access to data before they can operate a tool such as RiskScape 2.0. Mean values for each sector show that an interface feature to connect data to RiskScape was considered to be 'very important' by most sectors. 12% of sticky notes in the challenges and wish list activities mentioned vulnerability models, describing the need for transparent, open and accessible vulnerability functions and more collaborative development of these models to support risk analysis. Participants highlighted the need and opportunity for an expert-supported central repository or data-portal, a collaborative space where risk data can be shared securely and peer reviewed, including: national datasets, hazard data, asset data, vulnerability models and damage surveys / empirical data. A single natural hazards information portal was also one of the recommendations from Willis (2014).

Other common challenges and opportunities include initiatives or research to support better means of communicating risk, enable better risk literacy across sectors, build and refine risk modelling methodologies (with a focus on combining quantitative and qualitative

data, better representing complex dynamic hazard and asset systems, incorporating adaptive pathways and for business interruption and phyco-social/cultural impacts), build capability in early warning and impact forecasting, create national standards and datasets, quantify uncertainty and contribute toward filling data gaps around hazards, assets and vulnerability.

Participants in this study require RiskScape 2.0 to be inter-operable, open-access, transparent, intuitive, flexible, collaborative, reliable, expert-supported, secure, open-sourced, fast and visual. This research found diversity in needs both across sectors and within sectors; therefore, RiskScape 2.0 will need to be flexible around input and output file formats, analysis functionality, scale and visualisation of outputs to accommodate the diversity of users both across the sectors and within sectors.

Some participants that had used RiskScape 1.0.3 described the software as useful for evaluating scenario-based quantitative consequences to inform readiness, response and recovery but that it was limited by inflexibility, usability, stability and the inability to process non-point asset data. After seeing both the old user interface and new draft design, 79% of participants preferred RiskScape version 2.0 over RiskScape 1.0.3, and high success rates of tasks performed with the wire-frames indicate that the draft design is much more intuitive, with an opportunity to heed the advice of the participants around desired changes around design and functionality.

Future user requirement work should involve continued engagement with the sectors and user groupings in this study and expansion of the user groups to include wider representation, as well as to engage with sectors under-represented here, including iwi/hapū and Maori businesses and NGOs. Future engagement should also scope other users that may be interested or who may utilise the RiskScape tool in future. User needs of international collaborators also need to be assessed. As participants noted, user input will be integral in designing RiskScape 2.0 to be useful, usable and used. User requirements will change over time so continued two-way communication is vital.

6.0 ACKNOWLEDGMENTS

We would like to thank everyone who took the time to participate in the workshops or online survey; your contributions are greatly appreciated. The authors would also like to thank the wider RiskScape team for help in designing and facilitating workshop activities. We thank Christina Magill and Smrithi Talwar for reviewing this report. This work was funded by GNS Science strategic science investment funding.

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APPENDICES

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APPENDIX 1 RISKSCAPE USER PERSONAS

Personas were developed by Catalyst IT, based on the assumptions of RiskScape team members to understand the diversity of disaster risk reduction (DRR) professionals and their needs for operating a risk tool. This ranged from a Level 1 user to a Level 4 user. The results of this research can now be used to update these personas.

Ronnie (Level 4 user):

- Is a risk analyst and/or researcher, a power user possibly in the tertiary sector, in consultancy or at a research institute.
- Is happy with writing scripts (probably in Python) in a command-line interface (CLI) but would like an application programming interface (API).
- Will not be using a general user interface for any analysis as it will slow him down; he will be feeding the results of calculations into other tools and systems.
- He will want to extend RiskScape with a plugin, for example, write something to batch import hazard layers (100 tsunami spatial files).

Moana (Level 3 user):

- Is more likely a generalist, doing lots of diverse work for a CRI or for consultancy, and understands risk modelling methodologies but does not have the time to learn the code required to operate on command-line, so needs a user interface.
- Needs the path to least resistance to get the job done – uses apps with dialogs, etc., such as GIS, and knows how to use spreadsheet functions to model risk by applying vulnerability functions.
- Would have an understanding of the underlying data and types system.
- Might want to pick vulnerability functions from a repository and pair them with her own but needs some pointers on how to use templates to import functions.
- Likely to do processing of hazard and asset layers outside of RiskScape; she wants to find these in RiskScape and hit run.

Bart (Level 2 user):

- Likely a professional in local government or a student learning about risk modelling.
- Has regular GIS experience, is familiar with interfaces such as Flood Map and has basic spreadsheet skills and limited scripting skills.
- Interested in specific data and functionality to do a job, i.e. wants to make some decisions within the tool.
- Has a hazard map and wants to match it up with a local building set to select from a pre-packaged set of vulnerability functions for a particular scenario and press run.
- May contract consultants (i.e. Moana) to do some data set-up or analysis; will want to re-run with updated datasets.
- Bart would expect Moana to package up appropriate assets, risks and functions for him.

Leilani (Level 2 user in developing country with poor international internet connectivity):

- Is using RiskScape at work (may be CDEM or local Met office), where there is a good local network.
- The international bandwidth is likely to either be slow or poor quality, so she wants local copies of data and functions so it is not required to always reach back to Aotearoa-New Zealand for this.
- May be between a Janice and Bart level.

Janice (Level 1 user)

- Decision maker, she is more likely a user of the services and outputs and needs evidence base. It is likely that Bart or Moana will run RiskScape and give the outputs to Janice to make decisions and report with.
- Has some GIS user experience but does not write scripting code.
- Would like to point and shoot – uses tools/features in software that she has been shown how to use; she just wants to run the maths and get an output, e.g. “Run Hutt River Impact Model”.
- Will not be setting anything up in RiskScape that needs to be done from someone else, i.e. a Moana or Ronnie. May ask a Bart or Moana to provide appropriate hazard, asset and vulnerability datasets and update data in the model (e.g. asset layer has new building data) to re-run at a later stage.

APPENDIX 2 ETHICAL CLEARANCE

FORM 103
Version: Sept 2016

GNS Science

Te Pū Ao

Low Risk Human Ethics Notification

FOR APPROVAL OF PROPOSED RESEARCH/ EVALUATION INVOLVING HUMAN PARTICIPANTS

1. Project Title: RiskScape 2.0 User Experience Requirements Survey (SSIF 1.7.2.2)

   Project Start Date: July 1 2019

   Projected End Date: June 30 2020

2. Applicant Details

   Full Name of Applicant: Kristie-Lee Thomas

   Email address: k.thomas@gns.cri.nz

   Department: Society and Infrastructure

   Team Leader: SR Uma

3. Type of Project: Research to inform software development of RiskScape 2.0

Science/Research Staff	Kristie-Lee Thomas, Maureen Coomer, Finn Scheele, Richard Woods	Support Staff	Catalyst software developer Russel Garlick

4. Summary of Project

   Please outline in lay language why you have chosen this project, what you intend to do and the methods you will use (200 words or less).

New Zealand's natural hazard risk and impact modelling software – RiskScape, is undergoing major redevelopment to improve functionality of the tool and user experiences. This phase of redevelopment provides an opportunity to design the tool to best suit the requirements of our end-users. To do this, we require information from our end-users around their:

- Current interaction with risk tools (what tools they use, and how they use them),
- How they want to interact with risk tools in the future and what data they require,
- The type of risk outputs our users need and how they then use those outputs (interoperability),
- Desirable functions to help users navigate through the user interface.

We would like this information from a variety of sectors who may (or may not) interact with RiskScape 2.0 including:

- Ministry and Central Government
- Civil Defence and Emergency Management (Central and Local Government)
- Planning and Policy
- Lifeline agencies/infrastructure providers
- Insurance providers
- Businesses
- Iwi/hapū (note RiskScape has not yet engaged with any Maori/iwi/hapū/marae and we will not be sending this survey directly to any contacts. However, we would like to include this field in case some of our registered RiskScape members work for iwi/hapū and are involved in risk assessment or emergency management and who may choose to complete the survey)
- International Aid
- Hazards, risk and social scientists.

The survey responses will be used to inform the development and design of RiskScape 2.0 and help to guide future investment. The survey will anonymous, but respondents will be asked what sector they belong to and their role e.g. Local Government planner, CDEM resilience coordinator (to gauge spread of user needs across a sector), data collected will not be identifying. Data will be stored securely within the GNS data management system.

The survey will be distributed through the network of registered RiskScape users (registered to receive RiskScape newsletters) and sent to RiskScape end-user workshop participants. We will ask RiskScape users to pass on the survey to others if they see fit (snowball methodology).

5. List any attachments to your application e.g. completed 'Screening Questionnaire' Advertisement, other.

- Ethics screen survey
- Survey questions https://www.surveymonkey.com/r/RiskScapeUserNeeds
- Survey invite email

FORM 103
Version: Sept 2016

I have read the Notification and approve this project as low risk:

Social Science Reviewer:

Name: Suzanne Paisley Signature:  Date: 22/10/19

Programme Leader

Name: Richard Woods Signature: 

Date: 17/10/2019

FORM 103
Version: Sept 2016

GNS Science

Te Pū Ao

Low Risk Human Ethics Notification

FOR APPROVAL OF PROPOSED RESEARCH/ EVALUATION INVOLVING HUMAN PARTICIPANTS

1. Project Title: RiskScape 2.0 User Experience Requirements Workshops (SSIF 1.7.2.2)

   Project Start Date: July 1 2019

   Projected End Date: June 30 2020

2. Applicant Details

   Full Name of Applicant: Kristie-Lee Thomas

   Email address: k.thomas@gns.cri.nz

   Department: Society and Infrastructure

   Team Leader: SR Uma

3. Type of Project: Research to inform the design of the RiskScape 2.0 user interface.

Science/Research Staff	Support Staff
Kristie-Lee Thomas, Finn Scheele, Richard Woods	Catalyst IT software developer Russel Garlick Other RiskScape team members who may help facilitate workshops

4. Summary of Project

   Please outline in lay language why you have chosen this project, what you intend to do and the methods you will use (200 words or less).

New Zealand's natural hazard risk and impact modelling tool – RiskScape, is undergoing major redevelopment to improve functionality of the tool and user experiences. This phase of redevelopment provides an opportunity to design the user interface to best suit the requirements of our end-users. To do this, we would like to hold workshops around the country to:

- Update our users of changes to the RiskScape programme including the re-design of the engine and user interface,
- and to gather feedback from our users on the design of a draft user interface. This would involve the participants of the workshop working through the new design, at their own pace, while a programme called 'Chalkmark' (a New Zealand formed user testing software https://www.optimalworkshop.com/chalkmark recommended by our software developers Catalyst IT) would evaluate where participants click and in what order when they work through tasks they would undertake while using RiskScape. The participants will then be asked about what they thought of the interface design, whether it was easy to carry out tasks and for suggestions to improve the design. This will provide useful information to Catalyst IT to better the design of the interface to better suit our users.

Participants will be informed about Chalkmark, what data is being collected, how it will be processed and security of the data. The responses collected will be anonymous, but respondents will be asked what sector they belong to e.g. Local Government planner, GIS specialist (to understand how we can best design the interface for our range of users), this information will not be identifying. Data will be stored securely at Catalyst IT where only Russel Garlick will have access to the data. There are no risks to the participant while undertaking this activity.

List any attachments to your application e.g. completed 'Screening Questionnaire' Advertisement, other.

- Completed screening questionnaire
- Workshop invitation
- Workshop agenda
- Chalkmark questions associated with the participants response to the draft design.

I have read the Notification and approve this project as low risk:

Social Science Reviewer:

Name: Suzanne Paisley Signature:  Date: 22/10/2019

Name: Richard Woods Signature: 
Date: 17/10/2019

APPENDIX 3 RISKSCAPE SURVEY

A3.1 Survey Demographics

The following graphs help to understand survey demographics to better understand representation included in the results of this research.

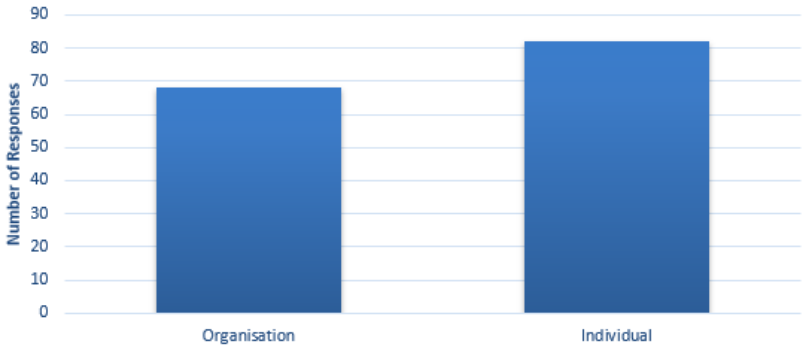

Figure A3.1 Responses to Question 1: Are you completing this survey as a representative from an organisation or as an individual?

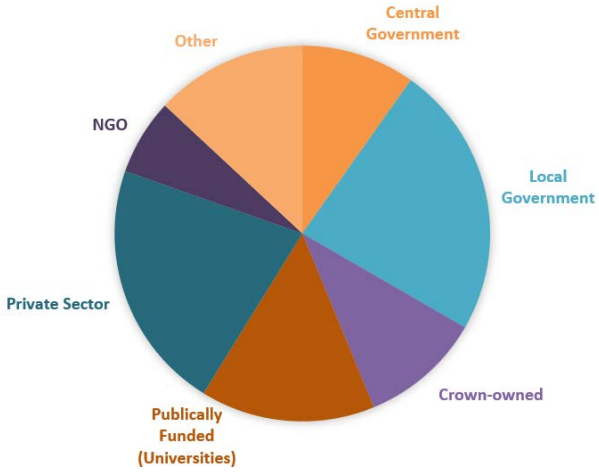

Figure A3.2 Responses adapted from Question 2: Please indicate which category best applies best to you / your organisation.

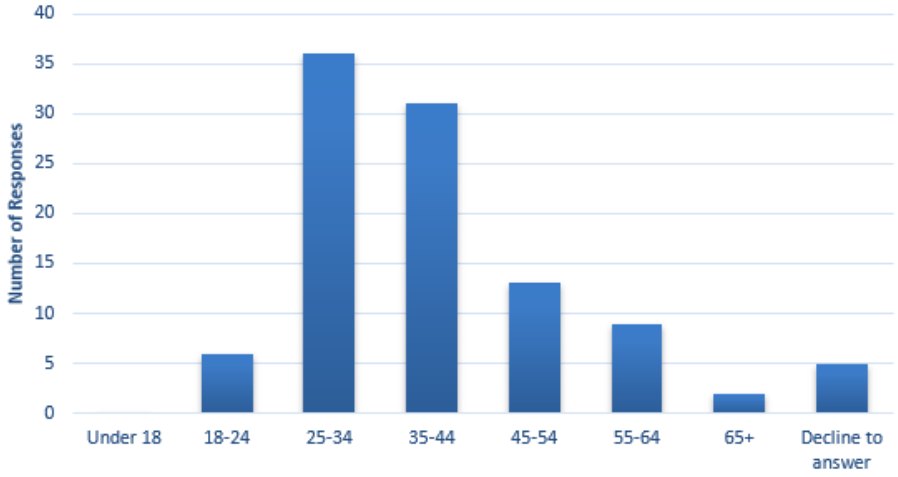

Figure A3.3 Responses to Question 17: What age bracket are you in?

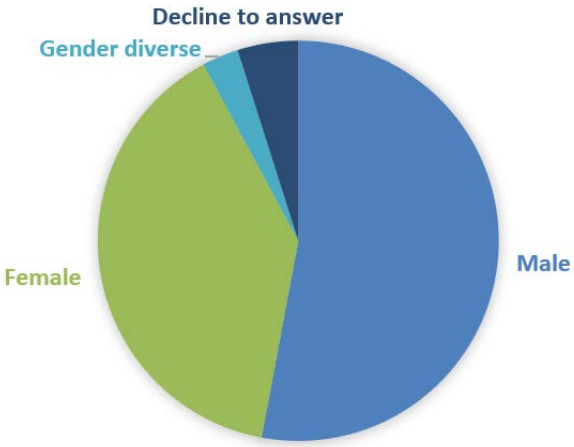

Figure A3.4 Responses to Question 16: What gender do you most identify with?

A3.2 Outreach and How Users Want to Interact with RiskScape 2.0

The following graphs help to identify useful marketing avenues for RiskScape 2.0 and user interaction with RiskScape 2.0.

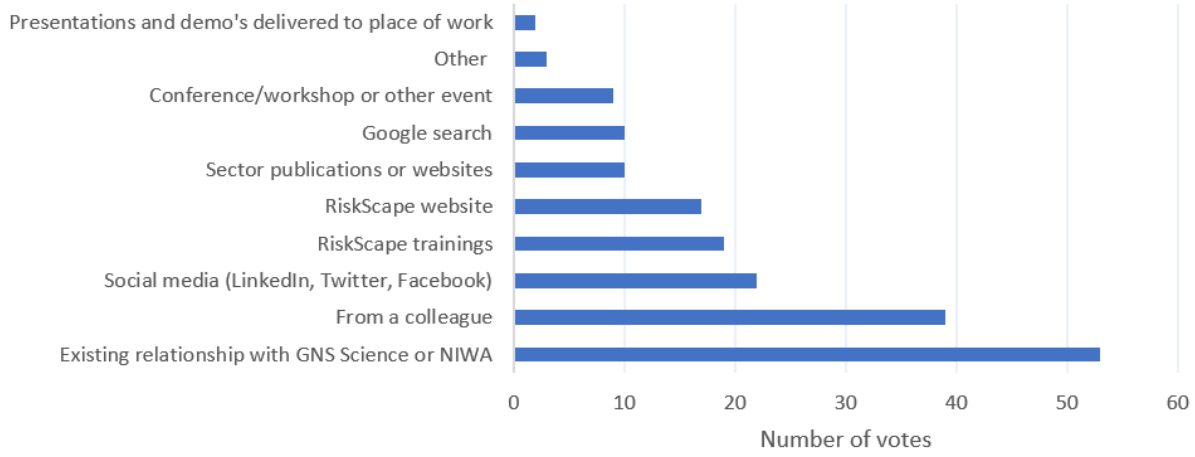

Figure A3.5 Responses to Question 3: How did you first hear about RiskScape? 'Other' included through hearing processes.

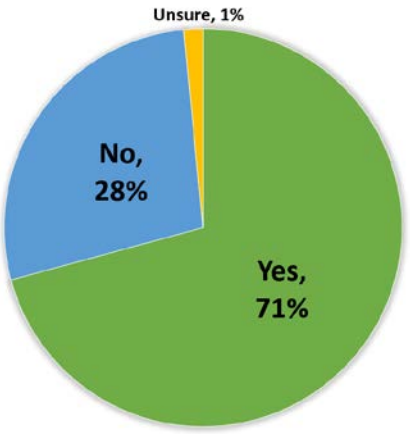

Figure A3.6 Responses to Question 4: Do you currently use software applications to create or assess natural hazard risk information?

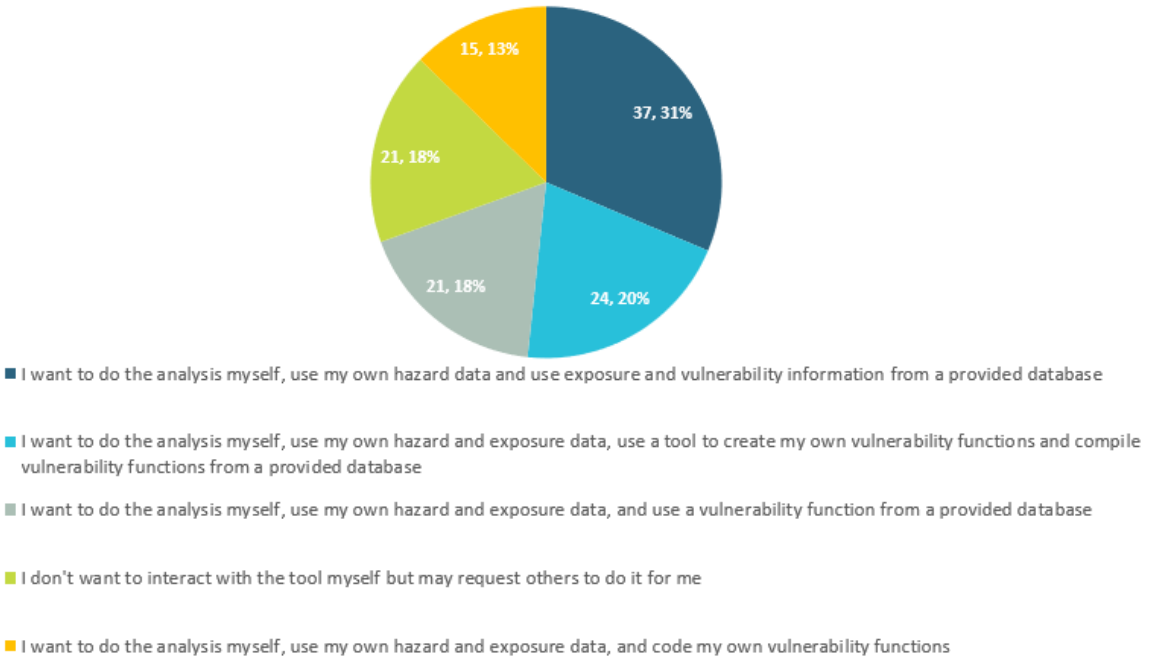

Figure A3.7 Responses to Question 13: How would you like to interact with a risk tool?

A3.3 Sector-Based Responses

Tables A3.1–A3.4 show sector-based results for Questions 4, 7, 8 and 9.

Table A3.1 Sector-based responses to Question 4: If you do use software applications to assess/model risk, what do you currently use?

Sector	Not Applicable		GIS		Excel		RiskScape		Scripting (e.g. Python)		Other Risk Tools (e.g. HAZUS)	
	Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %
Central Government	2	13.3	4	4.7	3	5.7	0	0	1	4	5	21.7
NEMA	0	0	0	0	0	0	0	0	0	0	0	0
Local Government Planning or Policy	1	6.7	6	7	2	3.8	1	5	0	0	0	0
Local Government Asset Manager	0	0	8	9.3	4	7.5	1	5	1	4	3	13
Local Government Researcher	1	6.7	5	5.8	2	3.8	0	0	0	0	0	0
Local Government Emergency Management	0	0	9	10.5	6	11.3	4	20	0	0	0	0
Iwi, hapū or iwi-owned company	1	6.7	1	1.2	0	0	0	0	1	4	0	0
Crown Research Institute Researcher	1	6.7	13	15.1	9	17	6	30	7	28	3	13
University Researcher	1	6.7	12	14	9	17	3	15	7	28	1	4.3
Private Sector / Risk Consulting	0	0	7	8.1	5	9.4	1	5	2	8	4	17.4
Private Sector Infrastructure	2	13.3	11	12.8	5	9.4	1	5	3	12	1	4.3
Private Sector Researcher	1	6.7	2	2.3	1	1.9	1	5	1	4	1	4.3
Insurance/Re-insurance	0	0	3	3.5	4	7.5	1	5	1	4	4	17.4
Non-Governmental Organisation	1	6.7	3	3.5	2	3.8	0	0	1	4	0	0
Non-New Zealand Government	2	13.3	0	0	0	0	1	5	0	0	0	0
Non-New Zealand Researcher	1	6.7	2	2.3	1	1.9	0	0	0	0	1	4.3
Other	1	6.7	0	0	0	0	0	0	0	0	0	0
Total	15	100	86	100	53	100	20	100	25	100	23	100

Table A3.2 Sector-based responses to Question 7: In what context do you need risk outputs?

Sector	Pre-Event Scenario		Pre-Event Probabilistic		Post-Event Scenario		Post-Event Probabilistic		Other (Please Specify)	
	Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %
Central Government	10	10.5	8	8.6	6	8.7	3	5.2	2	25
NEMA	0	0	0	0	0	0	0	0	0	0
Local Government Planning or Policy	7	7.4	7	7.5	4	5.8	4	6.9	1	12.5
Local Government Asset Manager	7	7.4	3	3.2	7	10.1	3	5.2	1	12.5
Local Government Researcher	6	6.3	5	5.4	1	1.4	0	0	0	0
Local Government Emergency Management	8	8.4	8	8.6	8	11.6	6	10.3	0	0
Iwi, hapū or iwi-owned company	1	1.1	2	2.2	0	0	1	1.7	0	0
Crown Research Institute Researcher	15	15.8	14	15.1	13	18.8	12	20.7	0	0
University Researcher	9	9.5	12	12.9	7	10.1	8	13.8	1	12.5
Private Sector / Risk Consulting	6	6.3	7	7.5	5	7.2	4	6.9	1	12.5
Private Sector Infrastructure	9	9.5	9	9.7	7	10.1	6	10.3	1	12.5
Private Sector Researcher	3	3.2	2	2.2	2	2.9	2	3.4	0	0
Insurance/Re-insurance	4	4.2	6	6.5	2	2.9	2	3.4	0	0
Non-Governmental Organisation	6	6.3	6	6.5	5	7.2	5	8.6	0	0
Non-New Zealand Government	1	1.1	1	1.1	0	0	0	0	1	12.5
Non-New Zealand Researcher	3	3.2	3	3.2	2	2.9	2	3.4	0	0
Other	0	0	0	0	0	0	0	0	0	0

Table A3.3 Sector-based responses to Question 8: Which risk outputs would you use to carry out your work?

Sector	Exposure	Physical Damage	Infrastructure Outage	Cost to Repair or Replace Assets	Habitability Information	Recovery Time (Houses + Infrastructure)	Downtime of Businesses	Cost of Downtime	Social and Cultural Impact
Central Government	5.17	4.75	3.83	4.33	4.50	3.92	3.58	3.82	3.92
NEMA	0	0	0	0	0	0	0	0	0
Local Government Planning or Policy	4.38	4.38	3.63	3.50	3.75	3.88	3.13	3.00	3.75
Local Government Asset Manager	4.67	4.44	4.11	4.11	3.00	3.56	3.44	2.89	3.56
Local Government Researcher	4.17	3.83	3.83	4.00	3.67	3.67	3.50	3.50	4.00
Local Government Emergency Management	4.67	4.78	4.78	3.44	4.88	4.33	3.89	3.00	4.67
Iwi, hapū or iwi-owned company	3.50	4.00	4.50	3.50	4.00	4.50	4.00	4.00	4.50
Crown Research Institute Researcher	4.35	4.29	3.82	4.06	3.65	3.41	3.76	3.82	3.88
University Researcher	4.53	4.73	4.67	3.71	3.67	4.20	3.60	3.40	3.60
Private Sector / Risk Consulting	4.43	4.63	3.88	4.38	4.57	4.43	4.00	4.13	3.71
Private Sector Infrastructure	3.92	4.54	4.08	3.31	3.23	3.38	2.92	3.00	3.15
Private Sector Researcher	4.00	3.67	4.67	2.33	3.33	3.00	3.67	2.00	3.67
Insurance/Re-insurance	3.33	4.67	3.83	4.67	3.50	3.83	4.00	3.83	3.50
Non-Governmental Organisation	4.67	4.17	4.00	3.83	4.67	4.17	3.67	3.50	4.67
Non-NZ Government	3.50	5.00	4.50	4.00	4.00	4.00	3.50	2.50	3.00
Non-NZ Researcher	5.00	4.75	3.50	4.00	4.25	4.00	3.50	3.00	4.00

Table A3.4 Sector-based responses to Question 9: In what context do you need risk outputs?

Sector	Pre-Event Scenario		Pre-Event Probabilistic		Post-Event Scenario		Post-Event Probabilistic		Other (Please Specify)	
	Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %
Central Government	10	10.5	8	8.6	6	8.7	3	5.2	2	25
NEMA	0	0	0	0	0	0	0	0	0	0
Local Government Planning or Policy	7	7.4	7	7.5	4	5.8	4	6.9	1	12.5
Local Government Asset Manager	7	7.4	3	3.2	7	10.1	3	5.2	1	12.5
Local Government Researcher	6	6.3	5	5.4	1	1.4	0	0	0	0
Local Government Emergency Management	8	8.4	8	8.6	8	11.6	6	10.3	0	0
Iwi, hapū or iwi-owned company	1	1.1	2	2.2	0	0	1	1.7	0	0
Crown Research Institute Researcher	15	15.8	14	15.1	13	18.8	12	20.7	0	0
University Researcher	9	9.5	12	12.9	7	10.1	8	13.8	1	12.5
Private Sector / Risk Consulting	6	6.3	7	7.5	5	7.2	4	6.9	1	12.5
Private Sector Infrastructure	9	9.5	9	9.7	7	10.1	6	10.3	1	12.5
Private Sector Researcher	3	3.2	2	2.2	2	2.9	2	3.4	0	0
Insurance/Re-insurance	4	4.2	6	6.5	2	2.9	2	3.4	0	0
Non-Governmental Organisation	6	6.3	6	6.5	5	7.2	5	8.6	0	0
Non-New Zealand Government	1	1.1	1	1.1	0	0	0	0	1	12.5
Non-New Zealand Researcher	3	3.2	3	3.2	2	2.9	2	3.4	0	0
Other	10	10.5	8	8.6	6	8.7	3	5.2	2	25

APPENDIX 4 WORKSHOP DATA

This section provides examples of data collected from the workshops.

A4.1 Activity One: Risk Scene Setting

Figures A4.1–A4.7 show examples of the quadrant on which sector-based groups placed and prioritised their points (red dots).

Figure A4.1 CDEM and Planners group Activity 1 responses from the Wellington practitioners workshop.

Figure A4.2 CDEM and Planners group Activity 1 responses from the Auckland workshop.

Figure A4.3 Insurance group Activity 1 responses from the Wellington practitioners workshop.

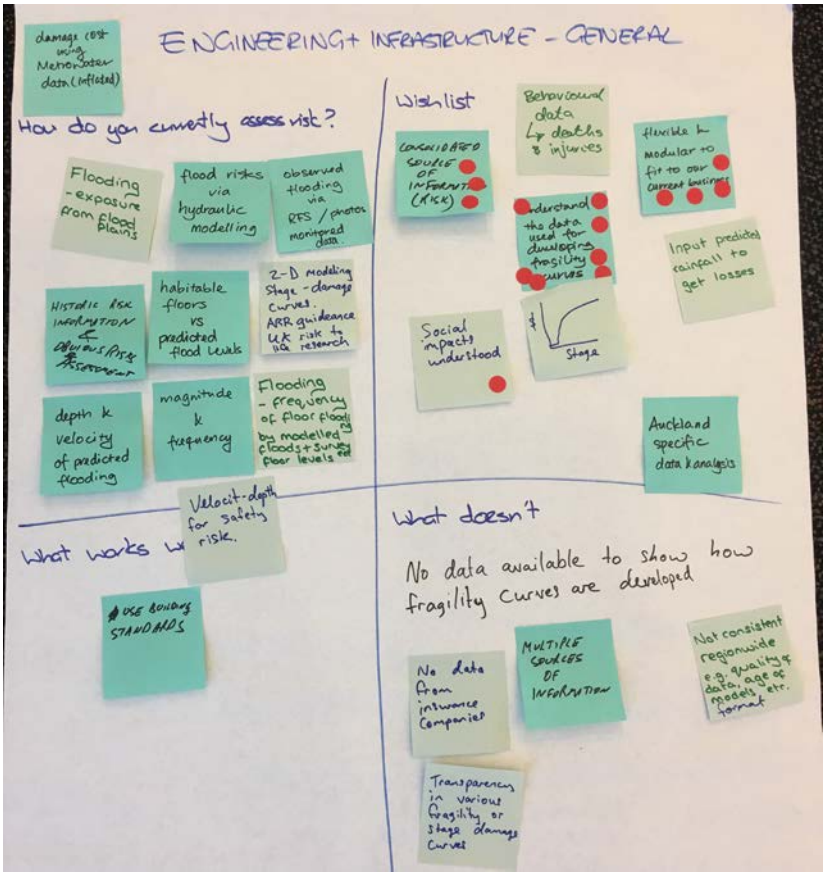

Figure A4.4 Lifelines group Activity 1 responses from the Auckland workshop.

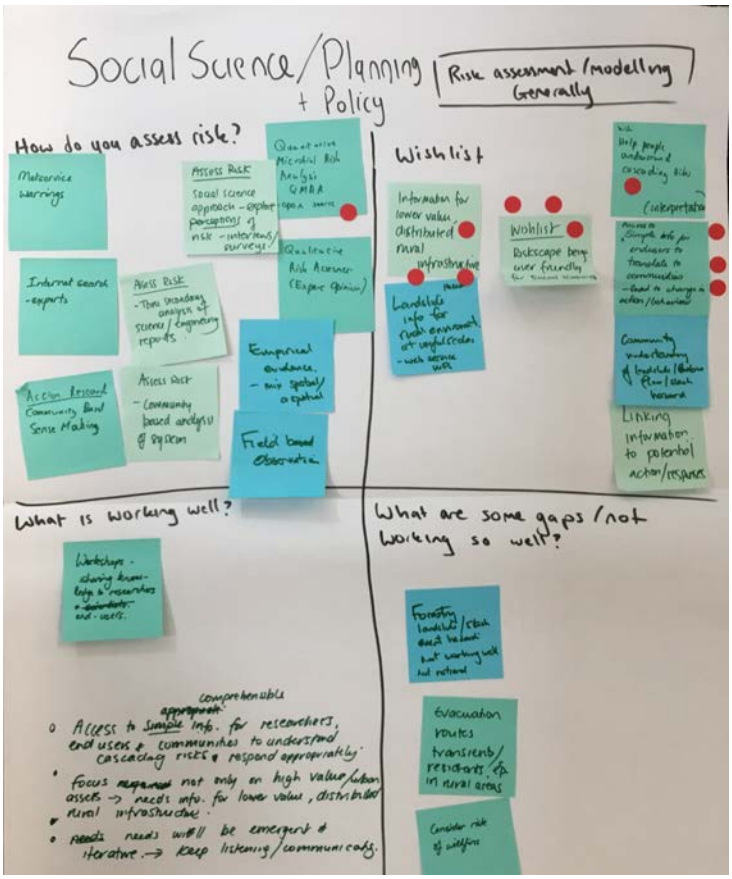

Figure A4.5 Social science and planning/policy academics Activity 1 responses from the Christchurch Science workshop.

Figure A4.6 Christchurch hazard and risk scientists group Activity 1 responses, specifically around RiskScape.

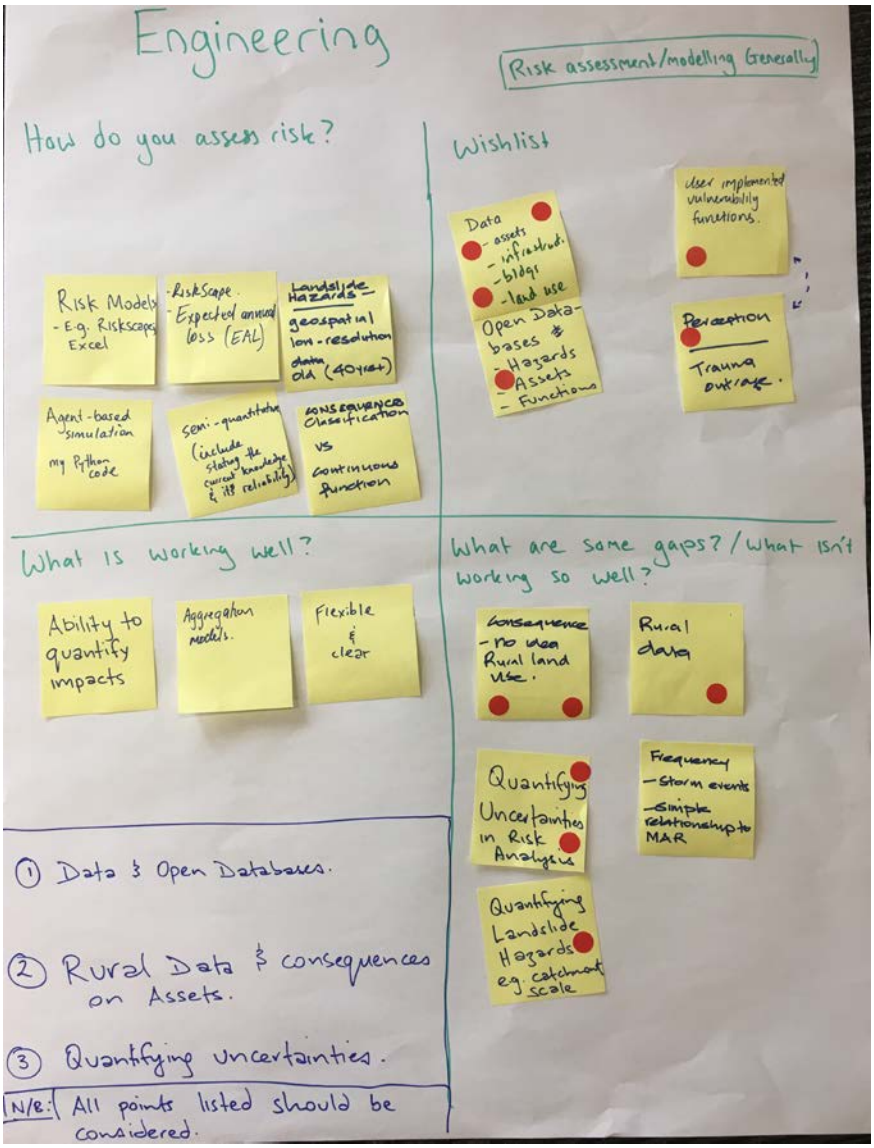

Figure A4.7 Engineering academics Activity 1 responses from the Christchurch Science workshop.

APPENDIX 5 USER TESTING

A5.1 Chalkmark Tasks and Survey

A survey was designed by Catalyst IT to accompany the user interface testing. This allowed more information to be gathered about the participants and how conditions, such as whether they would be using the tool, influenced the results. Some questions were the same as those in the RiskScape survey.

Before testing the wire-frames, participants were asked:

1. What best describes your role?
2. Please describe your role to us.
3. Which of these tools are you comfortable using?
4. When it comes to Risk Modelling, which of these activities do you expect to complete?
5. How do you currently use risk outputs? (Tick all that apply.)
6. How often do think you would use a Risk Modelling Tool such as RiskScape?

Workshop participants were asked to undertake the following tasks in Table A5.1 by clicking on the wire-frame. Figures A5.1–A5.8 show the responses as a heat map (in some cases, the participant could click on numerous locations to be 'successful'). Accompanying these tasks was a number of questions to help developers understand user requirements (summarised in Table A5.1). Task 1:

1. In a sentence or two, what do you think a 'project' is?
2. Given what you know of RiskScape and the way you structure your work, how much do you agree with the following statement: This screen makes sense to me.
3. Given your role, from the projects screen, what do you expect that you would be doing most often?
4. Was there anything missing that you expected to see on this screen?

Task 2:

1. Did the project screen look like what you were expecting?
2. Please give a short reason for your previous answer. A sentence or two is fine.
3. When using RiskScape, I expect to:

Task 3:

1. In a sentence or two, what do you think RiskScape is showing you here?
2. Is there anything missing?
3. If you answered 'Yes', what else would you expect to see?

Task 5: The Asset data in this instance is a table with a geometry attribute. When previewing this kind of data, what would you prefer?

Task 6: Using the scale below, mark how much you agree with the following statement: "I would expect to see a map preview all the time in RiskScape for it to make sense to me".

Task 7: Where do you expect to store the results of previous RiskScape runs?

Task 8:

1. Did you expect to see multiple files in the results?
2. The results listing for this analysis includes: 1) individual losses, 2) regional losses, 3) asset file used, 4) hazard file used and 5) the manifest (the manifest includes all the meta data, settings and parameters used for this analysis, including which vulnerability function was used. It includes version information for all the components). On the scale below, how useful is this for your day to day work?
3. Where would you prefer to carry out analysis of your results?

Task 9: Have you used RiskScape 1.0.3 before?

Task 10: Given you have now seen both screens from RiskScape 1.0.3 and RiskScape 2.0, please indicate which style of interface you prefer.

Following the activities, these questions were asked:

1. Now that you have seen a prototype of the RiskScape interface, how likely is it this tool is something you would use as part of your job?
2. Based on what you have seen today, do you have any comments you would like to make?

Table A5.1 Chalkmark tasks and responses.

Task	Description	Responses from All Participants	Only Participants That Indicated They Would Be the Ones Directly Using the Tools Themselves
1	You are viewing a list of projects set up in your RiskScape instance. You want to view your 'Monster Analysis' project. What do you click?	Clicks: 79 Successful: 75 Skips: 0 Average time: 16.5 (secs)	Clicks: 43 Successful: 42 Skips: 0 Average time: 16.6 (secs)
2	You are now looking at your Monster Analysis project. It contains three different models. You want to work with your 'Single Kaijū Attack' model. Where do you click?	Clicks: 77 Successful: 70 Skips: 0 Average time: 26.0 (secs)	Clicks: 43 Successful: 42 Skips: 0 Average time: 28.6 (secs)
3	You are now viewing your Single Kaijū Attack model. Where would you click to run the model?	Clicks: 77 Successful: 69 Skips: 0 Average time: 19.1 (secs)	Clicks: 43 Successful: 40 Skips: 0 Average time: 19.7 (secs)
4	Looking at your Single Kaijū Attack model, you want to look at the asset data being used. Where do you click?	Clicks: 76 Successful: 67 Skips: 0 Average time: 12.1 (secs)	Clicks: 43 Successful: 40 Skips: 0 Average time: 10.6 (secs)

Task	Description	Responses from All Participants	Only Participants That Indicated They Would Be the Ones Directly Using the Tools Themselves
5	You are now viewing the Asset step of your Single Kaiju Model processing pipeline. A pipeline is a series of steps that the user can define. You want to change the asset file to something else; where do you click?	Clicks: 76 Successful: 60 Skips: 0 Average time: 26.0 (secs)	Clicks: 43 Successful: 37 Skips: 0 Average time: 26.8 (secs)
6	You are now in the map preview for your asset data. You now want to look at the vulnerability function used to calculate the loss. Where do you click?	Clicks: 76 Successful: 40 Skips: 0 Average time: 36.3 (secs)	Clicks: 43 Successful: 25 Skips: 0 Average time: 36.7 (secs)
7	You need to view the results for the last model run of your Kaijū attack model. Where do you click?	Clicks: 76 Successful: 75 Skips: 0 Average time: 13.3 (secs)	Clicks: 43 Successful: 43 Skips: 0 Average time: 11.5 (secs)
8	You are now viewing the results for the Single Kaijū attack. You want to download the results for the latest run. Where do you click?	Clicks: 76 Successful: 74 Skips: 0 Average time: 26.2 (secs)	Clicks: 43 Successful: 43 Skips: 0 Average time: 28.3 (secs)
9	The screen below is taken from RiskScape 1. This is what it looks like when it is first installed. If you were going to replicate your Single Kaijū Attack analysis in RiskScape 1, where would you click first?	Clicks: 76 Successful: 0 Skips: 0 Average time: 34.8 (secs)	Clicks: 43 Successful: 0 Skips: 0 Average time: 36.1 (secs)
10	The screen below is taken from RiskScape 1.0.3, which has been set up by someone ready to use. If you were going to replicate your Single Kaijū Attack analysis in RiskScape 1, where would you click first?	Clicks: 76 Successful: 0 Skips: 0 Average time: 35.6 (secs)	Clicks: 43 Successful: 0 Skips: 0 Average time: 38.5 (secs)

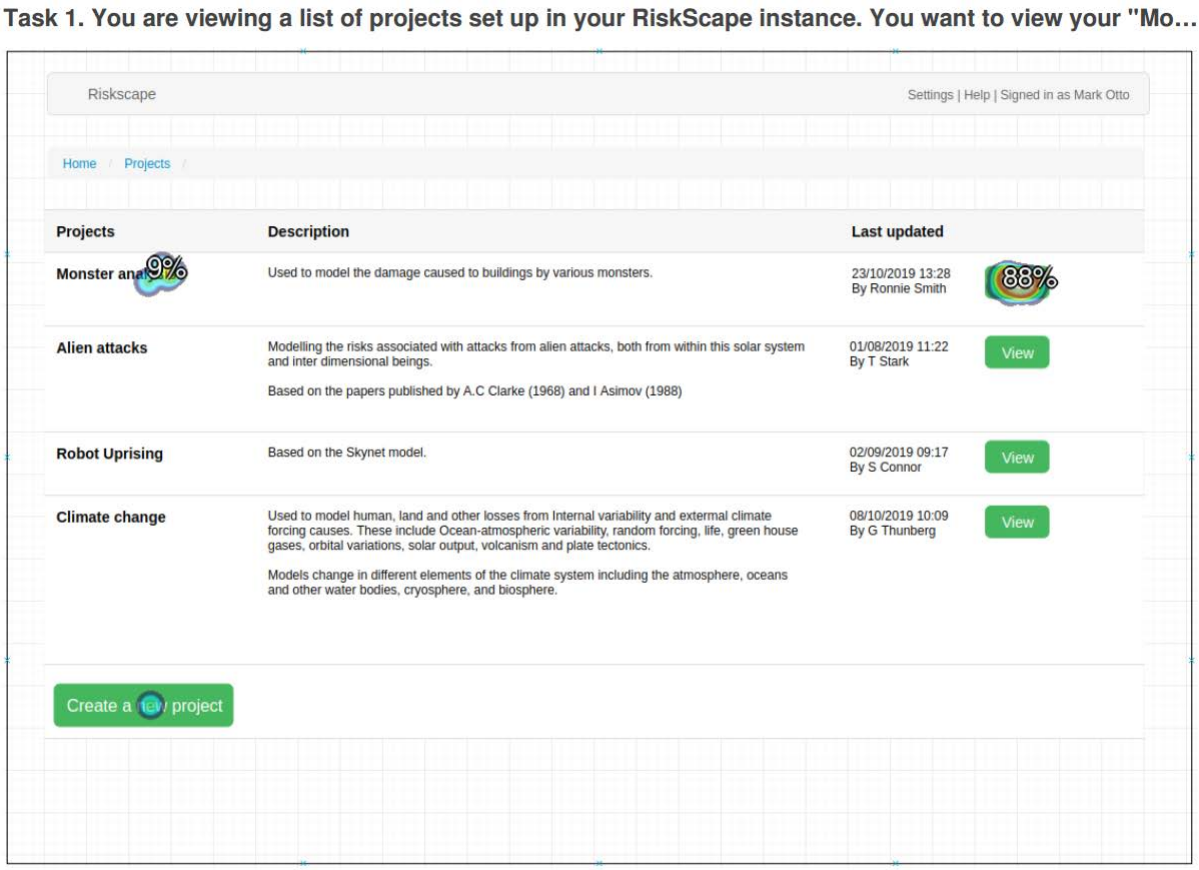

Figure A5.1 Chalkmark screenshot of responses to Task 1.

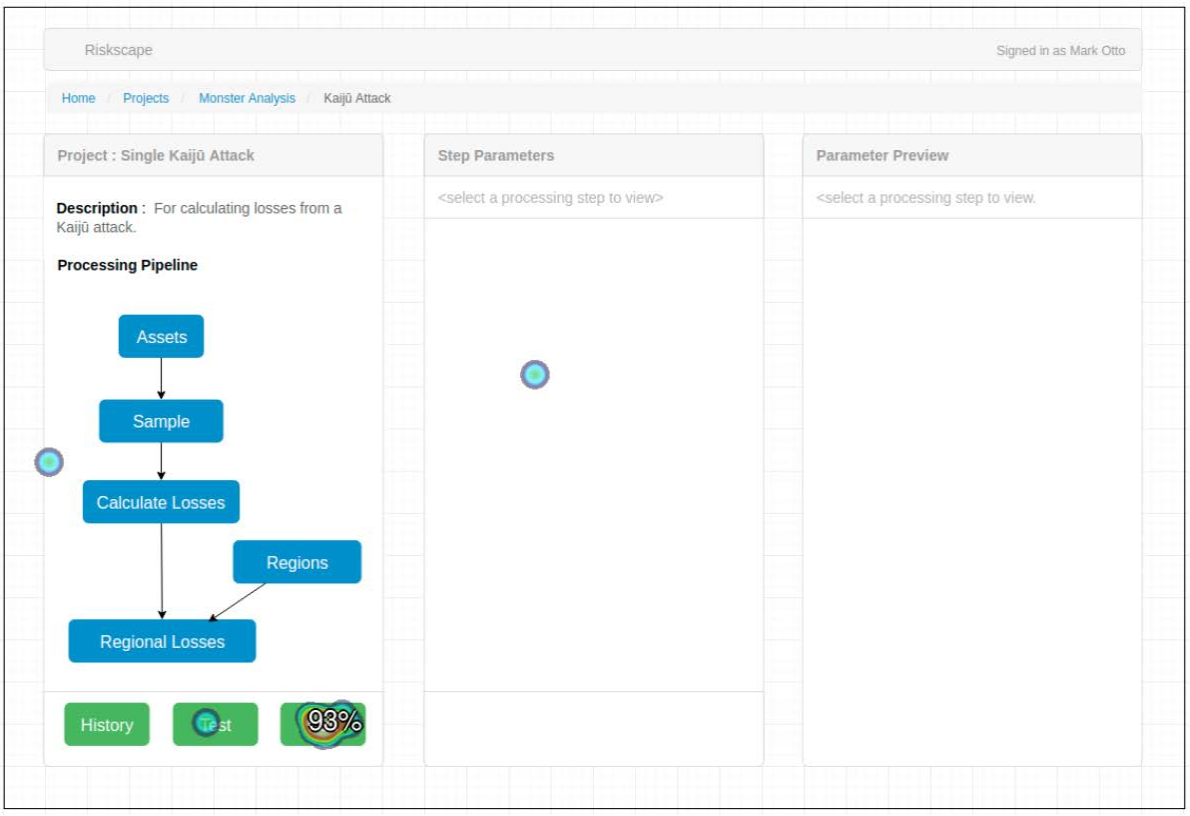

Figure A5.2 Chalkmark screenshot of responses to Task 3.

Task 4. Looking at your Single Kaijū Attack model, you want to look at the asset data being used. Where..

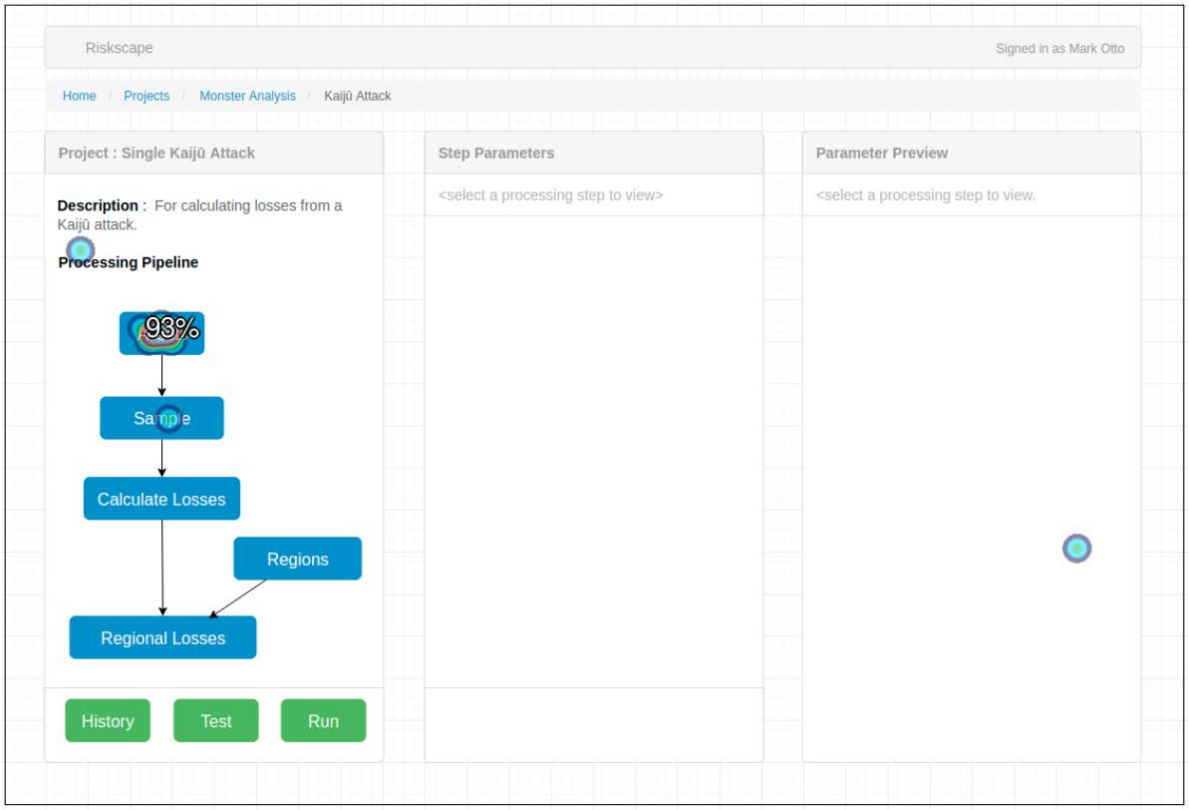

Figure A5.3 Chalkmark screenshot of responses to Task 4.

Task 5. You are now viewing the Asset step of your Single Kaijū Model processing pipeline. A pipeline i...

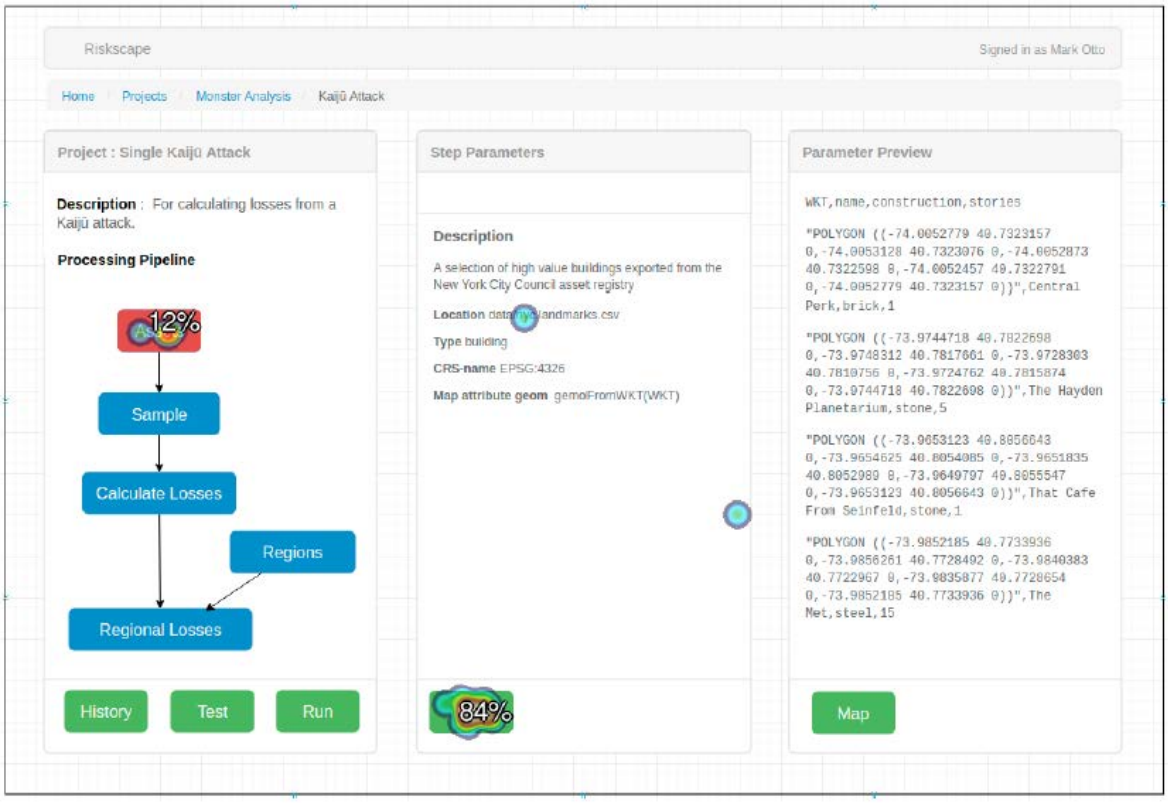

Figure A5.4 Chalkmark screenshot of responses to Task 5.

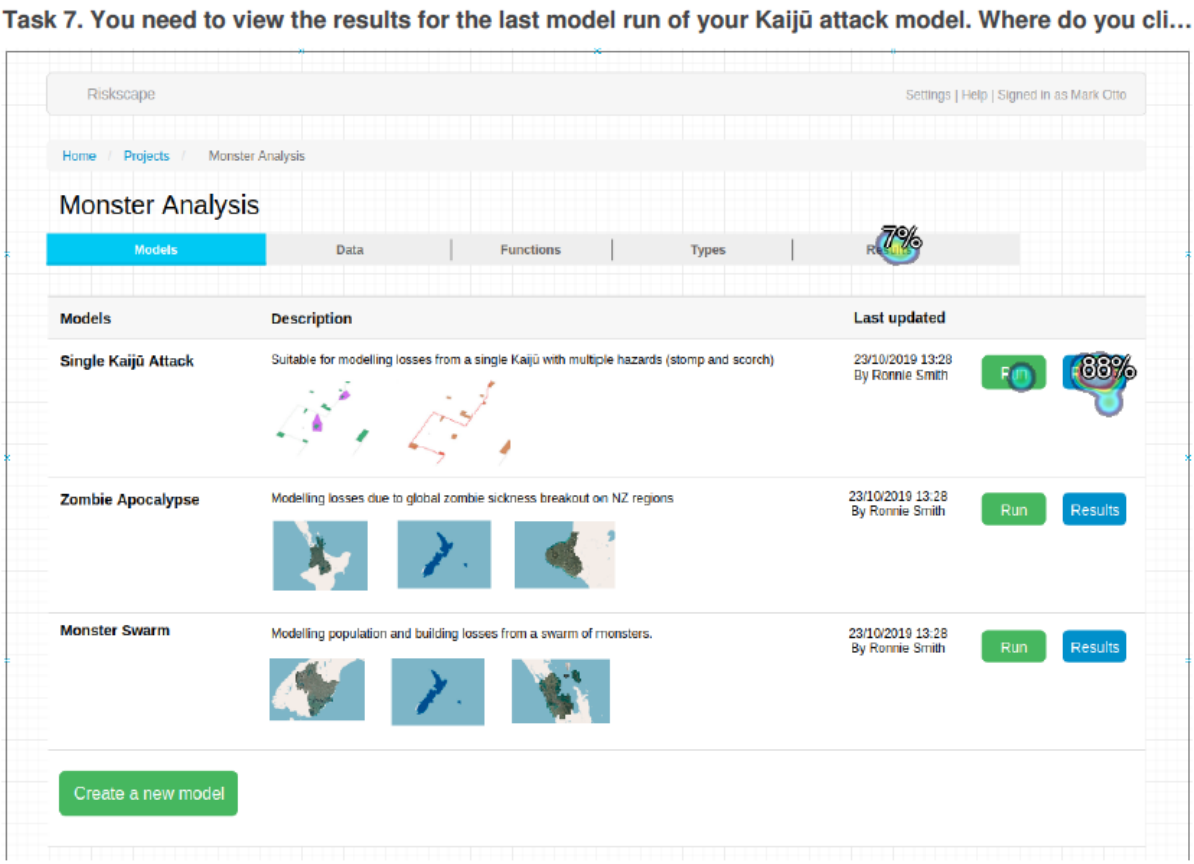

Figure A5.5 Chalkmark screenshot of responses to Task 7.

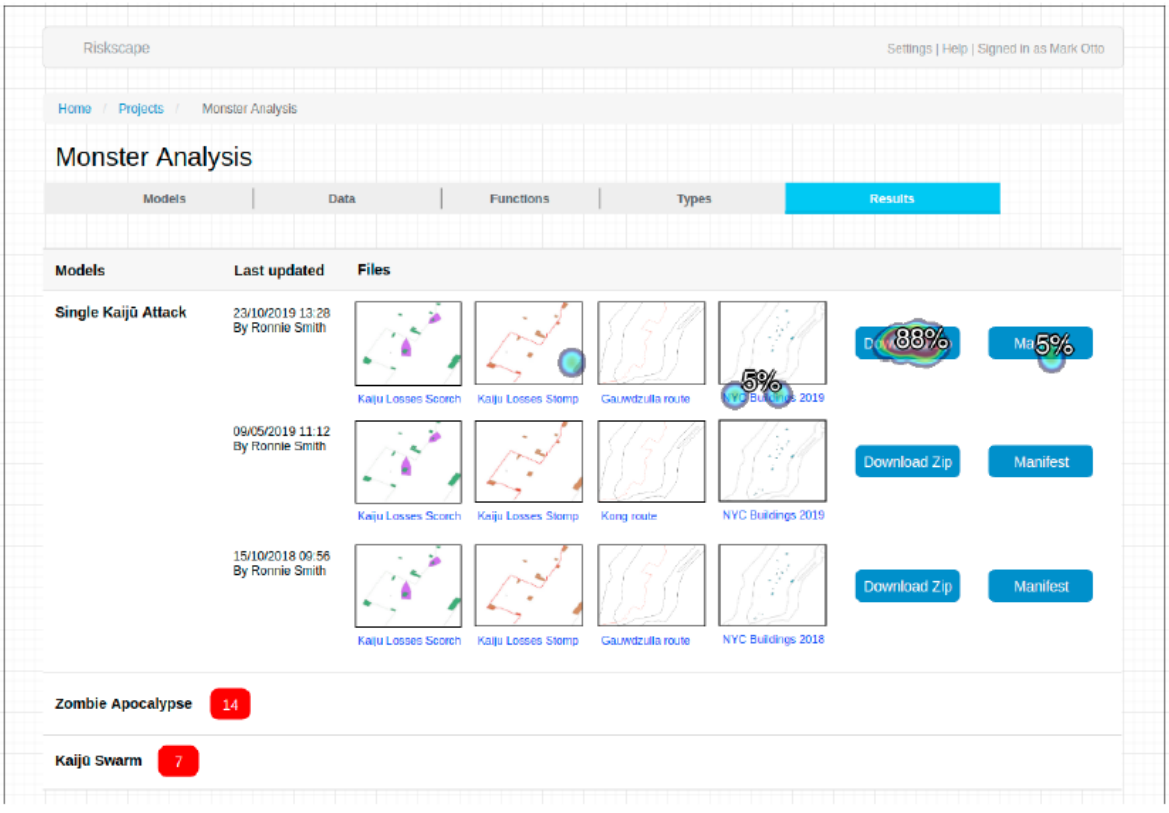

Figure A5.6 Chalkmark screenshot of responses to Task 8.

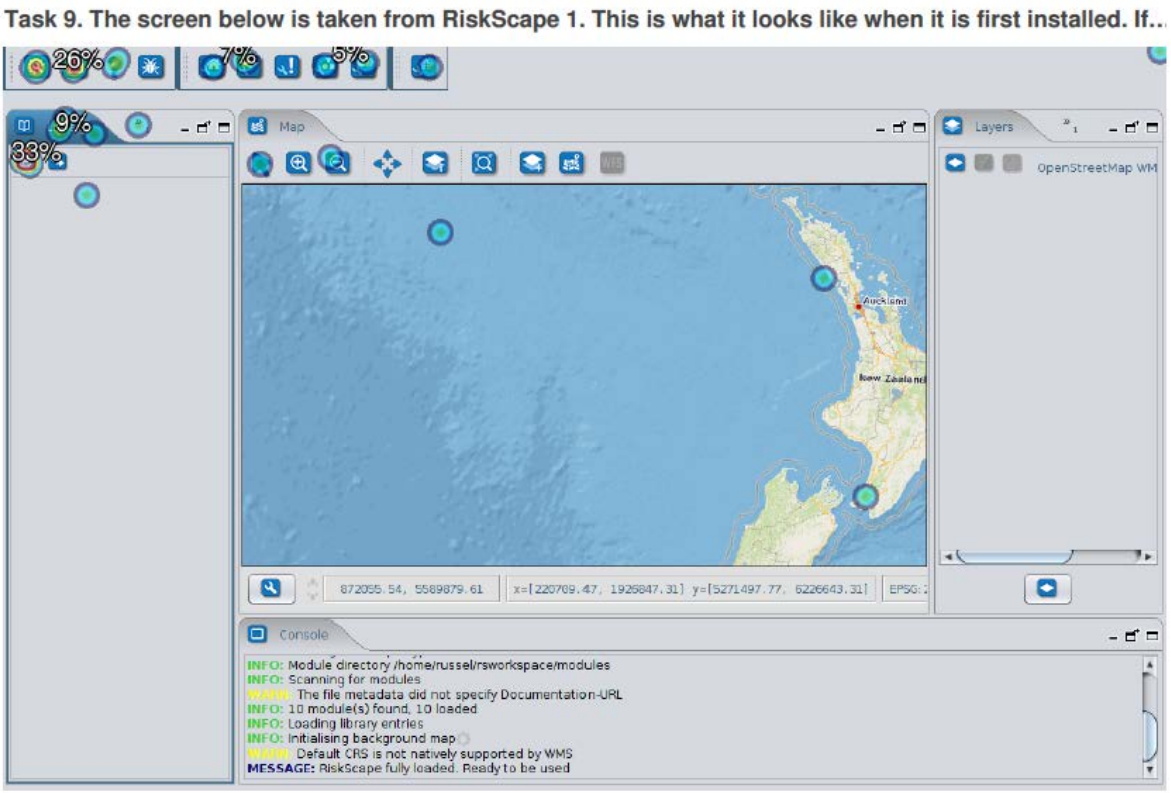

Figure A5.7 Chalkmark screenshot of responses to Task 9.

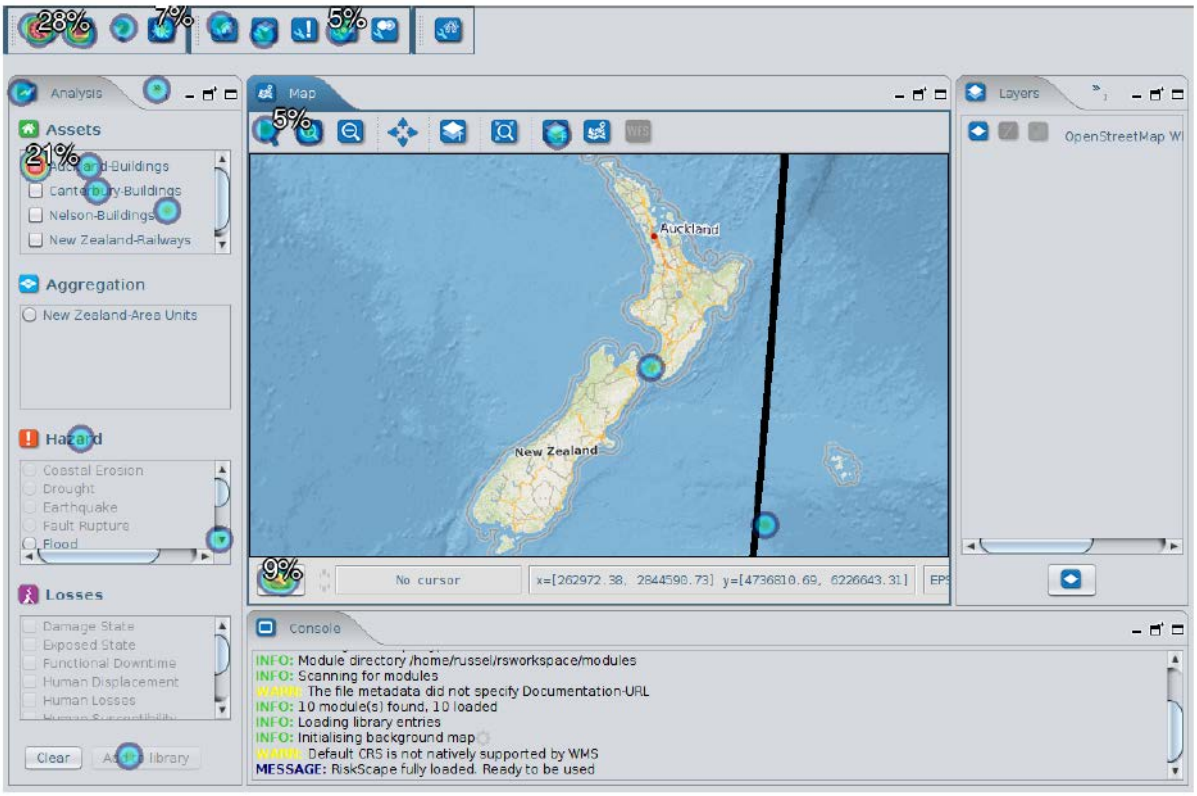

Figure A5.8 Responses to Task 10, where participants (who indicated they would use the software themselves) were asked to replicate a Kaijū analysis in RiskScape version 1.0.3.

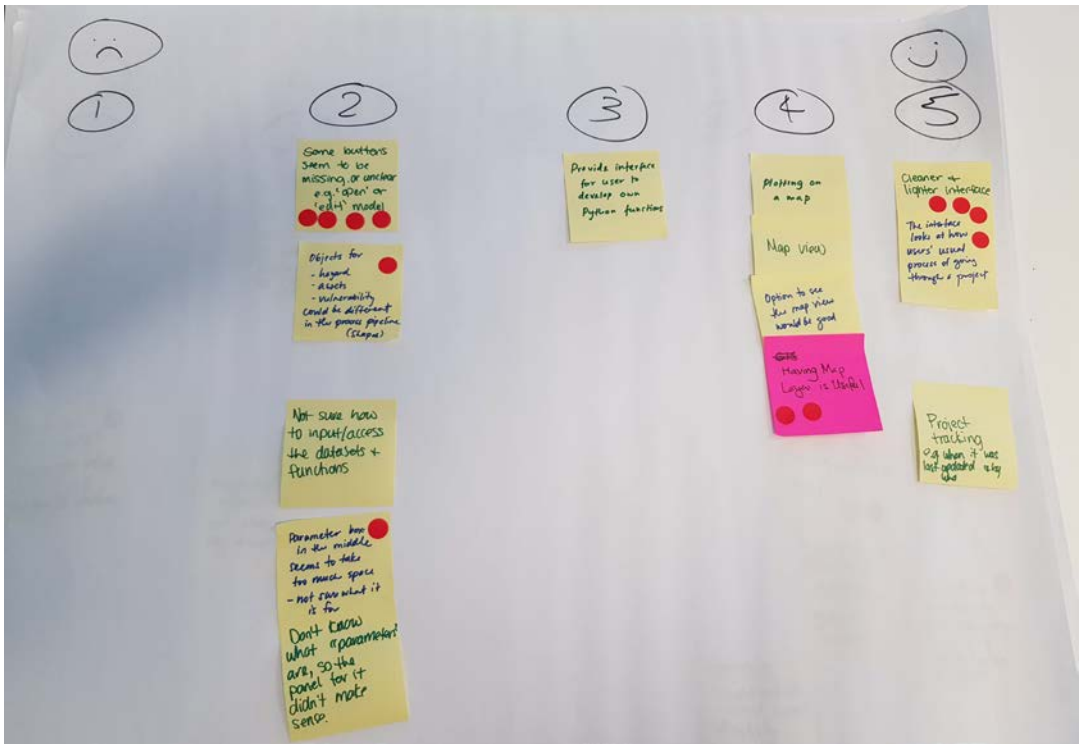

Figure A5.9 Social scientists' feedback of the draft interface design from the Wellington science workshop.

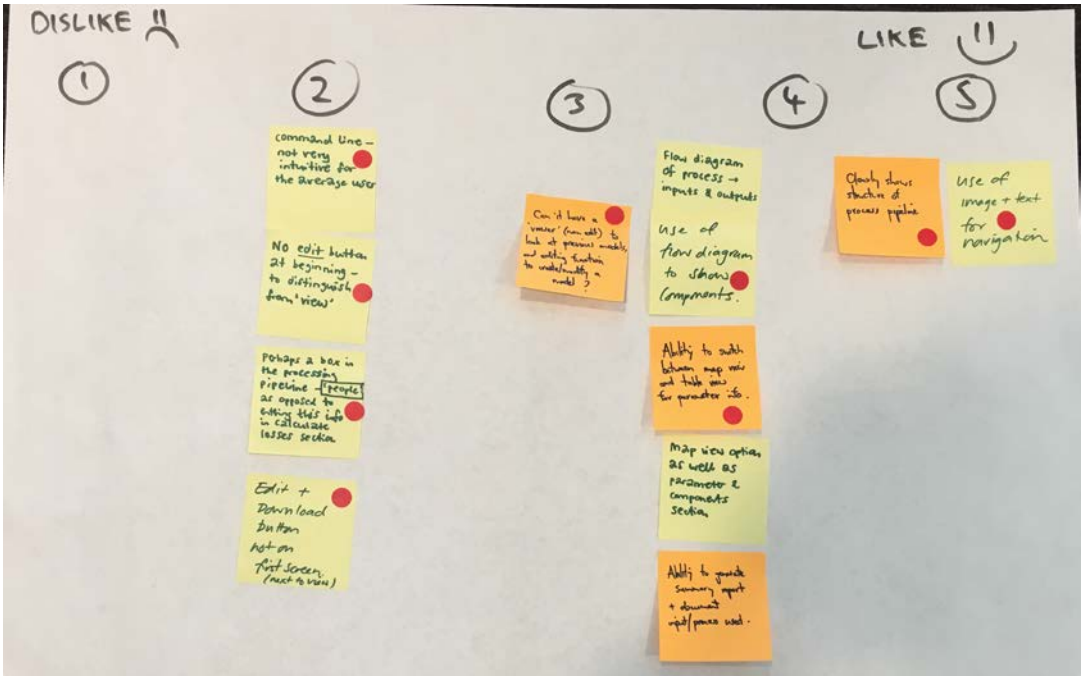

Figure A5.10 CDEM / hazard analysts' feedback of the draft interface design from the Dunedin workshop.

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