Pacific Risk Tool Design Plan Summary:

Vanuatu

Prepared for Vanuatu PARTneR Stakeholders

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Executive summary

The Pacific Risk Tool for Resilience project (PARTneR) aims to tailor the RiskScape tool for application to disaster risk management (DRM) in Pacific Island Countries, and is being piloted in Samoa and Vanuatu. RiskScape is a natural hazards impact and loss modelling tool developed to support DRM related decision making in New Zealand, with applications to overseas contexts. PARTneR is being funded through the New Zealand Partnerships Fund administered by the Ministry of Foreign Affairs and Trade, and is managed by NIWA in collaboration with 5 partners: the Samoa Disaster Management Office; the Vanuatu Disaster Management Office working with the Vanuatu Meteorology and Geo-Hazards Department; GNS Science and the Pacific Community - Geoscience Division.

The tailoring of RiskScape and the application of outputs for decision making is framed around demonstration case studies. For Vanuatu, these case studies were identified during a two day workshop in September 2016. A range of stakeholders were invited and those that attended took part in a series of discussions which aimed to identify the risk data available, as well as future needs and projects which would benefit from an impact based assessment.

This document provides a summary of the design plan and serves as a roadmap for the tailoring and application of RiskScape for Vanuatu. It consolidates the information generated and decisions made during the design workshops.

The case studies' content includes:

1. The context, e.g., what is the purpose for the impact modelling and what the information will be used for. Who are the users of the results?
2. Hazard scenario(s), e.g., single or multiple hazard events of the same or variable sources and magnitudes.
3. Asset types of interest that are potentially at risk to hazards; e.g., buildings, roads, pipelines, etc. Asset impact types of interest, e.g., damage state, asset repair cost, disruption time, etc.
4. Impact scale, e.g., geographical scale, and per-asset or aggregated results within geographical boundaries.
5. Impact information formats and post-processing requirements, e.g., model results delivered as spreadsheets, maps, posters, reports, Geographic Information System (GIS) shapefiles to be uploaded to GIS viewer.

The following are the three selected case studies for Vanuatu:

- Ash-fall impact on Tanna Island.
- Tropical cyclone impact to inform urban planning (and contingency response) in Lenakel.
- Connecting drought and extreme rainfall forecasts to agricultural production impacts for areas at risk.

The case studies will be co-developed and implemented over the next 2 years of the project. Collaborative teams will draw expertise and share data between government departments and agencies so that PARTneR can encourage and support a 'whole of government' approach to risk assessment for DRM.

1 Introduction

1.1 PARTneR project

Disasters in the Pacific undermine development, but where science-based risk assessments inform land use planning, urban development and investment in resilience, the impact of future hazard events can be greatly reduced and socio-economic development protected. Effective disaster Risk Reduction (DRR) decision-making, as a component of Disaster Risk Management (DRM), needs to be underpinned by sound, context-derived risk information. However in the Pacific this is limited because of a lack of appropriate tools and processes for gathering, analysing and applying existing and future disaster risk information to underpin, inform, and prioritise investment in resilient development.

To address some of these issues the PARTneR: Pacific Risk Tool for Resilience Project, funded by New Zealand Ministry of Foreign Affairs (MFAT), will implement three core components over the three year project timeframe:

- The co-design and development of a natural hazards impact mapping and modelling tool for the Pacific;
- Integrated disaster risk data management systems;
- Sustainable targeted and tailored training and skills development.

Cross-cutting these components is the development of a sustainable partnership model for the development and application of risk tools in Pacific Island Countries.

The rationale for PARTneR came from joint discussions between NIWA, the Pacific Community – Geoscience Division (GSD), GNS Science, the Samoa Disaster Management Office and the Vanuatu Disaster Management Office (NDMOs), and the Vanuatu Meteorology and Geo-Hazards Department (VMGD) who together saw the opportunity to tailor the New Zealand based risk and impact modelling tool for use in Vanuatu and Samoa and potentially for the wider Pacific region. The project has been co-designed and will be implemented within a joint implementing framework.

PARTneR will tailor RiskScape, a disaster impact mapping and modelling software developed jointly by New Zealand Crown Research Institutes' NIWA and GNS Science (Schmidt et al. 2011). The tailoring of RiskScape and the application of outputs for decision making is framed around demonstration case studies. PARTneR activities commenced with a review of current DRM stakeholder needs and risk data gaps. For Vanuatu, this was co-facilitated by all partners through workshops and consultations. Information obtained has been reviewed and provides the evidence base for this document; the Pacific Risk Tool Design Plan for Vanuatu.

The case studies which frame the design plan were identified during two day workshops held in September 2016. A range of stakeholders primarily from government sectors were invited to each workshop (see Appendix A for the list of participants and the workshop agenda). Those that attended took part in a series of discussions and hands-on activities which aimed to identify the available data, complementary projects, as well as upcoming needs and work which would benefit from an impact based assessment. This culminated in the identification of three targeted case studies (Section 3).

The case studies not only provide a framework for PARTneR implementation but also support the empowerment of the NDMO as they play a key role in communicating technical information on hazards and their impacts. Co-development also supports the various beneficiaries to take ownership of the project deliverables.

1.2 Pacific Disaster Risk Tools and Management Context

Priority for Action 1 of the Sendai Framework for DRR describes the requirement for DRM *to be based on an understanding of disaster risk in all its dimensions of vulnerability, capacity, exposure of persons and assets, hazards characteristics and the environment* (UNISDR 2015). Challenges for Vanuatu, as well as other Pacific Island Countries (PICs), to support this priority include accessing, translating and applying risk data, and to have mechanisms in place to share and use available risk information for decision making. Despite these challenges, there are a plethora of risk-related projects in the Pacific. These range from community-managed DRR through to regional scale programmes targeting government resources and capacity such as the Pacific Resilience Programme (PREP).

The complex myriad of projects in the Pacific is a challenge but also an opportunity. The PARTneR project aims to leverage off existing and planned work as illustrated by Figure 1. The PARTneR project aims to act as the 'glue' between projects seeking to make use of hazard and asset data and translate this into usable information to support specific decision-making for a wide range of government stakeholders. For example, asset data collected during the Pacific Catastrophic Risk Assessment and Financing Initiative (PCRAFI[1]) programme will be a key dataset for the PARTneR case studies. PARTneR will act as a conduit for adding value to existing data through delivering impact information directly to those who require it. It will also help better define the type of data required in Vanuatu for effective risk analysis.

PARTneR also intends to support Vanuatu to report directly to the new Framework for Resilience Development in the Pacific 2017-2020 (FRDP). The FRDP requests national and subnational governments and administrations in PICs to: *Collect, use, share and manage accurate data and information in user-friendly formats to inform sound risk reduction decision making in relation to disaster damage and loss as well as loss and damage under the UNFCCC Paris Agreement on Climate Change.*

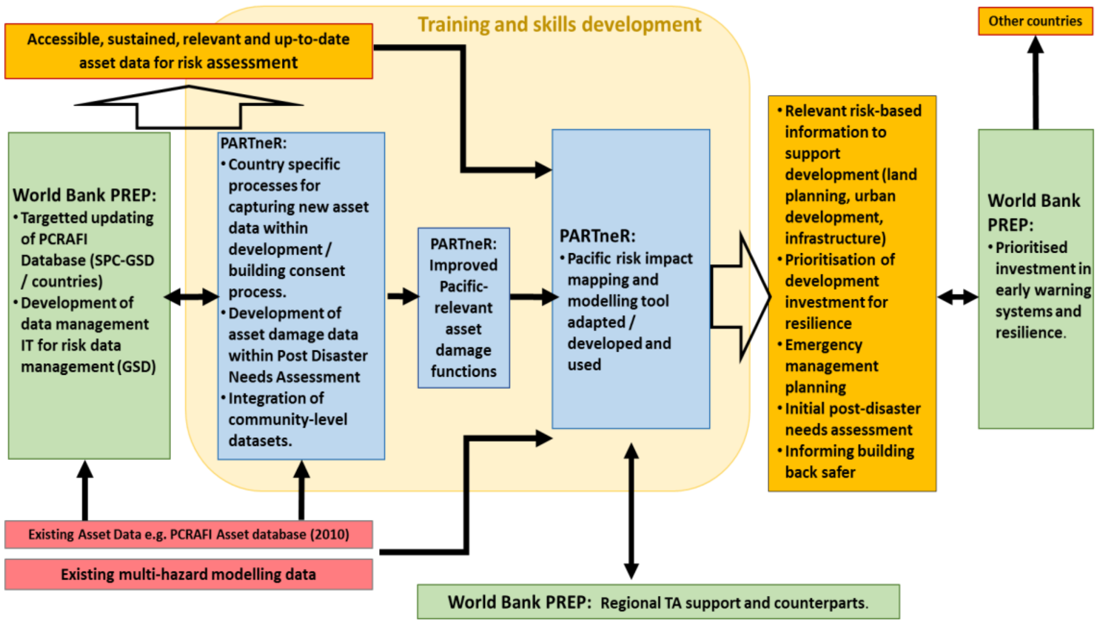

Figure 1: The alignment of PARTneR with existing and planned programmes in the Pacific.

[1] http://pcrafi.spc.int

1.3 Purpose and scope of this document

This document provides a roadmap for the tailoring and application of RiskScape for Vanuatu. It consolidates the information and decisions generated during two design workshops during September 2016. The agenda and attendance list of workshop participants is provided in Appendix A.

The case studies not only provide a tangible 'back bone' for the project but also a testing, learning and capacity development platform (see Figure 2). They will be critical to the monitoring and evaluation of the project as well as an opportunity to demonstrate the value of risk modelling tools resulting risk information to underpin decision-making in the Pacific.

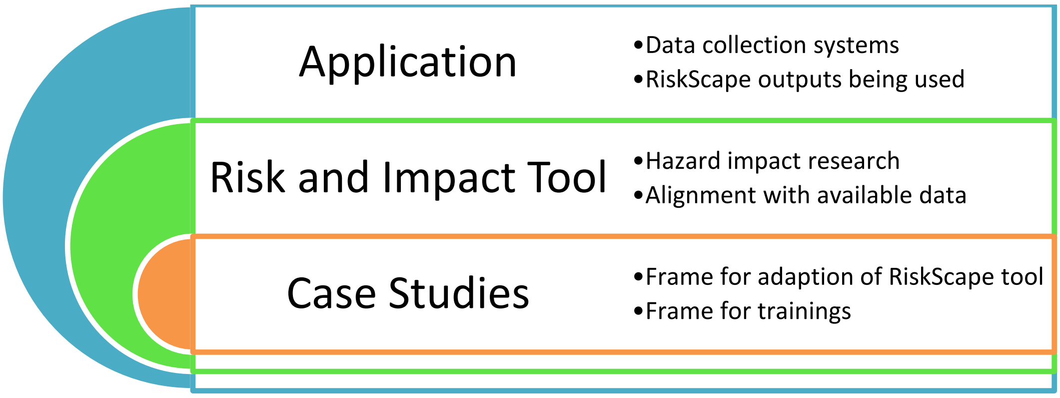

Figure 2: Illustrating how the case studies provide the 'framework' of the PARTneR project implementation.

1.4 Document structure

This document is a summary of the Pacific Risk Tool Design Plan which includes an overview of the Vanuatu risk setting, the method applied to select the case studies, an overview of each case study, implementation requirements and arrangements, timelines, milestones as well as a risk assessment for this stage of the project. A full version of the Design Plan can be obtained from the Disaster Management Office.

Sections 2 introduces quantitative risk assessment and a brief introduction to the RiskScape modelling process.

Section 3 of the report outlines the three case studies which were selected and designed by stakeholders which will be co-developed during the PARTneR project and refined as new information and ideas emerge. This is the first time RiskScape has been tailored and applied to specific Pacific Island contexts, and therefore the case studies and their components are considered experimental and may be transformed as the project evolves.

Section 4 outlines how these case studies will be implemented with an Implementation Framework and Work plan to monitor and guide the delivery of the case studies results. An overarching conclusion is provided in Section 5.

2 Risk assessment and the RiskScape software

Natural hazard risk assessment is performed to identify the costs and benefits of options to avoid or mitigate the impacts of natural hazards. Risk assessment is commonly applied within a broader framework for risk management (Figure 3). The framework is generic and applicable for any location, natural hazard type and risk management activity. Risk assessment tasks are sub-divided into the three components outlined in Figure 3, which are further described in this section.

A quantitative risk assessment begins with identification of assets that are at risk (i.e. people, buildings, roads, utilities). *Risk identification* includes measuring the extent and/or intensity of hazardous processes and identifying assets exposed (i.e. at risk) to these phenomena. This information is spatially and/or temporally represented as hazard models and asset inventories respectively. When combined, the datasets form an exposure model whereby assets exposed within the extent of hazardous processes are identified. Exposure models are commonly applied in risk identification and can inform the data requirements to further qualify or quantify risk through a *risk analysis*.

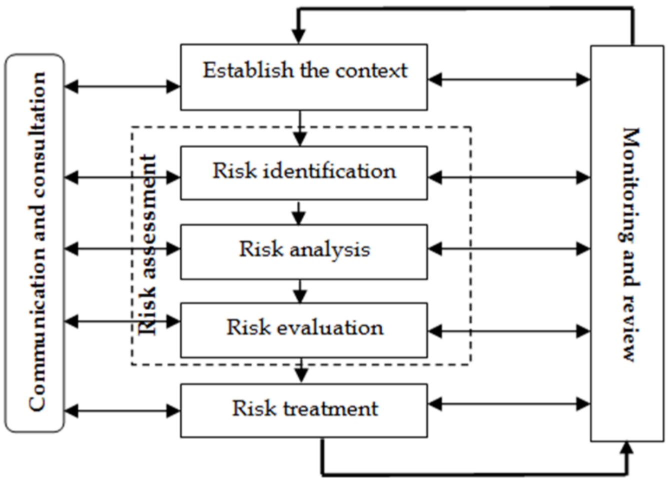

Figure 3: Conceptual framework for natural hazard risk assessment (AS/NZS ISO 31000:2009).

In risk analysis, a natural hazard *risk model* can be applied which commonly comprises of four components: hazard, exposure, vulnerability and loss (Figure 4). These components, often referred to as modules, are applicable in risk models for all natural hazards.

In a natural hazard risk model:

- The *hazard module* characterises hazardous processes in a natural hazard scenario that may expose and adversely impact assets at risk.
- The *exposure module* includes geospatial and attribute information about the assets at risk to hazardous processes. Hazard and exposure module information enables the vulnerability of assets to be quantified.
- The *vulnerability module* contains models relating the estimated degree of damage or loss sustained by assets exposed to hazardous processes of varying intensity.
- Finally, the *loss module* calculates direct and indirect impacts incurred by assets exposed to hazards processes. Losses are modelled for a single natural hazard event or

multiple events over a specified time period. For the latter, risk is estimated when relating an expected loss to an expected frequency of occurrence.

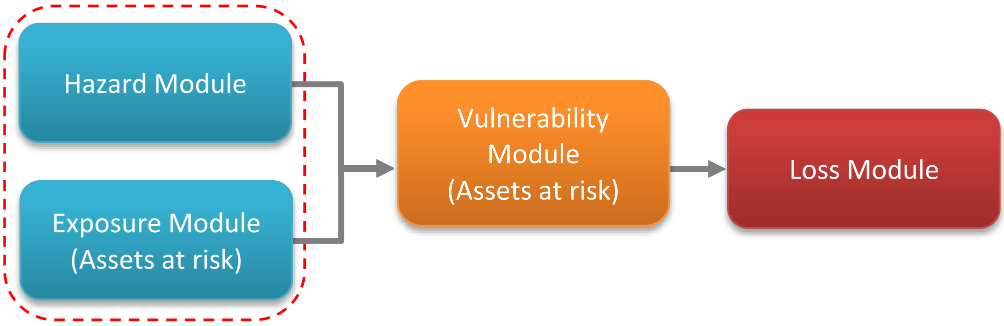

Figure 4: Module components of a natural hazard risk model applied risk analysis. Exposure model modules are identified within the red dash lines.

Loss information from a risk analysis assists an evaluation of costs and benefits for options to avoid or mitigate asset losses expected from exposure to hazardous processes.

Risk evaluation is performed to ensure that structural or non-structural risk treatment options to reduce asset losses are socially and economically viable. These options can reduce asset losses by either; avoiding the hazard exposure (e.g. excluding building in floodplains), mitigating the hazard exposure (e.g. defences to divert floodwaters around buildings), or becoming less vulnerable to loss from the hazard exposure (e.g. use more resistant building materials).

RiskScape (RS) is an open access software application built on a generic risk model framework for natural hazards (Figure 5). The software system is spatially configured for use worldwide and designed for multiple hazard, asset, vulnerability and loss types. A type standard 'language' employed by the system relates information in hazard, asset and vulnerability modules to calculate asset impact and loss. Type standards are adaptable, enabling modules conforming to the system language to be uploaded and used with other modules without requiring reconfiguration of the software system. This functionality supports both the management and application of module data at all spatial scales.

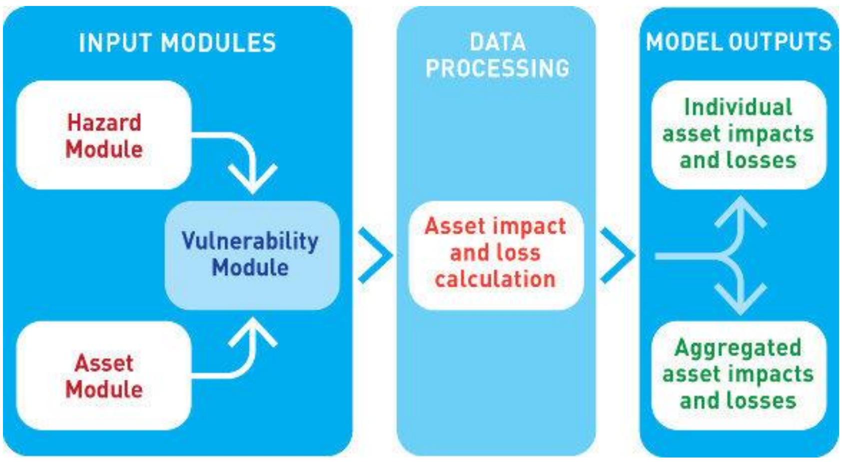

Figure 5: Conceptual diagram representing RiskScape software's natural hazard risk model framework.

Within RiskScape Spatial information is held in hazard and asset modules, which supports exposure modelling, a method commonly employed in *risk identification*. In these models, RS identifies assets located within a modelled natural hazard scenario extent and reports whether assets are exposed or not exposed to the hazard. Vulnerability models used in combination with this information enables risk modelling to be performed for *risk analysis*. Asset impact and loss estimates derived for each option can then be compared with the baseline estimate to determine the most cost effective form of *risk treatment*.

3 Case studies

An initial long list of case study ideas were identified by stakeholders based on their understanding of available data and risk assessment needs. The long list is provided in Appendix B and a glossary of key acronyms is provided in Appendix C. The long list was refined using criteria developed by the workshop participants. The criteria required that the case studies should aim to:

- Align or partner with existing projects and work plans;
- Benefit a significant population from the risk reduction decision making;
- Benefit those who are particularly vulnerable;
- Have multi-sector usage;
- Be realistic;
- Use data that is already available[2];
- Can be used for monitoring purposes: e.g., population density and impact change over time.

Figure 6: Reviewing risk data during the design workshop.

The long list case studies that ranked highest according to the criteria were then further refined during the workshop using the following checklist:

[2] PARTneR aims to leverage off and add value to existing and planned risk data collection. Risk datasets were identified through a desk based data mapping exercise and then validated during the design workshops.

1. The context e.g. purpose for impact modelling and what the information will be used for. Who are the users of the results?
2. Hazard scenario(s) e.g. single or multiple hazard events of the same or variable source and magnitudes.
3. Asset types of interest that are potentially at risk to hazards e.g. buildings, roads, pipelines etc. Asset impact types of interest e.g. damage state, asset repair cost, disruption time etc.
4. Impact scale e.g. geographical scale, and per-asset or aggregated results within geographical boundaries.
5. Impact information formats and post-processing requirements e.g. model results delivered as spreadsheets, maps, posters, reports, GIS shapefiles to be uploaded to GIS viewer.

The stakeholders identified three case studies which are outlined in the following section. The remaining long list case study ideas could be tackled outside of the PARTneR project. These case studies are not designed to be comparable but stand alone, focused on specific hazards rather than a broader multi-hazard assessment.

Impact modelling for all these case study scenarios requires further assessment of the adequacy of available hazard models, asset datasets and appropriate fragility functions, including potentially refining and/or developing them where required.

3.1 Key Case Studies

A short list of three case study ideas were identified by stakeholders during the workshops:

- **Case study 1:** Ash-fall impact on Tanna Island.
- **Case study 2:** Tropical cyclone impact to inform urban planning (and contingency response) in Lenakel.
- **Case study 3:** Connecting drought and extreme rainfall forecasts to agricultural production impacts for areas at risk.

3.1.1 Case study 1: Ash-fall impact on Tanna Island

Aim

To estimate ash-fall impacts from Mt. Yasur volcano, Tanna Island, on people and buildings for contingency planning.

Context

Many types of hazard are associated with volcanic eruptions including ash falls, pyroclastic density currents (pyroclastic flows and surges), lava extrusion (flows and domes), lahars (volcanic mudflows and floods), poisonous gases, and gravitational instability of the volcanic edifice (debris avalanches and sector collapse).

Workshop stakeholders identified that most frequent volcanic losses on Tanna are due to ash-fall. Proximal volcanic hazards, despite being devastating in nature, are relatively restricted in extent while ash fall can have extensive geographic coverage and impact. Therefore, this case study will aim to provide an assessment of the likely impact of ash-fall from volcanic eruptions of Mt. Yasur in affecting people's health, water, agriculture including livestock and buildings on Tanna Island, Vanuatu.

The estimated impact information would primarily target decision makers in the development of emergency response contingency plans and other preparedness measures at all levels. It will provide guidance on how to better manage the coordination and prioritization response during a volcanic eruption. At operational and tactical level a volcanic hazard risk map will help the DMO to improve staff safety during initial deployment period. Additionally, this information could be useful for infrastructure providers in assessing and inspecting damage to their networks to speed restoration of disrupted services (e.g., water supply), as well as to engineers in mobilising damage inspection teams to ensure rapid collection and processing of field data.

Hazard scenarios

After consulting with Vanuatu Meteorology and Geo-Hazards Department (VMGD), it appears that an ash-fall model for Tanna does not currently exist. However, VMGD does have maps for Tanna that incorporate ash fall boundary zones. Two different zones of ash fall thickness have been defined; 'thick ash zone' and 'moderate ash zone'. Ash fall distribution extents in these zones are based on the dominant southeast wind direction whilst ash fall thickness is based on historical observations.

For this study, the proposed hazard scenarios for consideration include:

- The available ash fall hazard zones available in the community maps provided by VMGD.
- The available ash fall hazard zones above but with varied wind direction. For example, if the wind direction is northeast the ash-fall area will shift towards the southwest area of Mt. Yasur.
- Ash fall hazard from other studies[3].

Asset types of interest

Close to the volcanic vent, ash-fall can be thick enough to cause severe damage to buildings and vegetation, as well as adversely impact people's health. While further away, although deposits are thinner and finer-grained, they can still be disruptive causing darkness during daylight hours, respiratory problems, contamination of water supplies, and damage to machinery.

In this case study, ash fall impacts from Mt. Yasur on Tanna Island on assets, including people, water, agriculture and buildings, are to be assessed. A detailed asset survey was conducted during the World Bank funded IRCCNH project (Increasing Resilience to Climate Change and Natural Hazards), which may provide much of the asset information needed. Based on the asset data available and the nature of the hazard, this case study will attempt to estimate exposure of buildings and people, as well as building damage. Indirect impacts that may be considered include water outage, crop damage and loss.

[3] e.g., Global Volcano Model (GVM; http://globalvolcanomodel.org/), CAPRA probabilistic risk assessment program (http://ecapra.org/).

Vulnerability functions developed by Jenkins et al. (2015), Stewart et al. (2006), and Cronin and Sharp (2002) along with post-disaster assessment (e.g., Korisa et al. 2013) will be reviewed and used to estimate the impacts to various assets. These functions define the relationship between ash fall hazard and subsequent impacts.

Impact scale

With detailed asset information available through the IRCCNH project and other sources, the estimated impact can be presented at various scales from individual buildings to aggregated village areas and council boundaries. Usage and limitations of these various impact results will be discussed further during the development of the case study.

Impact information formats and post-processing requirements

All of the produced results will be available in various formats, namely spreadsheets and GIS compatible formats in order to allow experienced end users to further investigate and analyse the results.

In addition, maps and multi-media will be produced by the Vanuatu NDMO accordingly to guide general public on the impacts from ash fall, including response and safety procedures (e.g., flyers or posters with brief information for community emergency response).

All of the information formats discussed above (e.g., videos, maps, spreadsheets, and posters) will be accompanied with detailed documentation in order to provide background and technical guidance (e.g., usage and limitations).

Key implementing partners

- NDMO
- VMGD
- Department of Statistics
- Ministry of Finance
- IRCCNH project, climate change
- Public Works
- Ministry of Lands and Natural Resources

3.1.2 Case Study 2: Tropical cyclone impact to inform urban planning (and contingency response) in Lenakel

Aim

A tropical cyclone impact study focusing on Lenakel's urban planning and the design of appropriate building codes.

Context

The threat from tropical cyclone (TC) events is of primary concern for most PICs. This was well illustrated in the last two years where two category 5 TCs (TC Pam in March 2015 and TC Winston in March 2016), made landfall in Vanuatu and Fiji, respectively. Extreme wind speed of greater than 250 km/h as well as extreme wave height allegedly greater than 15m caused unprecedented devastation, with damage and loss in Vanuatu estimated to be as high as 64.1% of the country's GDP.

This case study proposes to investigate impacts related to TC events for the town of Lenakel located on the west coast of Tanna Island. Lenakel is the main township of Tafea province and the third largest town in Vanuatu; with a population of around 13,000 people.

In September 2015, Lenakel became the first town in Vanuatu to develop a Development Control Plan (DCP) administered by the municipal council. All future developments in Lenakel are now required to comply with the requirements of the municipal council. This milestone, encompassed within a strong national development strategy, will pave the way to upgrade infrastructure, waste management, water supply systems and other basic government services.

Combining the Lenakel urban development control plan and the early development stage of the town, Lenakel could be an ideal location to showcase how an impact tool such as RiskScape can support decision makers in sustainable and resilient urban planning. For example, the tool could support mitigation options/ decisions and inform legislation on various building codes considered appropriate to acceptably mitigate TC hazards.

An impact study focusing on Lenakel's urban planning and the design of appropriate building codes would be instrumental for Vanuatu's physical planners within the department of Local Authorities at the Ministry of Internal Affairs. The Ministry of Infrastructure and Public Works Utilities could also be a primary user of such data. At a local level, the outcome of this case study could be used by the Lenakel's municipality council as a tool to revisit and enforce the DCP for the town using tangible information provided by the study.

The main beneficiary of this case study would be the Lenakel community, as building codes and urban planning would be designed to improve building resilience to TC hazard, in turn reducing loss, disruption time and potential injuries/ fatalities inherent from TC induced building damage.

The TC impact case study in Lenakel could also support the Vanuatu DMO in the development of a response plan for Lenakel, as well as their commitment to support better planning in terms of site selection for evacuation shelters. The NDMO would work with emergency response agencies (e.g. police, hospital, fire, humanitarian partners) and lifeline utilities agencies to implement contingency planning.

Hazard scenario

Tropical cyclone hazards include strong wind as well as flood and landslides inherent from potential heavy rainfall. TC's also trigger coastal inundation hazard due to a combination of storm surge and waves. Storm surge is an increase in water level at the shore resulting from wind setup (vertical rise of the coastal water level as the wind pushes surface water towards the shore) and the effect of the inverted barometric pressure. Thus, this case study will be constrained to the two primary hazards known to induce impact on buildings and population: wind and coastal inundation hazards.

Wind hazard information was generated for Vanuatu as part of the Pacific Catastrophe Risk Assessment and Financing initiative (PCRAFI) project (http://pcrafi.sopac.org/). While this information is relatively coarse it could still be a relevant hazard dataset for this case study.

Under a TC Pam recovery program funded by the German Bank, SPC-GSD will be working in the next 18 month on a multihazard project in Lenakel. This project will make TC induced inundation hazard data available for this case study. Through this project, SPC will also be looking at ways to downscale the PCRAFI wind hazard information for Lenakel.

Asset types of interest

Assessing the building code for Lenakel will require building data, which should contain all necessary building attributes such as foundation type, roof type, ground floor height above ground, location, etc. In order to investigate the most appropriate building code within the Lenakel municipality, this study will need to consider damage on buildings, cost of repair, and disruption time.

The contingency planning component of the case study will require a wide range of asset data, and will primarily focus on the population's foremost needs in the wake of a TC. These assets include: population; buildings (population casualties, number of people needing shelters, how long shelters will be occupied); water infrastructure (drinking water need, potential disease outbreak); health centers (estimated occupancy vs. service capacity); wharf, roads, airport (transport); access to humanitarian aid; power station; communication infrastructure; schools (disruption to education service) and crops (access to local food).

In order to investigate the most appropriate contingency plans for the Lenakel municipality, this study will also need to consider the following impacts: population casualties and injuries; building damage and repair time in relation to the evacuation center occupancy vs. duration; damage to water infrastructure relating to service disruption time, estimated demand on drinking water and potential disease outbreak; health center damage – disruption to health services vs. estimated need to meet the demand; damage on transport services (roads, airport, wharf) disabling government and humanitarian aid reaching the affected population efficiently.

Some TC impact data exists in Vanuatu and can be sourced from Post Disaster Need Assessment (PDNA) report after such events (e.g. Cyclone Pam).

For population and building data, the main provider may be the Vanuatu National Statistical Office (VNSO). Large amounts of asset data have also been collected on Tanna as part of the IRCCNH project. Where appropriate asset data is not available for Lenakel, infrastructure data collection as well as a household survey would have to be conducted within the municipality as part of this case study.

Impact scale

Impact scale for this case study will be the main township of Lenakel, and possibly the surrounding area, depending on the coverage and quality of available TC related hazard models, asset datasets, and fragility functions.

Impact information formats and post-processing requirements

Impact information should link with the needs of local land use planning authorities. The delivery of the building code design study should highlight the methodology in a non-technical way. Deliverables should also exhibit comparative maps showing different impact depending on the building code used.

The format could be in the form of presentation slides and reports for government stakeholders as well as community meetings, but also posters and brochures for dissemination to the wider population.

Some government stakeholders, such as the Ministry of Lands and Natural Resources, are well versed in GIS and would benefit from the delivery of a GIS shapefile format. It would also permit the case study deliverable to be overlaid with other relevant national geospatial information, in turn allowing the tailoring of the outcome to a given stakeholder, project or donor.

Key implementing partners

- NDMO
- VMGD
- Department of Statistics
- Ministry of Finance
- IRCCNH project
- Climate Change Department
- Public Works Department
- Ministry of Lands and Natural Resources
- Telecom Regulator (TRR)
- Local Authority, Ministry of Internal Affairs

3.1.3 Case study 3: Connecting drought and extreme rainfall forecasts to agricultural production impacts for areas at risk

Aim

To develop agricultural production impact forecast products for drought and extreme rainfall events.

Context

Drought and extreme rainfall hazards adversely impact agriculture production in Vanuatu. Agricultural production on most Vanuatu Islands is comprised of cash and subsistence cropping that supports the nutritional requirements and economy of island populations. Crop loss from drought and extreme rainfall hazards can cause significant socio-economic impacts.

Combining drought and extreme rainfall hazard forecasts with anticipated crop loss estimates can help local authorities and communities initiate response plans targeted at implementing activities which reduce crop losses, as well as manage socio-economic impacts caused by crop losses.

Piloting the concept of combining drought and extreme rainfall hazard forecasts with crop loss estimates to develop loss forecasts requires a case study area. PARTneR stakeholders identified Santo and Malekula islands as potential case study locations. These island have relatively long rainfall records

(>30 years) to support forecasting, in addition to economic and nutritional requirements that are highly reliant on local agricultural (e.g. crop) production.

PARTneR stakeholders cited interest in loss forecasts for direct impacts to exposed crops and indirect social and economic impacts on local populations. These may include estimates of financial or nutritional loss at the village or provincial levels.

This case study would test the feasibility of developing these forecasting products and whether they can become an additional service provided by the Climate Services Division of VMGD. Local disaster management officers and communities could significantly benefit from reliable crop loss forecasts for drought and extreme rainfall events.

Hazard Scenario

The Climate Services Division of the VMGD issues long-term (months) drought and short-term (days) extreme rainfall forecasts for both of the two potential case study locations identified by PARTneR stakeholders, Santo and Malekula Islands. As this case study attempts to pilot the concept of combining drought and extreme rainfall hazard forecasts with crop loss estimates to develop loss forecasts, only one case study island is required. This will be decided based on the data availability, as outlined in this case study narrative.

For the chosen case study island, geospatial data is required for developing drought and extreme rainfall hazard scenarios able to be imported into RiskScape for use as 'hazard modules'. Forecasts from previous drought and extreme rainfall hazard events that caused crop damage could be used as hazard scenarios.

Asset types of interest

This case study primarily focuses on direct impacts from drought and extreme rainfall events on crop assets and indirect socio-economic impacts for populations reliant on crop production for income and/or nutrition.

PARTneR stakeholders identified asset types of interest for drought and extreme rainfall impact forecasting to be contained within three broad asset categories: agriculture, buildings and population. Population assets relates to both the demographic composition and nutritional needs of people within the case study area. Other published resources on the nutritional requirements of Vanuatu's population will be utilised to determine related population asset attributes. Finally, information on building locations and attributes (e.g. use) for the case study area are required for modelling and presenting impact information.

PARTneR stakeholders expressed interest in developing vulnerability models to estimate direct impacts to crop types and indirect impacts to local populations resulting from crop loss e.g. reduced nutritional availability. These impacts would be assessed based on seasonal crop production values. Stakeholders were also interested in developing models to assess the resource and financial requirements needed to sustain local populations during crop loss scenarios.

Impact scale

Impact scale for this case study will be either the island of Malekula or Santo, as this case study will test the feasibility of developing forecasting products for Vanuatu, and therefore only one trial site is required.

Impact information formats and post-processing requirements

Impact forecasts for drought and extreme rainfall events requires outputs in spatial, tabular and report formats. In addition to current RiskScape output formats (.shp, .kml, .csv), pre-populated report formats were identified by PARTneR stakeholders as a useful decision-ready format that would summarise impact model outputs into key information for direct delivery to users.

PARTneR stakeholders also identified the need to convert outputs into hard or electronic resource materials such as posters and information sheets, as stakeholder and community education resources. Additionally, there is further potential for spatial outputs to be distributed to stakeholders and communities via web map or feature services (e.g., PacGeo).

Key implementing partners

- NDMO
- VMGD
- Department of Statistics
- DARD- spatial agriculture data

3.2 Limitations

The case studies outlined above will require further design and adjustment throughout the project. Elements may be adjusted due to data availability and quality, or changing user needs. The PARTneR team will remain flexible in their approach in order to deliver useful, useable and used case studies.

The case studies are not designed to provide a broad and comparable multi-hazard assessment, instead they are stand alone in order to address a range of stakeholder interests from emergency management to land use planning. In the future, opportunities may exist to support countries in developing approaches for multi-hazard comparisons.

4 Implementation, monitoring and milestones

The case studies outlined above will be co-developed and implemented with key stakeholders and the PARTneR team. An implementation framework as outlined in Table 1 below has been developed in consultation with stakeholders which will guide the development and implementation in four phases. NIWA will lead the software development changes required. Work to link databases, models and other tools with RiskScape will be jointly carried out by both the NIWA software development team and SPC-GSD.

Table 1: Case study implementation framework.

<table>
<tr><th>Phase</th><th>Tasks</th></tr>
<tr><td>Phase 1</td><td>Work plan (log frame) development;
Case Study Inception Meetings
Introduce work plan
Allocation and agreement on roles to deliver plan activities.
Meet with key stakeholders to organise data acquisition.
Refine case study deliverables based on data availability and consultations with key stakeholders.
Remove/ redefine unpractical deliverables and determine methodologies to complete the final deliverables
Deliverable: Case study work plan</td></tr>
<tr><td>Phase 2</td><td>Data preparation
Desktop review. Compilation of existing hazard, asset, vulnerability and aggregation data.
Desktop collection. Review and collection of missing asset geospatial or statistical data.
Desktop scoping. Development of any required hazard and vulnerability modelling.
Hold expert elicitation workshops to co-create relevant fragility models.
Undertake development of new RS modules where needed for the case study.
Case study site data collection if required.
RiskScape Software Configuration
Identify model output requirements.
Identify software type standard, module and functionality requirements to support case study.
Deliverable: Data collection complete.</td></tr>
</table>

Phase 3	• RiskScape Software Configuration
	  • Implement configuration requirements.
	
	• Impact modelling
	  • Simulation of scenarios in RiskScape; develop modules.
	  • Assess outputs generated against stakeholder expectations, including validation where historical data exists;
	  • Tool and output modification/tailoring as required;
	  • Evaluate and develop standard reporting and communication formats/avenues.
	Deliverable: Case study scenario runs complete, tested and documented appropriately

Phase 4 (can run parallel with phase 3 if appropriate)	• Application and utilization of results for emergency response planning/management, land use management/planning:
	  • Development of decision making guidance/support materials on how to use the output data;
	  • Applications training workshop for stakeholders;
	  • Communicate findings via a relevant hazard/risk/disaster conference (domestic and regional/international).
	
	Deliverable: Scenario integrated for decision making, with training materials and guidelines, communicated to relevant stakeholders.

The Gantt chart below (Figure 7) lists the phases and milestones for the development of the case studies. This was created by combining the recommendations from the design workshop participants, the PARTneR team and the existing PARTneR budget and timeline.

		Year 1		Year 2				Year 3			
	Activity	**Qtr 3**	**Qtr 4**	**Qtr 1**	**Qtr 2**	**Qtr 3**	**Qtr 4**	**Qtr 1**	**Qtr 2**	**Qtr 3**	**Qtr 4**
		Jan-March	April - June	July - Sept	Oct-Dec	Jan-March	April - June	July - Sept	Octo-Dec	Jan-March	April - June
Workshops budgeted											
Output 1 Tool - Workshops											
Output 2 Data - Workshops											
Output 3 - Training workshops											
Vanuatu											
Case Study 1: Ashfall impact on Tanna Island	**Phase 1**										
	Milestone: Case study work plan										
	Phase 2										
	Milestone: Data collection complete										
	Phase 3										
	Milestone: Case study scenario runs complete, tested and documented appropriately										
	Phase 4										
	Milestone: Scenario integrated for decision making and within training materials and guideline and communicated to relevant stakeholders.										
Case Study 2: Cyclone impact to inform urban planning	**Phase 1**										
	Milestone: Case study work plan										
	Phase 2										
	Milestone: Data collection complete										
	Phase 3										
	Milestone: Case study scenario runs complete, tested and documented appropriately										
	Phase 4										
	Milestone: Scenario integrated for decision making and within training materials and guideline and communicated to relevant stakeholders.										
Case Study 3: Connecting drought and extreme rainfall forecasts to agricultural production impacts	**Phase 1**										
	Milestone: Case study work plan										
	Phase 2										
	Milestone: Data collection complete										
	Phase 3										
	Milestone: Case study scenario runs complete, tested and documented appropriately										
	Phase 4										
	Milestone: Scenario integrated for decision making and within training materials and guideline and communicated to relevant stakeholders.										

Figure 7: Gantt Chart for Case Studies.

This provides an indicative guide for key milestones to deliver the case study results within the project lifespan. Timeframes may shift to align with emerging unforeseen opportunities. Yellow indicates a budget available for a workshop, green indicates budget available for mentoring visits and dots indicate vocational training visits.

5 Conclusion

This document outlines the design plan and systematic approach for the customization of the RiskScape natural hazards impact and loss modelling tool in Vanuatu under the PARTneR project. The design plan is framed using 3 case studies that were identified and refined during a stakeholder engagement workshop held in Vanuatu in September 2016.

Case studies identified include:

- Tsunami risk and loss modelling for response planning.
- Near real-time impact forecasting for tropical cyclones.
- Landslide risk for land use planning.

Additionally, a cross-cutting issue that overlaps each of the three case studies was identified which encompasses modelling a ‘water outage scenario’ in each case study.

Implementation of the design plan will be carried out in four phases from January 2017 to June 2019, and will run in parallel with the PARTneR training and guideline development component of the project. The implementation process is designed to be agile and flexible to emerging opportunities over the implementation timeframe, as well as potential risks that may be encountered. Contingency measures to mitigate these risks have been identified and will be implemented as required.

6 Acknowledgements

This document is a summary of the Pacific Risk Tool Design Plan document which was the first of a series of technical reports and guidance produced by the PARTneR project. The PARTneR project is a New Zealand Aid partnership fund project (2016-2019). This project has been co-developed and implemented by five collaborative partners: NIWA, GNS Science, the Pacific Community - Geoscience Division, the Vanuatu Disaster Management Office and Vanuatu Meteorology and Geo-Hazards Department, and the Samoa Disaster Management Office.

Participants who attended the Vanuatu Stakeholder Co-design Workshop in September 2016 and contributed their knowledge and experience during this process are acknowledged and thanked (see Appendix A). This project aims to work across whole of government of many departments whom have contributed time towards the selection and design of these case studies.

External advisors who reviewed this document are acknowledged and thanked.

7 References

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Appendix A Design Workshop Agenda and Participant Registration List

DAY 1 AGENDA	
Time	**Activity**
0900-1000	Introductions and welcome
1000-1030	Risk Assessments Needs
1030-1100	Refreshment Break
1100-1200	Risk Data Mapping
1200-1300	Mapping existing or upcoming complimentary projects/needs
1300-1400	Lunch
1400-1500	Case Study identification and ranking
1500-1530	Final Case Study selection

DAY 2 AGENDA	
Time	**Activity**
0900-0930	Recap & Introduce aims of day
0930-1030	Case study scenario development
1030-1100	Refreshment Break
1100-1200	Case study scenario development cont.
1200-1300	Action planning
1300-1400	Lunch
1400-1500	Presentation of Case Studies for final validation
1500-1600	Core team discuss workshop outcomes and plan any final requirements

Table Appendix 1 & 2: Vanuatu Workshop Agenda

	Name	Organisation
1	Gordon Willie	Lands Department
2	Pakoa Rarma	Department of Health
3	Mereia Carling	SPC (Social Department)
4	Juanita Laga	Vanuatu Met and Geo-hazards
5	Rebecca Iaken	Project Management Unit
6	David Gibson	Director VMGD
7	Abel Kalo	VMGD
8	Esline Garaebiti	VMGD
9	Naelo Tosso	Mapping, Lands Department
10	Nikita Solzer	CCDRR Officer/RRU
11	William Gamleo	ICT section, Lands Department
12	Iuma Bani	Forecasting, VMGD
13	Peter Korisa	DMO
14	Melinda Natapei	VMGD
15	Greg Vaughan	DFAT
16	Chris Bartlett	GIZ
17	Herve Damlamian	SPC
18	Ryan Paulik	NIWA
19	Sheng-Lin Lin	GNS Science
20	Kate Crowley	NIWA
21	Juliana Ungaro	NIWA

Table Appendix 3: Vanuatu Workshop Participant List

Appendix B Long list of case studies

Vanuatu	Case Study
Short List	**Tanna eruption** • Ashfall impacts on multiple sectors, e.g. health, agriculture, water, food security, etc.
	Tropical Cyclones for Lenakel: • Lenakel Cyclone response plan • What is the impact on the population? • What is the impact on the settlements? • What are the appropriate building requirements for Lenakel to significantly reduce cyclone hazard impacts?
	Land use planning for Agriculture sector and drought: • Socio- economic impacts from weather hazards • How many communities would be affected by a strong drought event? Water shortage? What water facilities are most appropriate to mitigate?
Long List	Tropical cyclone impacts for all of Vanuatu: • Number of people affected during an event • Number of Households affected • Number of displaced people during an event • Number of safe shelters
	Volcanic contingency planning for Ambae • Population at risk • Infrastructure • Evacuation planning
	Earthquake building and infrastructure impact assessment for Port Villa. 1) Economic loss; 2) Building repair time; Critical building (e.g. government, schools) impacts.
	Earthquake evacuation planning for schools
	Risk based flood hazard mitigation options for Luganville.

	How we can mitigate the impacts of 10 to 50 year flood hazard events?
	Flood evacuation of Luganville. 1) How will flooding impact future urban growth; 2) how can land use zoning inform where to locate new development in Sarakata and Pepsi; 3) how can a real time flood early warning system be implemented.
	Which areas are prone to flooding in extreme rainfall events?
	Impact of sea level rise on Port Vila: • What areas are most vulnerable? • Cost benefit analysis of mitigation solution (planning)
	Tsunami Evacuation plan for Port Vila: • Are there enough evacuation centers? • Cost benefit analysis of developing response plan (planning) • Impact on population
	Tsunami impact study to support planners identify the less disaster prone areas suitable for key infrastructure development
	Impact of tsunami on Vanuatu urban population
	Multihazard: Impact on tourism industry on the main islands; Santo, Efate, Malekula and Tanna

Appendix C Glossary

Acronym	Denotation
DLA	Department of Local Authorities
FRANZ Partners	France, Australia and New Zealand Partners
IRCCNH	Increasing Resilience to Climate Change and Natural Hazards
MCCAMGEEDM	Ministry of Climate Change Adaptation, Meteorology, Geo-Hazards, Environment, Energy and Disaster Management
MCCAMGEEDM - NDMO	MCCAMGEEDM – National disaster Management Office
MCCAMGEEDM - VMGD	MCCAMGEEDM – Vanuatu Meteorology and Geo-Hazards Department
MDRR Group	Melanesian Disaster Risk Reduction Group
MOE	Ministry of Education
MOF	Ministry of Finance
MOH	Ministry of Health
MOL	Ministry of Lands
MALFFB	Ministry of Agriculture, Livestock, Forestry, Fisheries and Biosecurity (also noted as MoLA)
NAB	National Advisory Board on Climate Change and Disaster Risk Reduction
NDC	National Disaster Committee
PMO	Prime Minister’s Office
PMO – OGCIO	PMO – Office of the Government Chief Information Officer
PWD	Public Works Department
SPREP	Secretariat of the Pacific Regional Environment Programme
UNDP	United Nations Development Programme
VQA – TVET	Vanuatu Qualifications Authority – Technical and Vocational Education and Training Program (funded by AusAID)