Climate Resilient Honiara

WP 7a: Climate Resilient Spaces**:** *Evacuation Centres*
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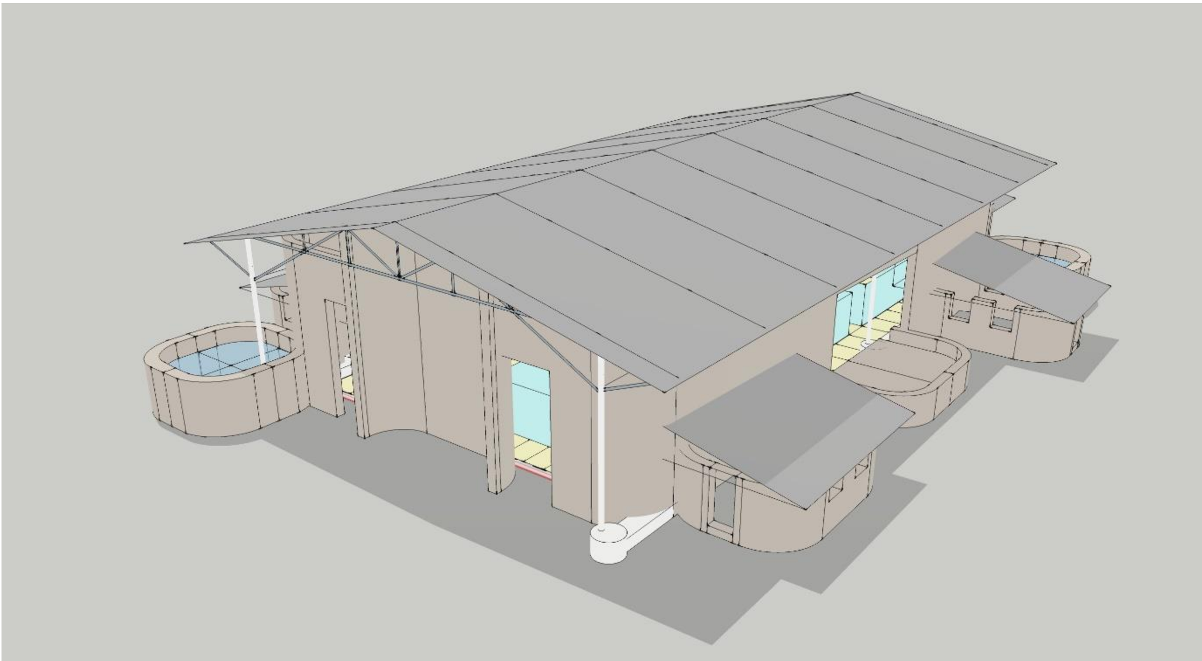

Concept 3D visualisation of an evacuation centre

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Executive summary

Work package 7 on climate resilient spaces, for purposes of analysis, was divided into two discrete components: a) hard infrastructure (evacuation centres) and b) nature-based solutions. This report presents an analysis of evacuation centres by architecture, engineering, and GIS experts from RMIT University. They worked closely with key stakeholders in Honiara to undertake preliminary analysis on evacuation centre needs, and to make recommendations for interventions for the Climate Resilient Honiara project (CRH). CRH is a four-year research project, commencing in 2018, funded by the UNFCCC Adaptation Fund and administered by UN-Habitat. Since early 2019, RMIT University have provided scientific support.

Providing better infrastructure for vulnerable communities and informal settlements is an important component of enhancing the resilience of Honiara to current and future climate impacts, and natural hazards. This provision also needs to explicitly consider the needs of a wide range of community stakeholders including youth, women, girls, elderly, and people with disabilities.

This report is based on a combination of desktop research and several field visits during which observations and informal discussions took place with local leaders and community members. Consultations also took place with the National Disaster Management Office; Ministry of Lands, Housing and Survey (MLHS); Honiara City Council; and Ward Councillors. Design guidelines and field observations have led to the development of concept designs which can be used as a starting point for further detailed discussions with the communities and related stakeholders. Various options for concept design approaches are presented in this report, however it is important to note that no formal community consultation on the designs has taken place to date. This report, and the proposed actions, should therefore be presented to the community for consultation and feedback to validate and endorse its findings, and to inform future work.

As well as recommending one new build pilot (Jabros), one upgrade of existing facilities (Aekafo-Feraladoa), and training activities for more resilient buildings; this report further recommends the formulation of a formal evacuation centre strategy for Honiara (including the development of a current day baseline, which is currently lacking for the city). This would involve: 1) an audit be conducted of existing centres, their facilities and capacities, and an assessment made of their structural integrity to withstand an extreme event; 2) a spatial risk assessment of the locations of buildings currently nominated as evacuation centres; and 3) identification of low risk areas for new community buildings, taking into account population densities and access, which can be used as evacuation centres at times of emergency.

It is also recommended that holistic approaches to long-term solutions be considered; including the use of local materials, enhancing local skills and where possible, and the introduction of building designs that integrate nature-based solutions.

Acknowledgements

The team who have contributed to this report are:

- RMIT: Professor Usha Iyer-Raniga, Dr Tariq Maqsood, Professor Darryn McEvoy, Dr Ata Tara, Dr Yazid Bin Ninsalam, Fiona Lawry and Bart van Bueren.
- National Disaster Management Office: Loti Yates, Director
- Honiara City Council: Solomon Saii Leonard, Panatina Ward Councillor and John Clemo, Climate Change and Resilience Advisor
- Compass Housing: Ben Wong and Donald Proctor
- Ministry of Lands, Housing and Survey: Steve Likaveke

The 2017 LiDAR data used to produce spatial maps were provided by the Solomon Islands Ministry of Health and Medical Services (Dr Aaron Oritaimae).

Abbreviations and acronyms

CRH – Climate Resilient Honiara

DRR/M – Disaster Risk Reduction/Management

HCC – Honiara City Council

GHA – Greater Honiara Area

MECCDM – Ministry for the Environment, Climate Change and Disaster Management

MLHS – Ministry of Lands, Housing and Survey

RMIT – Royal Melbourne Institute of Technology

SPREP – Secretariat of the Pacific Regional Environment Programme

UNFCCC – United Nations Framework Convention on Climate Change

UN-Habitat – United Nations Human Settlement Programme.

Contents

1 Introduction

This report about evacuation facilities in Honiara, Solomon Islands, has been developed as a component of the Climate Resilient Honiara project (CRH). CRH is a four-year research project, commencing in 2018, funded by the UNFCCC Adaptation Fund and administered by UN-Habitat. RMIT University was contracted at the start of 2019 to provide scientific support and capacity building to a range of urban climate resilience interventions (actions) for Honiara at community, ward and city levels. The RMIT team, led by Professor Darryn McEvoy, brings together researchers from six different schools to collaborate with partners in Honiara and internationally.

The overall aim of the CRH project is to reduce the vulnerability of those living in Honiara's informal settlements through a range of co-designed initiatives.

The overall CRH project aims to:

- Enhance the resilience of Honiara to current and future climate impacts and natural disasters;
- Provide better infrastructure for vulnerable communities and informal settlements;
- Target the specific needs of youth, women, girls, the elderly, and people with disabilities.

Evacuation Centre planning was an identified action in the 2016 Honiara Urban Resilience and Climate Action Plan (HURCAP), that aims for better disaster preparedness, risk reduction, and implementation of a climate action plan. This report brings together desktop research and observations gathered from field visits to inform the development of design guidelines and pilot studies for new and re-purposed evacuation centres in Honiara, with a particular focus on the needs of informal settlements and the urban poor.

2 Work Package 7a: Climate Resilient Spaces – Evacuation Centres

This report provides details on Work Package 7 (WP7a) 'Climate Resilient Spaces – *Evacuation Centres*', led by Professor Usha Iyer-Raniga and Dr Tariq Maqsood. It provides details of steps taken in 2019 towards developing new and re-purposed evacuation centres and lays out a series of aims and actions for the remainder of the CRH project.

2.1 Project scope

In line with the overall aims of CRH, the project scope for developing evacuation centres was to:

- Conduct site visits, scoping meetings and consultations, and stakeholder workshops;
- Undertake preliminary mapping and analysis to determine suitable locations for future and existing evacuation facilities;
- Provide a review of existing information and best practice appropriate to the Pacific context;
- Provide best practice guidelines for the design and building of evacuation centres;
- Develop two pilot study concept designs for evacuation centre sites including:
    - a retrofitted evacuation centre (2020)
    - a new evacuation centre (2020)
- Produce an action plan for 2020-2022.

2.2 Limitations

No formal community consultation has taken place in relation to evacuation centres with community members. This report acts as a starting point to generate discussions with the community and other local stakeholders. The following information is based on field visits conducted in June, September, and December 2019; where observations and informal discussions took place with local leaders and community members. This report, and proposed actions, need to be presented to the community for consultation, feedback, and endorsement.

Most data on population and any maps are outdated, inaccurate, or even not available at all in Honiara. To cope with this, the project team has had to make many assumptions. The assumptions are based on expert-insight and community feedback provided either during the field visits or in response to specific questions from the local stakeholders.

In the Greater Honiara area, rapid population growth has been accompanied by deforestation. As urbanisation is poorly regulated, it is also very difficult to make assumptions for the coming 5-50 years.

2.3 Brief

The brief (see Table 1) was developed during the September 2019 field visit to Honiara in consultation with ward councillors and Loti Yates, Director of the National Disaster Management Office.

Table 1: Brief for evacuation centres in Honiara (in consultation with key local stakeholders)

Provide more than one evacuation centre per ward:

- Several evacuation centres are required for each ward (numbers TBC after WP1: Community Profiles are completed as population information is required to determine number of centres).

Creating multi-purpose facilities:

- Multi-purpose centres are preferred, so that they add community value and are regularly maintained;
- schools, churches, sports halls, youth centres may be upgraded for evacuation centre use;
- Use of schools is a problem if people do not leave the school sites after the disaster (as was the case after the 2014 flood event).

Considering safe houses:

- Some settlements may not have any space for new buildings;
- In such cases, houses may need to be upgraded as safe houses.

Exploring church facilities:

- These are a good option to upgrade/retrofit but there are questions about whether people can sleep in them, and whether people of other faiths can access them?

*Note: most of the churches visited did not have power and none had toilets indoors. Kitchen facilities and running water were also not present in the churches visited.

Considering cultural issues:

- There needs to be multiple centres across the island. Ethnic tensions have resulted in the use of some existing facilities as emergency shelter.

Providing access:

- Access may be limited by road to the centre and accessing other infrastructure may be an issue;
- Access for medical and other support services by road;
- Steep, sloping sites need to be mediated.

Ensuring safety for vulnerable groups:

- Women, pregnant women, children, and people with disability;
- Sex/family segregation and privacy.

Functional requirements:

- Indoor toilets with separation for men, women, and those with disability;
- Access to water;
- Kitchen and food preparation, storage, and disposal;
- Emergency power generation;
- Basic medical supplies and proximity to medical services;
- Separation for males and females and family groups with children.

Maintenance considerations:

- Evacuation centres may become default permanent accommodation
- Asking communities to manage and maintain centres through the Community Development Committees (CDCs);
- If portable toilets are used, they may become 'permanent' and cleaning and maintenance is an issue;
- Developing a maintenance schedule (responsible organisation for this needs to be clarified e.g. NDMO)
- Developing communication tools to inform communities about location, function, access and evacuation procedures;
- Communications to include all types of disasters (not just cyclone or flooding).

Source: Iyer-Raniga 2019.

2.4 Existing evacuation centres in Honiara

The most recent inventory of evacuation centres for Honiara is in the 'Honiara City Council Disaster Operating Procedures' (HCC Technical Working Group 2013). The inventory divides centres by disaster type – either Cyclones/Flooding or Earthquake/Tsunami. The tables include contacts for each centre and estimate the number of families each facility can accommodate. The tables are poorly organised, and some centres are listed twice across different settlements, giving the impression that capacity is higher than it actually is.

Regarding evacuation facilities in Honiara, the advice received from Loti Yates, Director of the National Disaster Management Office, in November 2019 states:

> *"There are no designated evacuation centres in Honiara. There are however public buildings such as schools and churches … that have been used as evac centres for a long time. It has been the practice and will always be the practice until someone … funds … purpose built evac centres across all wards… in the Solomon Islands. The issue of evac [sic] centres and… lists of where they are will be a new exercise which … will start with a clean sheet of paper".* (Email correspondence, Nov 22, 2019).

3 Emergency shelters and the local context

In April 2014 the island of Guadalcanal was badly impacted by heavy rain and major flooding, resulting in the deaths of at least 22 people. Most of these people were from the Koa Hill informal settlement on the banks of the Mataniko River, where the floods destroyed up to 675 homes. This event caused thousands of people to be relocated to evacuation centres for many weeks. For instance, during on-site meetings in Honiara in September 2019, it was found through informal discussions with stakeholders in Honiara that there were issues with people staying on in evacuation accommodation because the quality of the shelter exceeded the standard of living in their previous homes.

[On this topic, the Bangladesh Ministry of Disaster Management and Relief and Secretariat (2012), suggests that centres should be within 1.5 km (walking distance) from vulnerable people. They prefer multi-purpose centres and state that shelters are temporary during emergencies and not for displaced persons].

Five vulnerability 'hotspot' settlements in Honiara had been identified in a previous climate change vulnerability assessment (UN Habitat, 2016, p.17; in Trundle A and McEvoy D, 2016). These are Aekafo-Feraladoa, Kukum Fishing Village, Ontong Java, Gilbert Camp (Jabros) and White River (Wind Valley). These areas are categorised as informal settlements due to poor quality housing, a lack of infrastructure, and that poverty and disadvantage is prominent.

People seeking emergency sheltering have generally experienced varying degrees of trauma and come with needs that encompass more than just a roof over their heads (McInerney, 2012). According to Smith and Parsons (2015), emergency centres need to meet a variety of needs and may take forms including emotional protection, a location, a place to store belongings, a place used solely for receipt of services, or a staging point for future action (Davis, 1978; in Smith and Parsons, 2015). Emergency sheltering therefore involves meeting "a combination of needs at the level of the individual themselves" (The Sphere Project, 2011). Further, in the Australian context, the Red Cross found that people experience disasters in variable ways and bring with them expectations that may not be transparent:

> *"People accessing emergency shelters have been affected by disasters in a variety of ways and arrive with a range of emotions, needs and expectations… and uncertainty about the future can result in people feeling anxious, vulnerable, powerless or angry."* (Somasundaram and Davies, 2014).

Much of the literature regarding the design, construction, and management of evacuation shelters is written by governments, NGOs, or humanitarian organisations. This information consists largely of applied guidelines for practical on-ground implementation and planning purposes. Many of the principles found in these guides are underpinned by the Sphere Project Humanitarian Charter and Minimum Standards in Humanitarian Response (2000, 2004, 2011, 2018). The charter aims to improve the quality of humanitarian response in situations of disaster and conflict, and to enhance the accountability of humanitarian action to crisis-affected people.

Humanitarian concerns apply to persons considered particularly vulnerable during emergencies and multiple sources emphasise the need to provide privacy and safety for women and children and other vulnerable evacuees during emergencies (Ministry of Disaster Management and Relief Secretariat Bangladesh 2012, Republic of Vanuatu 2016, Iyer-Raniga 2019).

SPREP (2016) provides an example of the integration of humanitarian concerns in its guide that includes a comprehensive survey dataset of regional and country-based strategic plans and guides. Their document reviews each country's report and provides analysis by region measured against the Sendai Framework for Disaster Risk Reduction 2015-2030. The SPREP Framework is favourably assessed in this world-based review of national and regional strategies for disaster risk reduction. According to Yonetani (2018), the SPREP Framework:

> *"provides the strongest example of the integration of displacement and other human mobility concerns, reflecting Pacific leaders' championing of concerns about displacement from low-lying islands and coastal areas in the context of climate change, along with a call for 'migration with dignity'."*

The Republic of Vanuatu (2016) produced a guide for the assessment of both existing and design of new evacuation centres that provides contextually aligned parallels with the Solomon Islands. The guide references international humanitarian best-practice and recommends design of evacuation facilities that respect the privacy of affected people; as well as responding to gender, culture and religion (Republic of Vanuatu 2016). The guide presents a comprehensive list of design and functional criteria that would also be applicable in the Honiara context.

Criteria and best practice for the siting of evacuation centres that utilises GIS mapping has been interrogated by Kar and Hodgson (2008), where a system-based suitability model is used to assess a Weighted Linear Combination (WLC) against a Pass/Fail screening technique in 17 counties in Southern Florida. They found 48% of existing shelters to be in physically unsuitable areas and that geographic location has not previously received adequate attention, and that it may be as important as structural stability. Also, with respect to GIS methods, Jia Yu et. al (2018) interrogate multi-agent simulation and multi-criteria evaluation for the siting of evacuation facilities through a case study in in Jing'an District, Shanghai, China. They utilised a population estimation method and formula to provide equations estimating population capacity of shelters (p 1889). They found that the proposed simulation and iterative optimisation methodology could achieve better spatial allocation results than static methods.

In the Honiara City context, Reuben and Lowry (2016) evaluated 27 existing evacuation facilities. They indicate that poorly covered areas are Lungga, Burns Creek and the Southern fringes of Honiara. Their paper highlights poor emergency preparedness and planning, and the inadequate numbers of people who could be accommodated.

Issues associated with the ongoing maintenance and management of centres emerged in the Ministry of Disaster Management and Relief Secretariat Bangladesh (2012) who found ineffective policy guidelines and implementation resulting in poor maintenance that made many shelters uninhabitable.

This view is backed up by Christopher Govers, Head of International Programs at Habitat for Humanity Australia, who suggests that designing multipurpose facilities should be a priority:

> *"Generally, cyclone shelters need to be multi-purpose… if they are going to have any chance to remain in a functional state and this means being inclusive of the communities from the outset and having their buy in and acceptance. If this is not a priority the cyclone shelters fall into disrepair or are occupied for other means that do not allow people to use them when needed"* (personal communication, November 2019).

Trundle and McEvoy (2016) found that there are issues with using educational facilities and schools as evacuation centres because of the disruption caused to ongoing education:

> *"Schools and educational facilities across the city were employed as evacuation centres during the April 2014 floods, however the role of schools as evacuation facilities during disaster response was viewed by many stakeholders as having a negative impact – in terms of education disruption and facilities damage – rather than an asset."* (Trundle & McEvoy, 2016).

Furthermore:

> *"If sound practices are not used, we can create many future problems such as erosion, deforestation, landslides and floods; deprive communities of essential livelihood resources; and put people, infrastructure and ecosystems at greater risk of future disasters."* (WWF 2016).

3.1 Summary

People seeking emergency sheltering will likely have experienced trauma and come with needs that extend beyond physical shelter. Findings in the literature include the need to design facilities with reference to principles of decency and humanity to ensure accountability and safety; particularly of women, children, the elderly or disabled, who are considered particularly vulnerable during emergencies. The literature review also found issues with people staying on in evacuation facilities in Honiara during the 2014 floods, because the quality of the evacuation shelter exceeded the standard of living in some informal settlements. This can negatively affect the ongoing functionality of public amenities, like schools. Disaster 'hotspots' that were identified include Aekafo-Feraladoa, Kukum Fishing Village, Ontong Java, Gilbert Camp and White River, Lungga, Burns Creek, and the Southern fringes of Honiara.

Applied guidelines about the design, construction and management of evacuation shelters is primarily written by governments and NGOs. These are applicable to Honiara and may be used for planning future evacuation facilities, and assessing and upgrading existing buildings. Simulation and iterative optimization methodology for GIS mapping can achieve better spatial allocation results than static methods to identify potential evacuation centre sites. The ongoing maintenance and management of centres emerged as a theme and identified poor planning and governance, and inadequate building standards in informal settlements as contributing factors. Solutions proposed included designing multi-purpose facilities to ensure regular use and community ownership. Finally, themes of sustainable building practices and materials emerged as important considerations so that the facilities themselves did not contribute to environmental and societal problems.

4 Literature review on guidelines for evacuation centres

A scan of the literature on evacuation centres identified some seminal works. The following six documents are considered to be the most relevant publications for evacuation centres in Honiara:

- Building back safer and greener; A Guide to Sound Environmental Practices for Disaster Recovery in Nepal (WWF Nepal 2016).
- The Sphere Handbook: Humanitarian Charter and Minimum Standards in Humanitarian (UNICEF Response Sphere Association 2018).
- After the Tsunami - Sustainable building guidelines for South-East Asia (UNEP SBCI and SKAT 2007).
- Republic of Vanuatu National Guidelines for the Selection and Assessment of Evacuation Centres (Vanuatu NDMO 2016).
- Bangladesh Cyclone Shelter Construction, Maintenance and Management Policy (MDSPBD 2011).
- Preferred Sheltering Practices for Emergency Sheltering in Australia (Australian Red Cross 2015).

The following guidelines (Table 2) from these documents synthesise the key principles found in the literature to develop a set of guiding principles towards design and development of new evacuation facilities for Honiara, as well as criteria with which to assess existing ones.

Table 2: Best practice guidelines for design of evacuation centres

GEOGRAPHIC & HAZARDS	〉 Elevated above impact from high tide or storm surge 〉 Not exposed to wind impacts 〉 Raised at least 500mm above highest predicted flood levels 〉 on stable land 〉 Not subject to potential landslip or landslides 〉 No nearby large trees, structures, power lines (or other potential hazards) 〉 Away from facilities making or storing hazardous materials 〉 Accessible by vehicle and foot, for those with disability and other vulnerable individuals.
OCCUPANCY CAPACITY	〉 Minimum 1.5 m^2/person for the shelter 1 to 3 days (short term) 〉 Minimum 3.5 m^2/person for the shelter 4 days and above (long term).
BUILDING REQUIREMENTS	〉 Local national building codes or equivalent codes from New Zealand or Australia (certified by a practising structural engineer as capable of withstanding expected wind and/or earthquake loads for the Pacific region) 〉 Building materials and methods should withstand potential hazard events for that area (i.e. category # of cyclone) 〉 Existing buildings to be assessed for structural integrity and suitability to withstand predicted hazards (if not, upgrades are needed) 〉 Square or rectangular-shaped buildings are better than L-shaped or U-shaped buildings due to aerodynamics. 〉 Buildings should be fitted with cyclone shutters for windows and doors 〉 Buildings should be weatherproofed against water penetration 〉 Ensure enough ventilation for proposed capacity usage 〉 Provide for people with disabilities, including ramps where necessary and appropriate design for wheelchair access 〉 Gas cylinders must be installed outside and gas cylinder regulators to be positioned in secure cages away from building 〉 All-weather access for vehicles, adequate parking, safe areas for vehicle manoeuvring (including trucks) 〉 Protection from mosquitoes, rodents and other pests.
BUILDING MATERIALS	〉 Choose sustainable materials and technologies to protect natural resources, reduce energy consumption and pollution 〉 Use locally available and certified materials or products to provide benefits for local communities, resource management and environments, including using local construction technology and skills.
MINIMUM FACILITIES	〉 Kitchen equipped for hygienic food preparation with adequate ventilation to exhaust the fume/ventilation 〉 Running water tap and sinks inside kitchen 〉 Refrigerator or freezer 〉 Adequate fire exits, smoke alarms and fire extinguishers 〉 A dedicated medical treatment area or close to a health facility 〉 Open space for a recreational area.
MINIUM WATER REQUIREMENTS	〉 3-5 litre person/day drinking water 〉 2 litre person/day for hygiene 〉 3 litres per person/day for cooking
SANITATION AND HYGIENE	〉 10-20 litre water person/day for conventional flushing toilet 〉 1.5-3.0 litre per person/day if pour flushing is used 〉 1 toilet/30 females 〉 1 toilet plus 1 urinal/50 male or 1 toilet/40 male 〉 1 toilet for people with disabilities

	〉 1 hand washbasin/10 toilets 〉 1 shower/ 30 persons 〉 Toilet > 20m away from kitchen but < 30 meters from main building 〉 Laundry block 〉 Sustainable systems for waste and sanitation (i.e. composting toilets).
GENDER SEGREGATION	Apply gender protection and dignity principles including: 〉 Moveable partitions for privacy for women/girls, children 〉 Male and female toilets not face to face and gender segregated 〉 Water point should not be in dark areas 〉 Gender segregated showers 〉 Toilets are internally lockable.
ELECTRICAL INSTALATIONS AND EMERGENCY POWER SUPPLIES	〉 Electrical installation and alternate/emergency backup system 〉 If alternate/emergency backup is a generator, a manual changeover switch to connect the generator should be provided 〉 If alternate/emergency backup is a solar panel, batteries/UPS to be provided with inlet for the battery/UPS to connect with the switch board 〉 Generator and fuel tank should ideally be located outside and should be protected from rain, wind born debris 〉 Access to fuel and generator should be all weather 〉 Inspection of electrical installation should be done upon completion by an electrical engineer 〉 All corridors, toilet areas, shower points, drinking water points and hand washbasin areas should be lit during the night 〉 Provide exhaust fan/ventilation in the evacuation centre to avoid suffocation due to large number of people inside.
SAFETY AND PROTECTION	〉 Building properly secured with night latches for doors 〉 Burglar proof bars for windows 〉 Perimeter fencing with a dedicated main entry/exit 〉 All dark areas, toilets washrooms, showers, water points are provided with lighting 〉 Ideally an evacuation centre should be small for an easy operations and management from activation to closure (smaller evacuation centres mean self-regulation for protection is more likely within smaller groups).

Table source: Bangladesh Ministry of Disaster Management and Relief and Secretariat 2012, Compass Housing 2019, Republic of Vanuatu 2016, Smith, C, Parsons C 2015, Sphere Association 2018, World Wildlife Fund (WWF) Nepal 2016.

5 Criteria for evacuation centres

5.1 Guidelines

The design criteria discussed in the document is based on guidelines by Queensland Government, Australia (2006). The design criteria primarily address the safety of people within the evacuation centre which provides temporary shelter during an emergency. The centre is not intended to be occupied for longer periods or to be used as a storage facility. It is intended that people enter the centre with minimal personal belongings for a limited time during an extreme event, usually up to three days. However, during the community consultations in Honiara, there was a strong demand to build the evacuation centres to be used for multiple purposes i.e. it could be used as a shelter during an emergency and as a community centre during normal days.

The criteria mentioned in this document is specific for the intended use as a building being used to protect a large group of people from the impacts of an extreme event. It is recognised however, that due to the infrequent need as a public shelter it may be used for alternative purposes, such as a school building, sports facility, or community hall on a day to day basis.

While evacuation centres are designed to resist more extreme loads than normal residential buildings, it is possible that an event with greater severity could occur and may result in the failure of the building. The main design criteria are discussed below.

5.1.1 Location

The evacuation centre should be located so that access to the centre is maintained. The location should not be inundated by river, creek or storm tide; nor prone to landslide hazard or at a site with problematic soil conditions. Moreover, the centre should not be located near hazardous materials (fuel and chemical storage), physical hazards (falling debris), and high voltage power lines.

Therefore, a site-specific detailed investigation needs to be conducted before design and construction of the evacuation centre.

5.1.2 Structure

The building structure and external fabric should be able to resist the following loads and should be designed according to the local building codes:

- Permanent and imposed (dead and live) loads,
- Wind and storm loads,
- Debris loads,
- Earthquake loads, and
- Wave and flood loads.

5.1.3 Human Factors

Human factors that needs to be included in the design of evacuation centre include:

- Area per occupant,
- Occupancy duration,
- Lighting,
- Safe movement and access,
- Gender segregation,
- Access for people with disabilities,
- Ventilation,
- Amenities (kitchen, storage, toilets, showers),
- Communications,
- Emergency power, and
- Emergency provisions (food, water, medical aid, blankets, etc.).

5.1.4 Other Factors

Other factors that needs to be included in the design of any evacuation centre include:

- Emergency warning,
- Fire protection, and
- Community acceptance.

It was noticed during field visits in Honiara that much of the required information is not available or haven't been developed yet e.g. only limited geological and seismological data are available from the Ministry of Mines, Energy and Rural Electrification. Furthermore, a preliminary flood risk study conducted by the World Bank could also be utilised to assess local hazard levels. However, this information seems to be inadequate for design purposes. Therefore, a site-specific detailed investigation needs to be conducted to assess and incorporate these various issues in the design and construction of the evacuation centre.

5.2 Operations over time

The evacuation centre is a static building, but its operations are in fact very dynamic. What is needed, and what is available to the community, changes from during the disaster to days, weeks and months afterwards. This is important to realize during the planning, designing and operations of an evacuation centre. Figure 1 presents a simple overview of this.

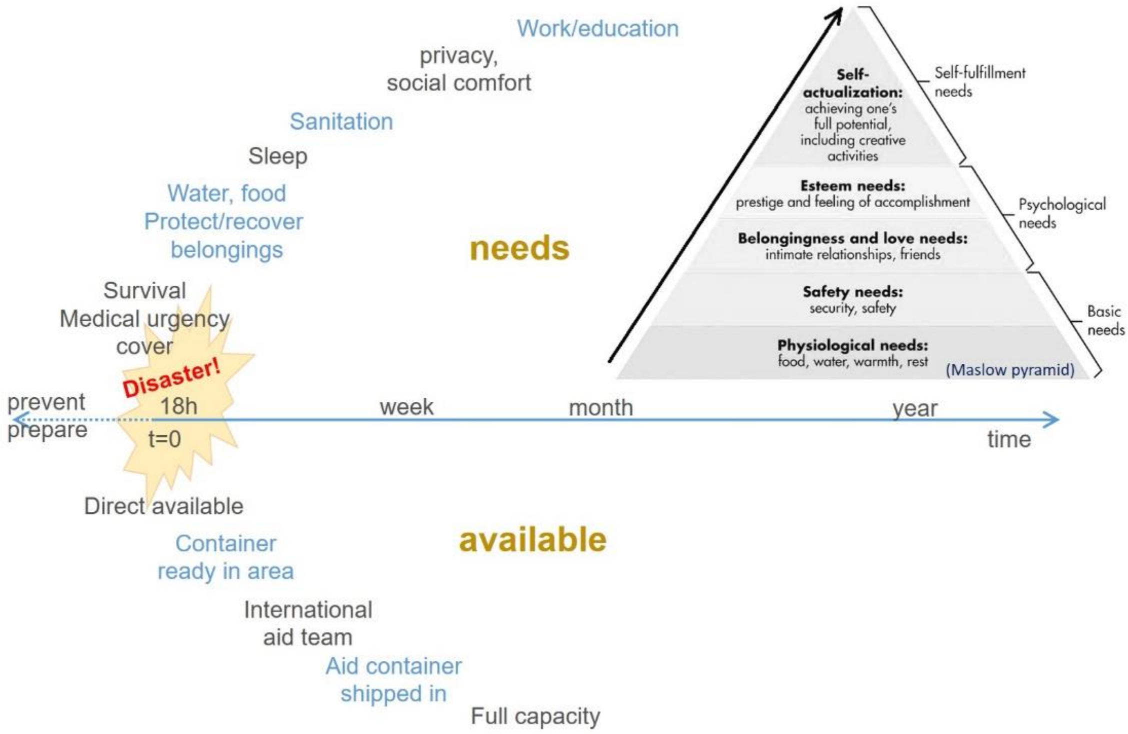

Figure 1: Disaster relief operations for an evacuation center and community. Source: van Bueren (2019).

6 Field surveys

Field surveys were undertaken in September and December 2019 in various informal settlements to better understand on the ground issues and to undertake a needs analysis. As reported in the field visit report for September 2019 (McEvoy et al 2019), the buildings visited were the Old Sports Club in Rove (used as an emergency centre during the 2016 ethnic tensions), Epalle School, Aekafo Church Hall, Jabros Church and Naha. In addition, the Holy Cross Parish Hall, Koa Hill church, King George VI School, SINU pavilion, April Ridge and April valley were all covered as part of the site visits.

6.1 Meeting with Director, National Disaster Management Office

The RMIT evacuation centre team met with Loti Yates, Director of the National Disaster Management Office. Issues raised by Loti included a lack of communication between various arms of the NDMO and the Government / Honiara City Council (this was also apparent from discussions with a MFAT representative), and being under resourced. Furthermore, he emphasised that the evacuation centres:

- Need to consider privacy for women, children, and the disabled.
- Need to have indoor toilets for children and women to use.
- Need gentle slopes to allow for ease of access.
- If portable toilets are to be used, they may become 'permanent' and cleaning and maintenance then becomes an issue.

6.2 Workshop with Honiara Ward Councillors

As part of DRR training with Ward Councillors, a workshop was undertaken with the Councillors to canvass local needs and determine whether there were any specific issues or concerns that they wanted to raise in relation to the design and construction of evacuation centres. In addition to the points already discussed, Councillors raised these other issues:

- Ethnic tensions make it harder to have one evacuation point, and therefore there needs to be multiple centres across Guadalcanal island.
- There is a risk that evacuation centres may end up becoming permanent accommodation, so it may be better to get communities to take charge and maintain them through the Community Development Committees (CDCs).
- Using schools as evacuation centres can be a problem if people do not leave the school sites after the disaster when things return to normal (as experienced after the 2014 flood).
- In the recent past earthquake and tsunamis have impacted the Western Province at regular intervals (2007, 2010, 2013 and 2016). NDMO uses a M6.5 earthquake at shallow depth (10km) as a threshold to trigger a tsunami warning. The tsunami arrival time is considered to be extremely short (4 minutes) due to the proximity of potential rupture location. The warning messages are usually communicated through FM radio channels.

7 Spatial mapping and analysis

Spatial mapping and analysis of the terrain and site mapping provides a basis to inform retrofitting activity as well as investigation areas for new evacuations centres. Firstly, existing sites and capacities are assessed against physical and environmental conditions at the regional scale to understand the requirements and relationships.

To conduct the investigation, a multi-criteria decision analysis (MCDA) was undertaken in GIS to provide a robust spatial framework for assessing environmental constraints and hazards. The mapping methodology integrated multiple criteria and factors, allowing for more in-depth suitability analysis for the sites of existing evacuation centres. In addition to assessing the existing conditions and capacities, suitability analysis offers the potential for weighted site selection and identifying new investigation areas for new evacuation centres.

Preliminary land suitability analysis was conducted based on the following factors including:

- Population density (modelled based on 2009 census data);
- Landslide risk (areas with slope greater than 45 degrees);
- Tsunami risk (modelled based on bathtub method up 10m above sea level);
- Storm surge (modelled based on bathtub method up 5m above sea level);
- Riverine flooding (modelled based on 1 in 500 ARI);
- Distance to roads.

The combination of all these factors resulted in a 10 units suitability index to check the suitability of existing evacuation centres. The following sections presents results from the preliminary spatial analysis conducted for evacuation centres.

7.1 Existing capacities and population density

In absence of recent population data, 2009 census data (the most recent official figures available) was used to model the population for Honiara. The overlay of existing evacuation centre capacities on population centres highlights the correlation between capacities and demands. Figure 2 displays underserviced population areas located in informal settlement zones by existing facilities. Furthermore, an overlay on 10min walking distance from existing centres highlights the following (Figure 3):

- The potential investigation areas to identify new sites outside of 10min walking catchments;
- Requirements to increase capacities of existing centres servicing the catchment area. Some centres (i.e. Kolale Community School) require more capacity to service the nearby population.

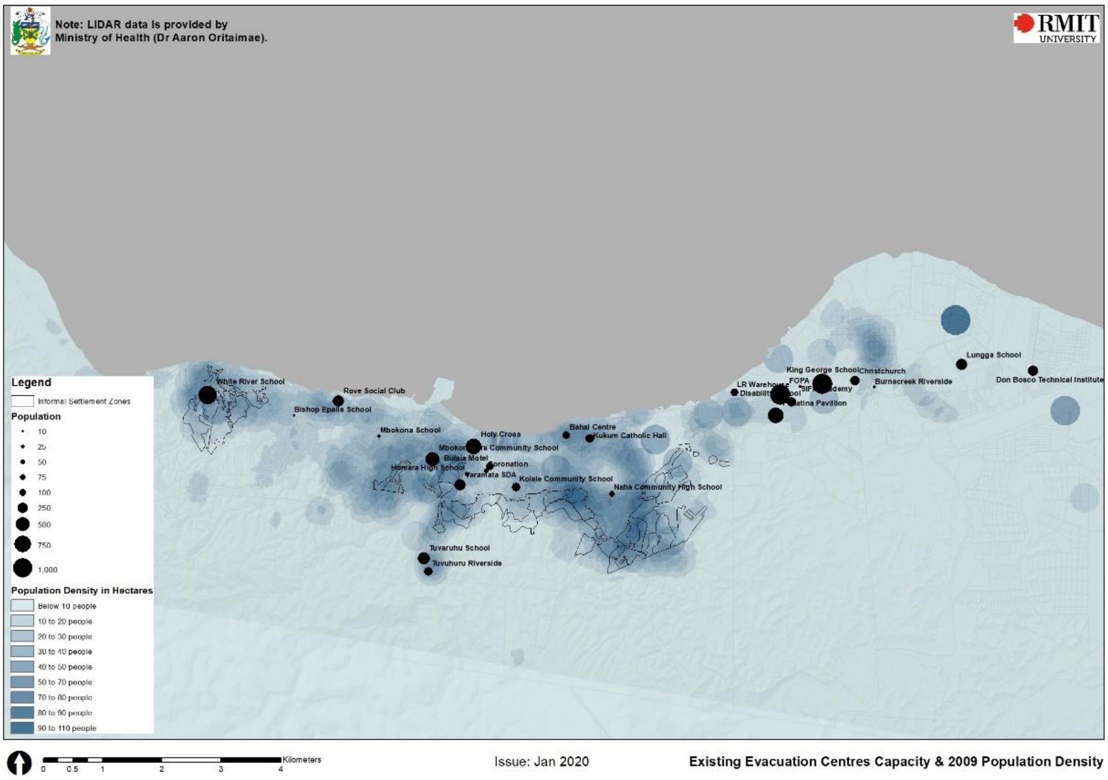

Figure 2: Existing evacuation centres capacities and population density (2009 census)

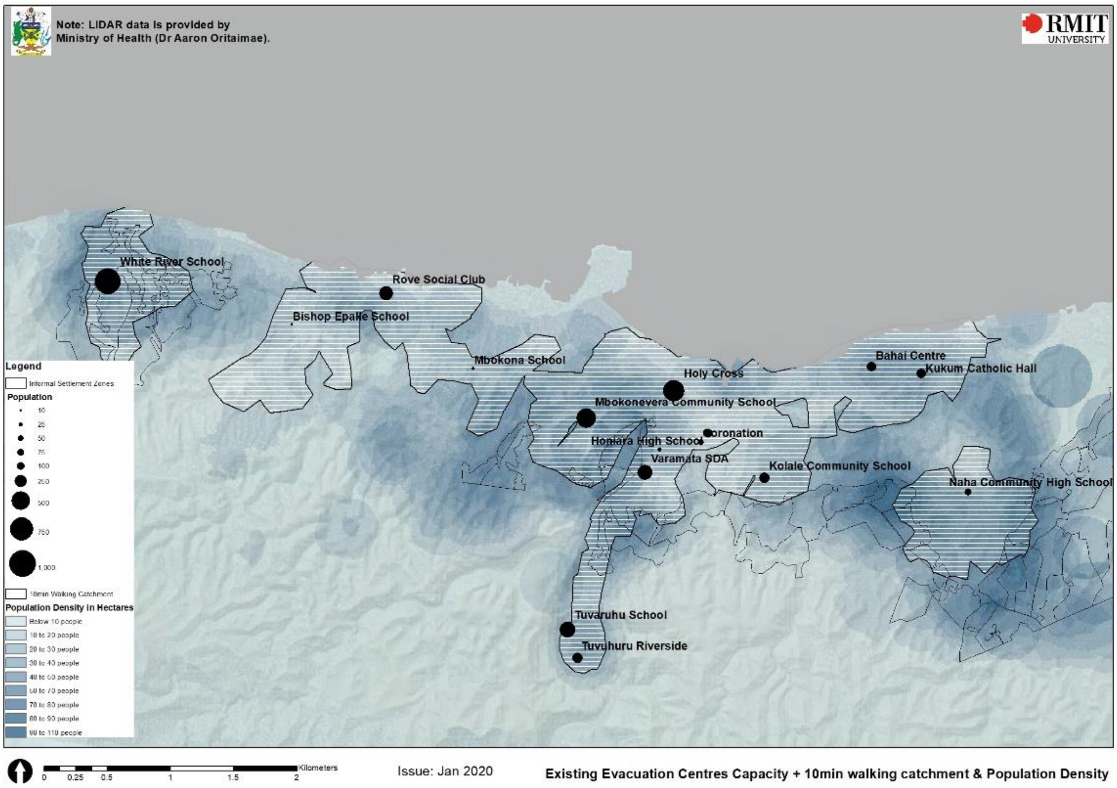

Figure 3: Existing evacuation centres capacities and population density (2009 census) with 10min walking catchment

7.2 Existing Centers and Tsunami Risk

Based on the modelling of tsunami risk (areas below 10m above sea level), the majority of existing evacuation centres are inside risk areas (see Figure 4).

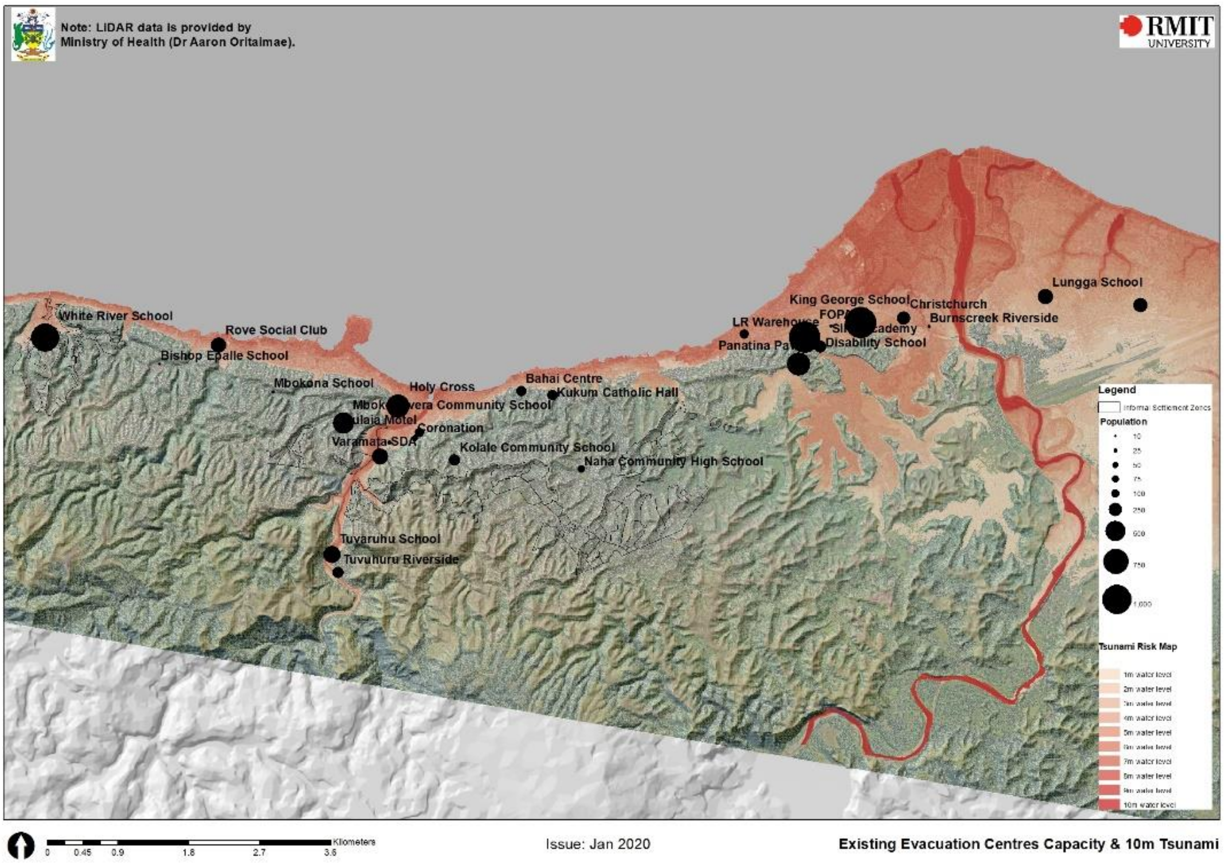

Figure 4: Existing evacuation centres and tsunami risk

7.3 Suitable sites for new and retrofitted evacuation centres

A land suitability map based the criteria above was used as a basis to check the suitability of existing centres. It can also be used to identifying areas for expansion of existing sites, as well as informing the selection of new sites for evacuation centres. Figure 5 shows that majority of existing evacuation centres are located at unsuitable sites.

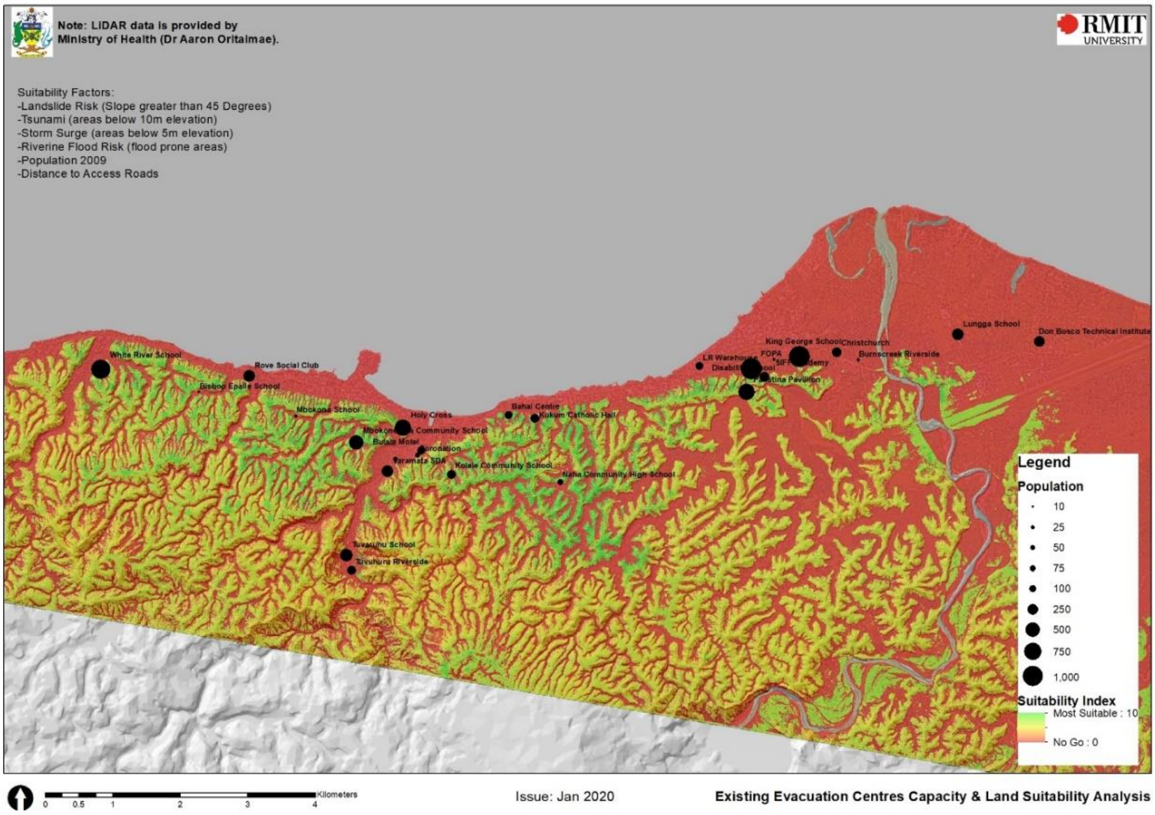

Figure 5: Existing evacuation centres and suitability map

7.4 Proposed sites for new and retrofitted evacuation centres for 2020

Based on the observations during the field visits and preliminary analysis conducted above, the two locations for building new evacuation centre and retrofit/extend an existing facility in 2020 are proposed to be:

- Jabros (new multi-purpose community hall / evacuation centre);
- Aekafo-Feraladoa (retrofit/extend an existing community facility).

Figure 6 and Figure 7 show the location and suitability of the proposed sites. Further details are given in Section 8 and 9 of this report.

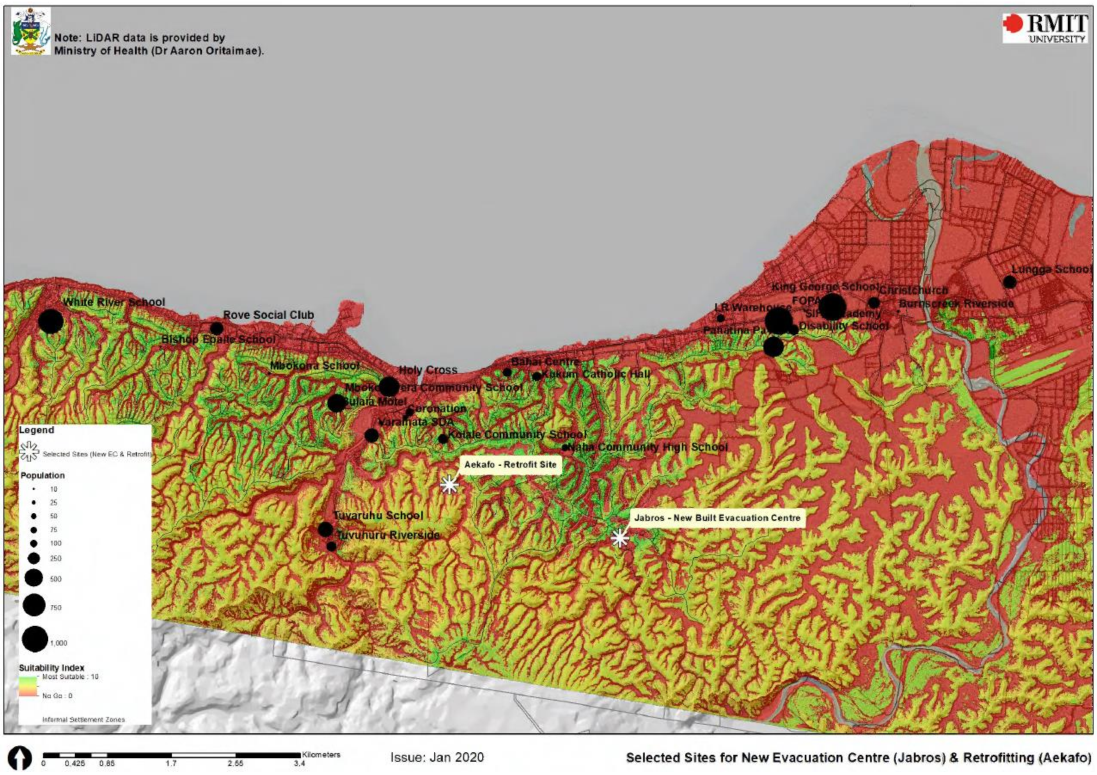

Figure 6: Land suitability map (all hazards) and proposed priority sites for 2020 actions

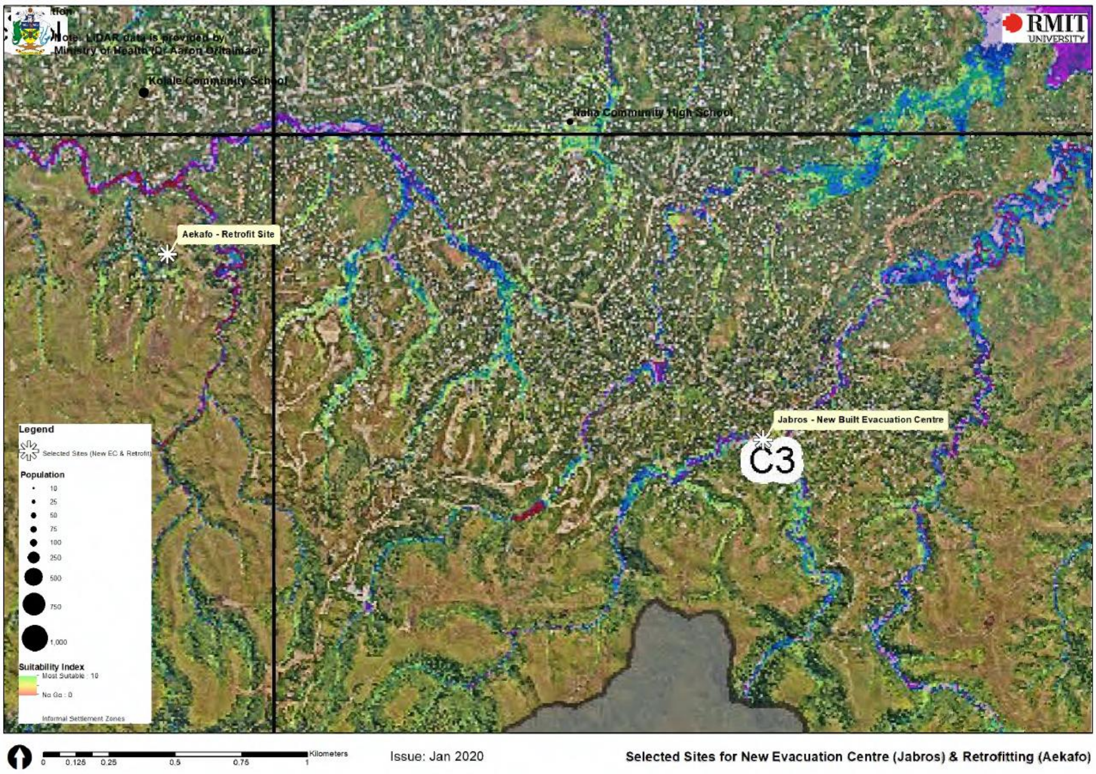

Figure 7: Land suitability map (riverine flooding) and proposed priority sites for 2020 actions

8 New build (Jabros) and Retrofit (Aekafo-Feraladoa)

8.1 Community consultations

A field visit to Jabros and Wind Valley was carried out in December 2019. The workshop in Jabros was organised with the local community to specifically discuss the requirements and community expectation regarding the design and construction of an evacuation centre. The key discussion points are given below:

- Initially the Chairman of the community committee mentioned plans for construction of an evacuation centre at the top of the ridge across the creek, however, it was suggested in group discussions within the workshop that the community preference would be to use a vacant flat area (see Figure 8a) to build an evacuation centre. This would be used as a multi-purpose facility (a community hall or sporting facility during normal days) that could be used as an evacuation centre during times of emergency. The location of the proposed evacuation centre in Jabros is shown in Figure 9a.
- The community hasn't experienced any severe cyclone or flooding in recent years, however, low intensity events (cyclones, floods, earthquakes) occur on a regular basis. There is a creek close to the existing church (Figure 8b). A detailed assessment therefore needs to be undertaken to assess natural hazard risk at the proposed site.
- It was proposed by members of the community that an evacuation centre should have a capacity of 500 to 1,000 persons as when the evacuation centre would be built, people from adjoining areas may also come to seek shelter within the new facility.
- It was confirmed that the land parcel is on Government land with a perpetual title, hence titles are secure. In future, a communal lease for community area would need to be arranged.
- There are two main sources of access to the proposed site, however, these are access routes that would also require upgrades (see Figure 8c).
- The community would be happy to participate in the construction of the new evacuation centre. There have been good examples where the community has worked together to improve their facilities (see Figure 8d). Moreover, the community would provide labour to carry out the construction.
- In terms of facilities, the design should consider separate toilets for male and females, access for people with disabilities, safe movement and access for the vulnerable, kitchen and emergency power.
- The existing church facility could also be considered for retrofitting / strengthened to increase its capacity. It could also be used as a resilient building training example (see Figure 8e).
- A technical committee linked to the CDC should be created for training-the-trainer activities.

A potential retrofit choice is the church hall located in Aekafo-Feraladoa, which was visited in September's field survey (see Figure 8g). There is flat land (see Figure 8h) available at the front of the church which could potentially be used for a multi-purpose hall as an extension and part of retrofitting actions (see Figure 9b).

Figure 8a: Vacant flat area and potential site for an evacuation centre

Figure 8b: Creek behind the church evacuation centre

Figure 8c: Access road to Jabros and site

Figure 8d: Jabros community workshop

Figure 8e: Community built facility

Figure 8f: Existing church (retrofit required)

Figure 8g: Existing church (Aekafo)

Figure 8h: Vacant flat area in front of the church (Aekafo)

Figure 8: Jabros community workshop and site locations (Jabros and Aekafo-Feraladoa)

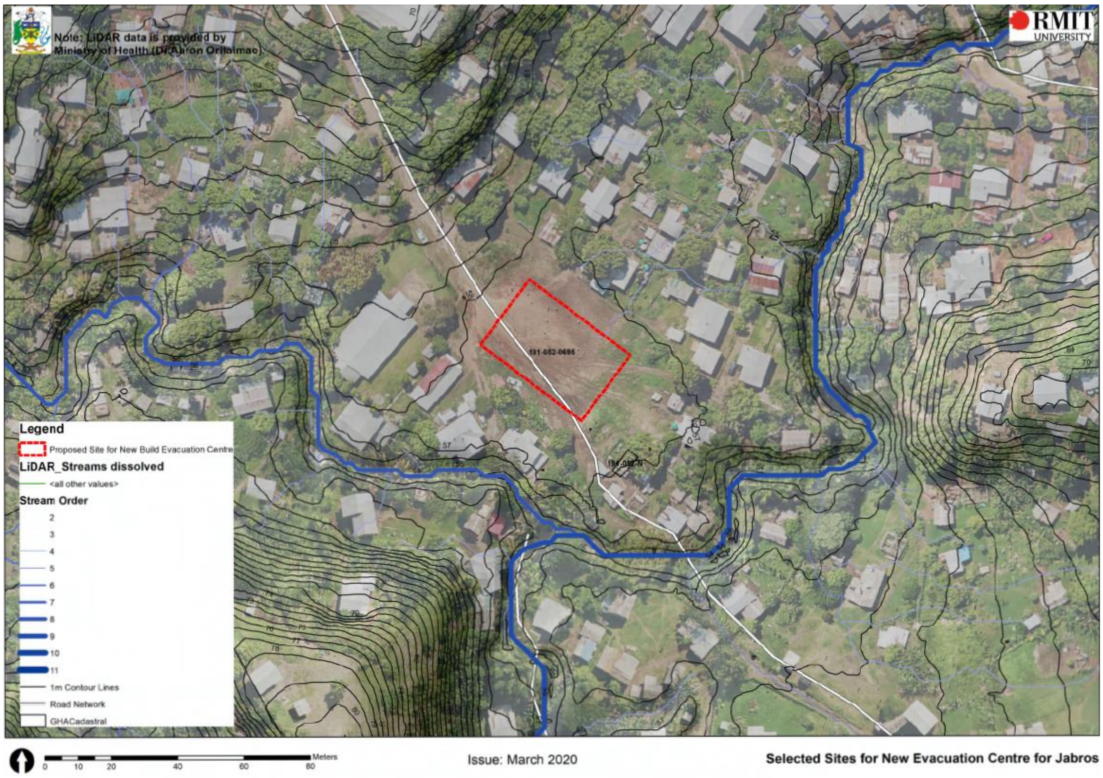

Figure 9a: Jabros

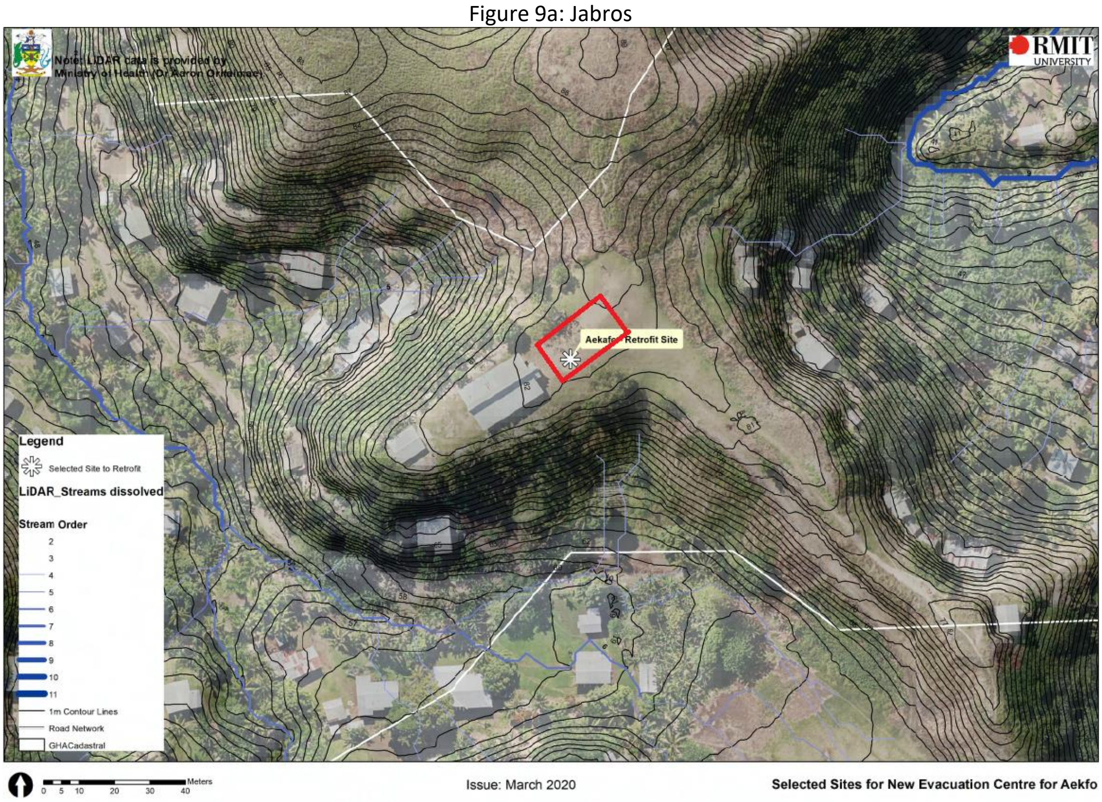

Figure 9b: Aekafo

Figure 9: Location and preliminary site assessment for proposed evacuation centres at Jabros and Aekafo

8.2 Design precedents and local considerations

Compass Housing funded and built the Louniel Community Centre, Tanna Island, Vanuatu; which was built in response to Cyclone Pam on a site identified by the local community (see Figure 10). It is located on the Western part of the island on a long and hilly drive from the airport, main town, and resorts. This case study provides examples of what can be achieved with donor materials and labour, as well as utilisation of local building expertise. According to Donald Proctor (presentation at RMIT, 5th December 2019), negotiations with local chiefs was key in terms of getting buy-in and endorsement of local communities; as well as determining the most appropriate site.

Figure 10: Louniel Community Centre & Evacuation Centre being built with donated and local labour. Source: Compass Housing 2019.

8.3 Building program (Jabros)

For Jabros (Gilbert Camp), the main focus of the evacuation centre is on short-term sheltering of 500-1000 people. A more exact number of people needs to be determined for specific locations within Honiara. The detailed design (later in the project phase) will follow the guidelines mentioned in Section 5 of this report. To develop a concept design, a concise building program of space and facilities for such an evacuation centre has been listed in Table 3.

Table 3: Concept building program for an evacuation centre in Honiara

Program requirement	Details, requirements	Details, as in concept design
Multifunctional options/use	Evacuation centre, community hall, sports facility	• 30.6 x 17.6m hall designed for multifunctional purposes. • Movable partition walls to create separate spaces. • Six additional side buildings and large canopy offer space for facilities.
Design requirement	More detailed investigation on design loads. Avoid L and U-shaped buildings for earthquake resilience and to reduce wind turbulence. Maximum height 9m. Size to be determined. Large spaces are required, movable partition walls or alike for privacy. Ensure good ventilation. Suggested space: 350 m2 bedding space. Structural resilience to natural hazards.	• Main structure is rectangular and will be designed according to design codes. • Side buildings have independent structure • Height is ~9m. • Hall enclosed by wire fence for max. ventilation. Wind protection from nearby bamboo, side buildings, fence and possibly bamboo mats on fence. • 535m2 for bedding space (incl. corridors and partition walls).
Sanitation women	2x toilets including one with disability access; 1x washbasin 2x showers, all within 50m of bedding space. 1x laundry block (may be accessible for men, refer to Table 2 for min no of toilets based on numbers).	• 30m^2 side building allocated for sanitation women. • Laundry block at the adjacent water tank.
Sanitation men	1x toilet with disability access; 1x urinal, 1x washbasin, 2x showers, all within 50m of bedding space. For safety, it is preferred to plan men and women sanitation units not opposite each other (refer to Table 2 for min no of toilets based on numbers).	• 30m^2 side building allocated for sanitation men.
Kitchen & dining	Size to be determined. 20m from sanitation units. Include a public water point. 2.5 wheelie bins (240l each) or similar collection bin, which can be emptied responsibly off-site.	• 30m^2 side building allocated for cooking or dining. • 28m^2 side outdoor platform allocated for cooking or dining. • 55m^2 canopy at the back of the building allocated for dining and seating.
Medical treatment area	Size and specific program to be determined. This function may be off-site nearby.	• 30m^2 side building allocated for medical treatment in front of building near coordination office.
Emergency power back-up	This may require storage of gas-cylinders or wood. Consider if solar panels and batteries suffice.	• Plenty of canopy for cylinder or wood storage. • Large roof surfaces for solar panels. • Two large water tanks for water storage, collected from the large roof.
Outer border / safety measures	Ensure protection from burglars/water/cyclone on all doors and windows.	• Bamboo plants (NBS) around building will block most winds, rain and burglars.

	The site should be secured with a fence with one main entrance. The fence may be living bamboo and can be linked with nature-based solutions (NBS).	• Side buildings and elevated foundation block water and some wind. • Main hall is fully enclosed by wire fence for burglars and debris in storm, yet it allows full ventilation. This may be a safer option than cyclone-proof windows that may fail. • Burglar protection, crowd control and security via coordination office at main entrance and all doors/windows can be locked.
Entrance / accessibility	The site is to have truck access and considerations for disabled people. To shorten evacuation time Jacobs ladders can aid in steep locations.	• Building has main entrance with coordination office. • Concept design has unspecified location, but Jabros site would enable trucks to manoeuvre.

Note: these are only the basic program requirements to draft a concept design, more requirements will be addressed in site-specific investigations.

8.4 Options for Building Typologies

Four options for building typologies have been considered for evacuation centres; the final selection will depend on each building's multi-function purpose and siting. For instance, an elevated building has benefits for flood risk but may not be recommended for earthquake risk or landsides. Figure 11 displays the four possible typologies.

The typologies for a 'compact building', 'stretched building or 'set of buildings' are all composed out of a repetitive set of rooms of similar size. Room size will depend on the usual daily function of the emergency centre. Rooms should have eight beds maximum to avoid overcrowding while supporting social cohesiveness for women and child safety. Figure 12 shows examples of multi-functional spaces that would be suitable as evacuation centres.

A large hall could provide a larger space but will be less comfortable for medium-long term shelter. However, this option could be the best choice to fulfil the community demands to use the evacuation centre as a multi-purpose facility.

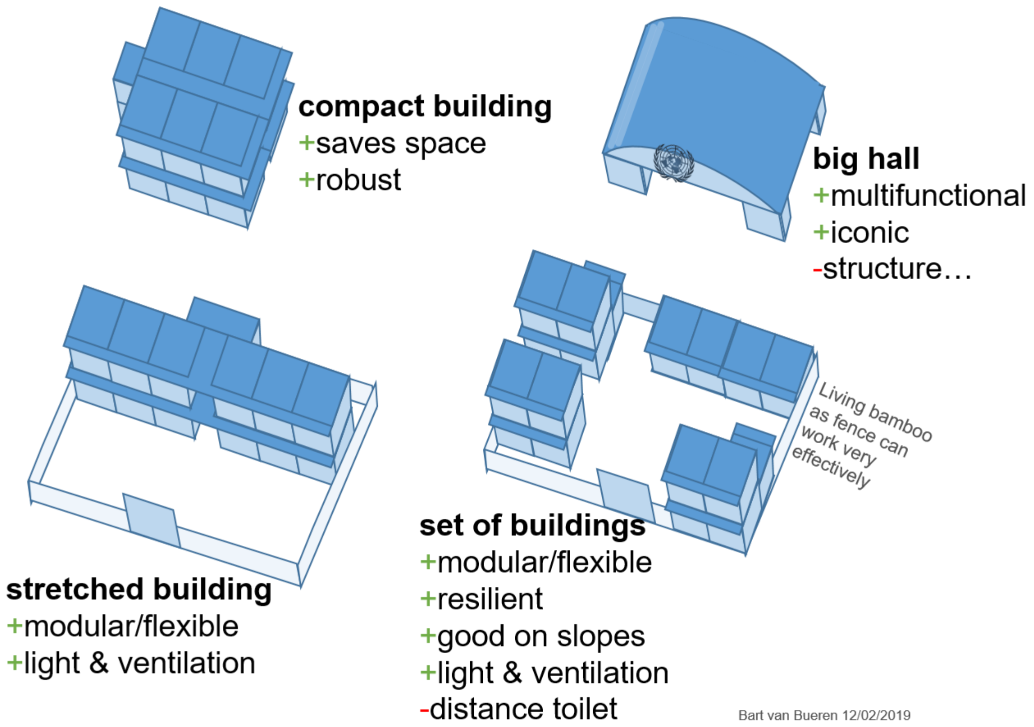

Figure 11: Four different building typologies for evacuation facilities, source: van Bueren (2019)

Figure 12: Examples of multifunctional spaces suitable as evacuation centres, Source: van Bueren (2019).

8.5 Design Concepts

The best practice guidelines are used in the following concept designs for short-term sheltering of approximately 500 - 1,000 people. A more exact number of people will be determined by a detailed investigation.

Concept 1: Evacuation centre in a budget hotel

Hotels may be considered for use as emergency evacuation centres. To increase capacity per room, the walls can hold bunkbeds. Bunkbeds are ideal for high capacity sheltering within acceptable levels of privacy and comfort (see Figure 13).

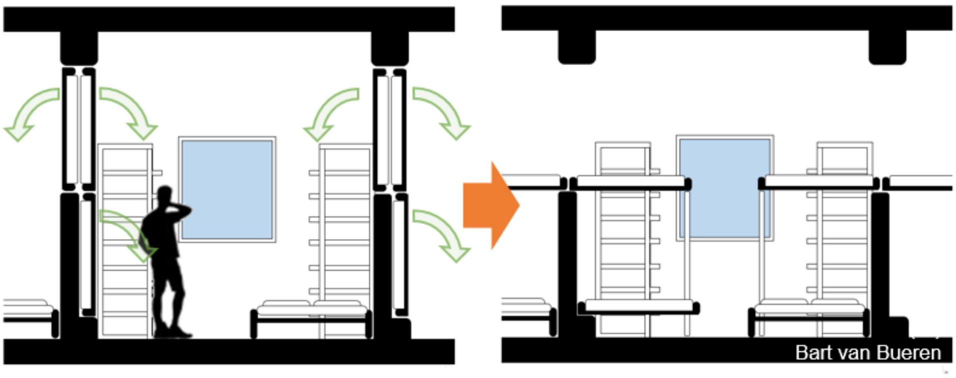

Figure 13: Concept of bunkbeds in the wall of a hotel room, Source: van Bueren (2019).

Concept 2: Safe houses

Safe houses (see Figure 14) could be distributed throughout every community. A hub-and-spoke design, with the hub could be a medical centre. Benefits of this concept include:

- Community resilience and ownership;
- Multi-functional;
- Minimum evacuation distances;
- Redundancy when one safe house is struck, another safe house will be nearby.

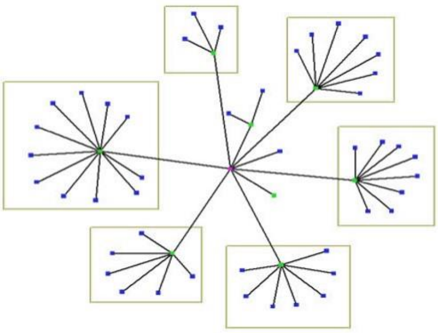

Figure 14: A distributed evacuation centre safe house model

Concept 3: Big hall (open multi-functional facility)

A big hall (see Figure 15) for an evacuation centre could easily be used for events and sports. However, it may lack privacy for longer term functioning, without appropriate internal design. More community consultation would be needed to identify the type of sport the centre should be designed for. A multi-functional sports hall for badminton, basketball, volleyball and some indoor football would require minimum dimensions of 30.6m x 17.6m x 7.6m (Neufert 2000).

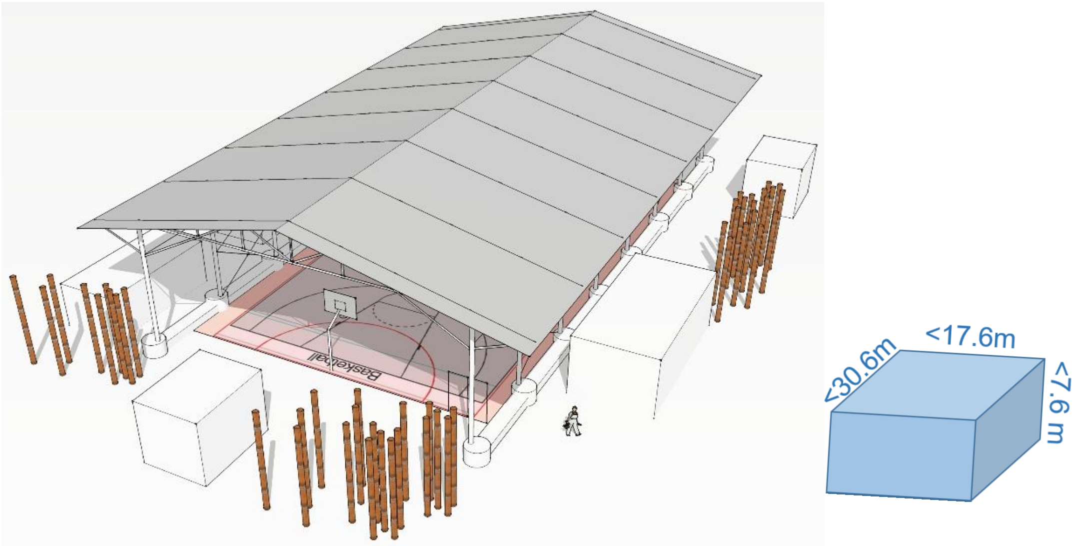

Figure 15: An open multi-functional (sports) hall, Source: van Bueren (2020)

8.6 Building materials and suitability

Different materials have been considered and weighted on strength, durability, affordability, local benefits, reliability and lifespan/maintenance (see Table 4). More principles and tips can be found in UNICEF Response Sphere Association (2018) and NEP SBCI and SKAT (2007). Local costs would need to be assessed for different materials.

Table 4: Building materials and their suitability

Material		Main Structure	Strength	Maintenance	Reliability	Lifespan
Industrial	Steel portal frame	yes	*****	*****	*****	*****
	Reinforced concrete	yes	*****	*****	*****	*****
	Timber	Possible	***	***	***	***
	Prefabricated containers	yes	****	***	***	***
Natural	Rammed Earth	Yes	*	**	**	***
	Plastic Brick	No	**	***	*	**
	Adobe (earth bag)	Yes	*	***	***	***
	Bamboo	Yes	***	****	*	*

9 Pilot concept design

From the considered building typologies, it is a 'big hall' which matches most design criteria and community expectations. Figures 16-21 present a pilot concept plans and associated visualisations.

The big hall (see Figure 16) is optimal for short term evacuation and would hold 300-450 people when each is given 1.5m^2 of space. The number of 300 may be appropriate with walking paths and 450 is appropriate when walking paths are through the 1.5m^2 reserved space, but still with designated corridors along the edge in the hall. Six small buildings and other designated spaces below the large roof provide facilities required for such a large shelter group. These facilities also provide a function for daily use as multifunctional hall for sports, ceremonies etc. There are multiple options available to select with regards to building configuration, materials, and indoor facilities. One option for the big hall could be a steel portal frame construction with concrete block walls to enclose the facility (see Figure 17a). Another option could be an open design with sliding curtain wall made of local woven bamboo (see Figure 17b). Another option could be a simple open steel portal frame construction with a large overhang for shading and rain protection (see Figure 17c). The roof surface can be used to collect rain water in two water tanks. An open steel-wire or bamboo fence may be used to enclose the hall from burglary. The side buildings and strategically planted bamboo can be designed to protect from winds and align with nature-based solutions.

Figure 16: Proposed evacuation centre at Jabros

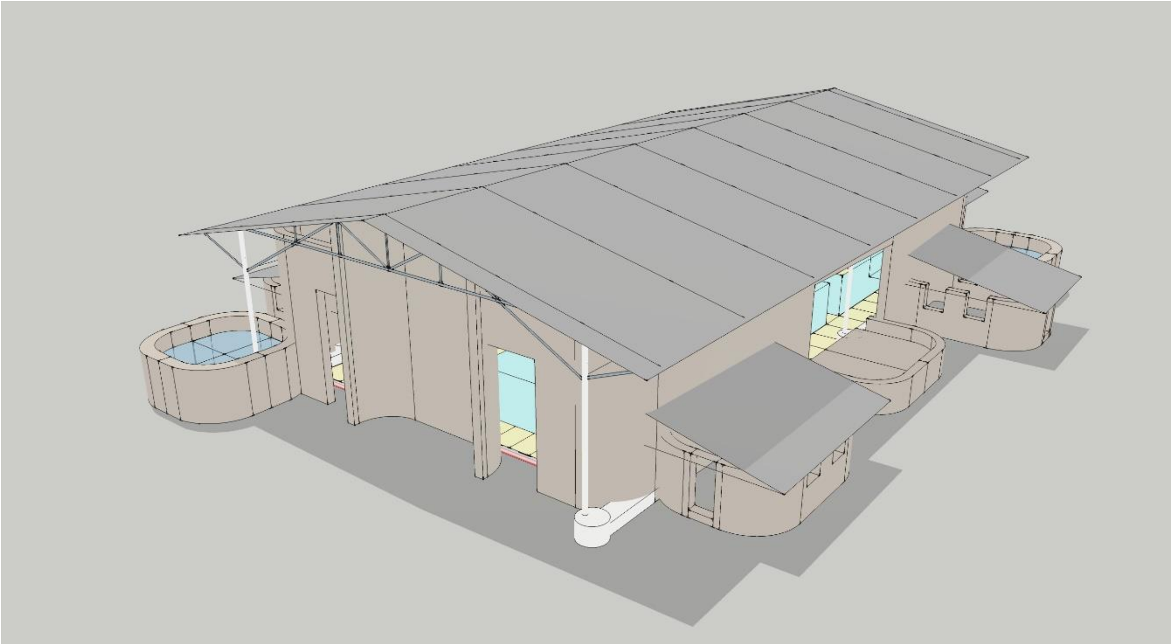

Figure 17a: Steel portal frame construction with concrete block walls

Figure 17b: Steel portal frame construction with bamboo curtain

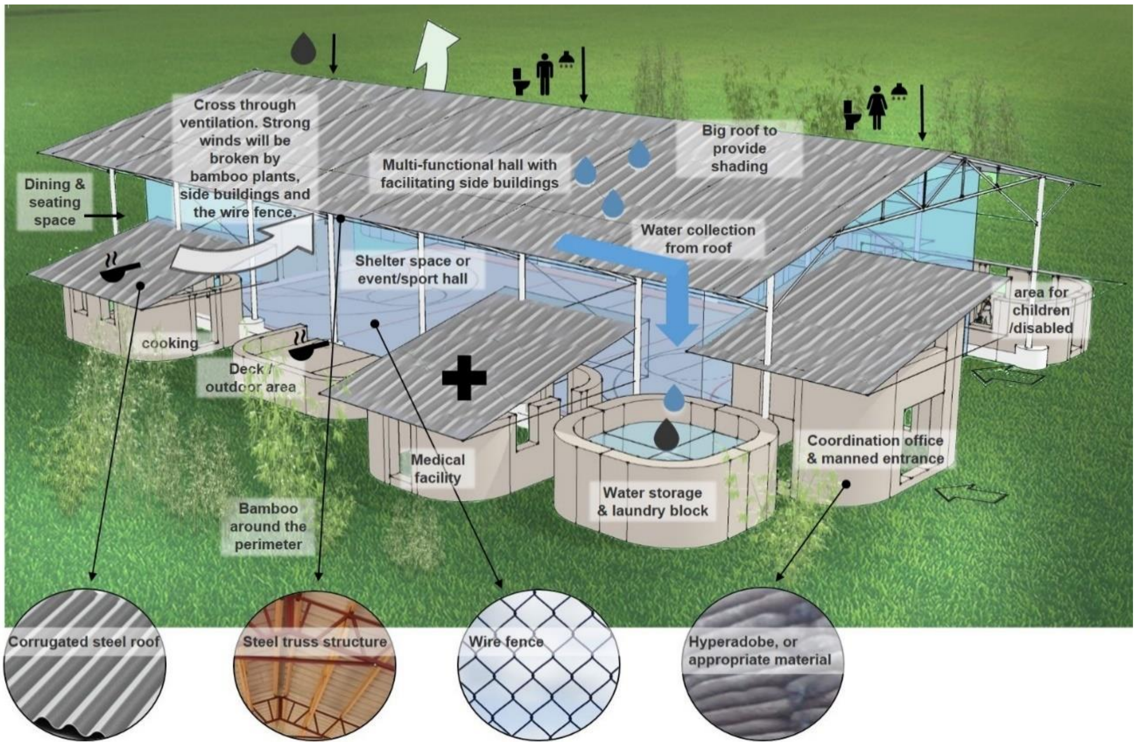

Figure 17c: Open steel portal frame

Figure 17: Conceptual designs for the proposed evacuation centre

Figure 18 shows the floor plan configuration of the concept design.

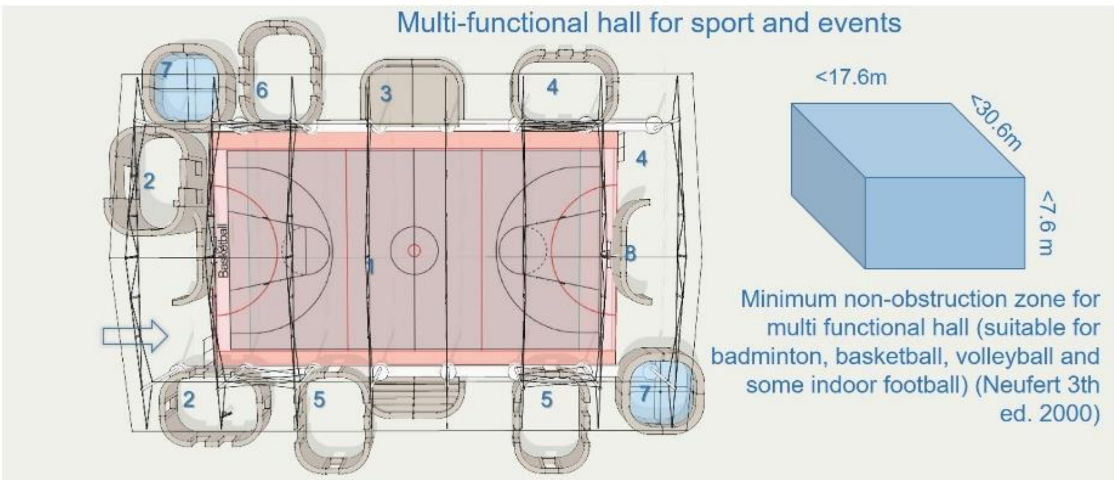

Figure 18: Floor plan configurations of pilot concept design of a big multifunctional hall

Figure 19 shows layout options and demonstrates the flexibility of usage options by using moveable partition walls within the evacuation centre. Figure 20 presents the internal view showing the internal walls and sporting facilities within the proposed centre. Figure 21 shows an example of usage of the evacuation centre as a multi-purpose facility during normal days to organise community functions.

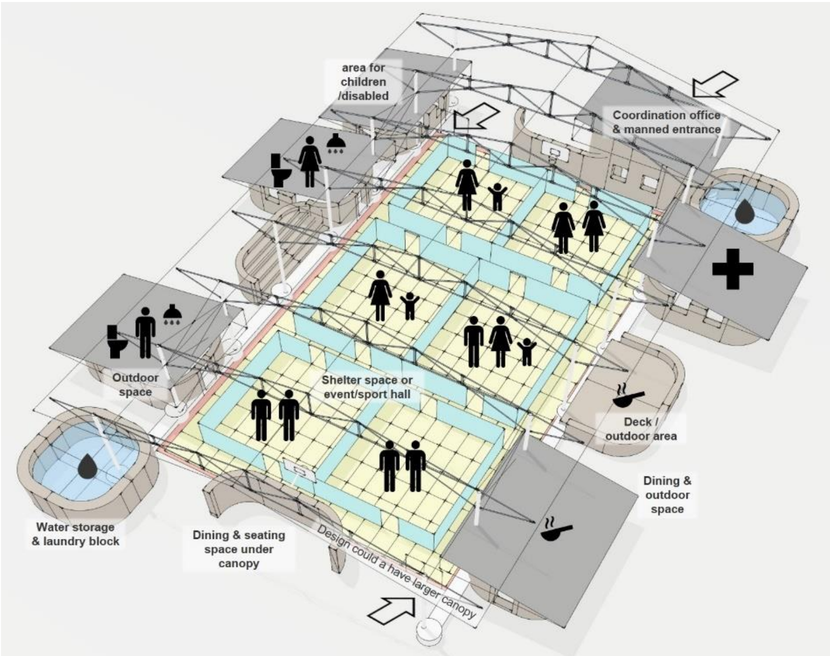

Figure 19a: Internal layout option with moveable partition walls

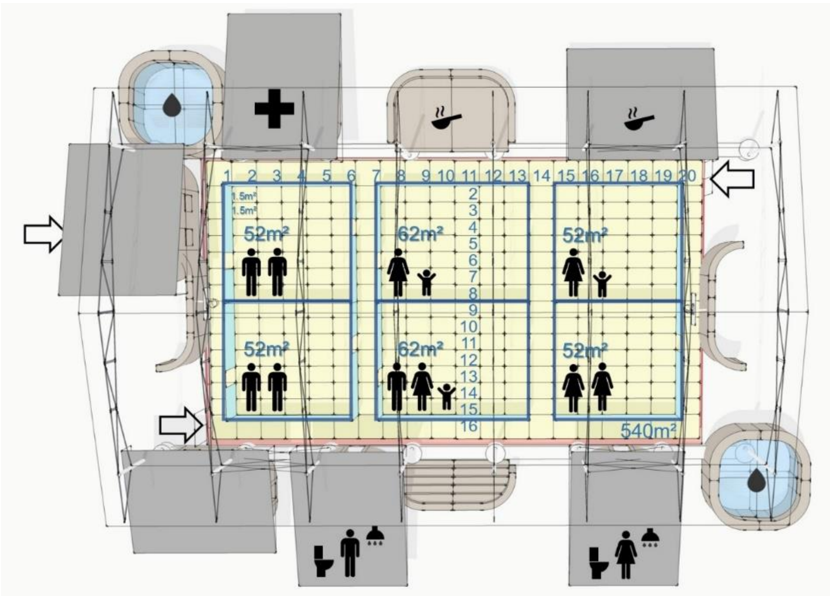

Figure 19b: Internal layout option with moveable partition walls

Figure 19: An example of layout plan of the proposed evacuation centre

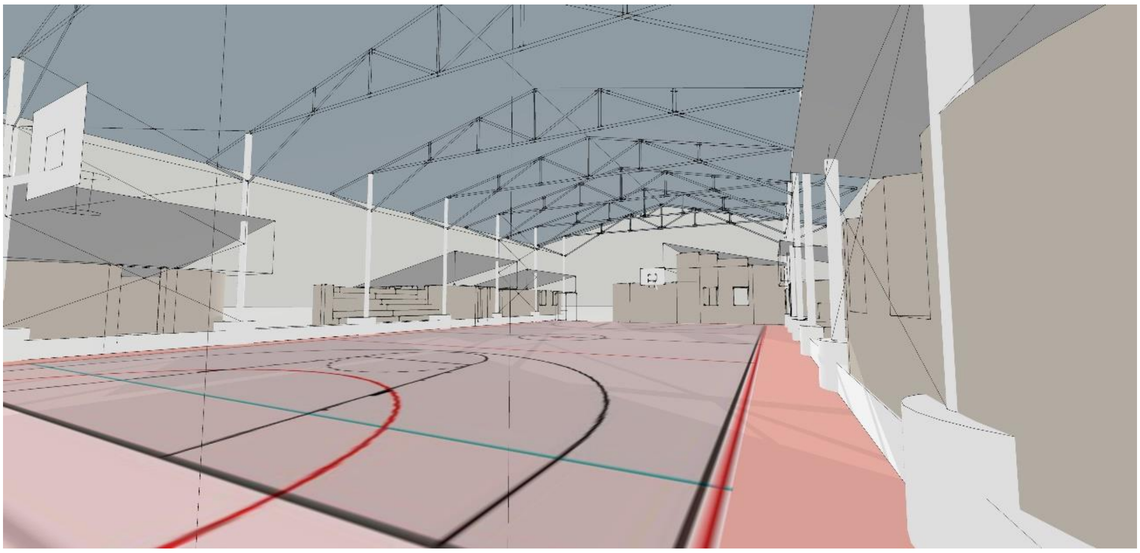

Figure 20a: Internal view - sports field

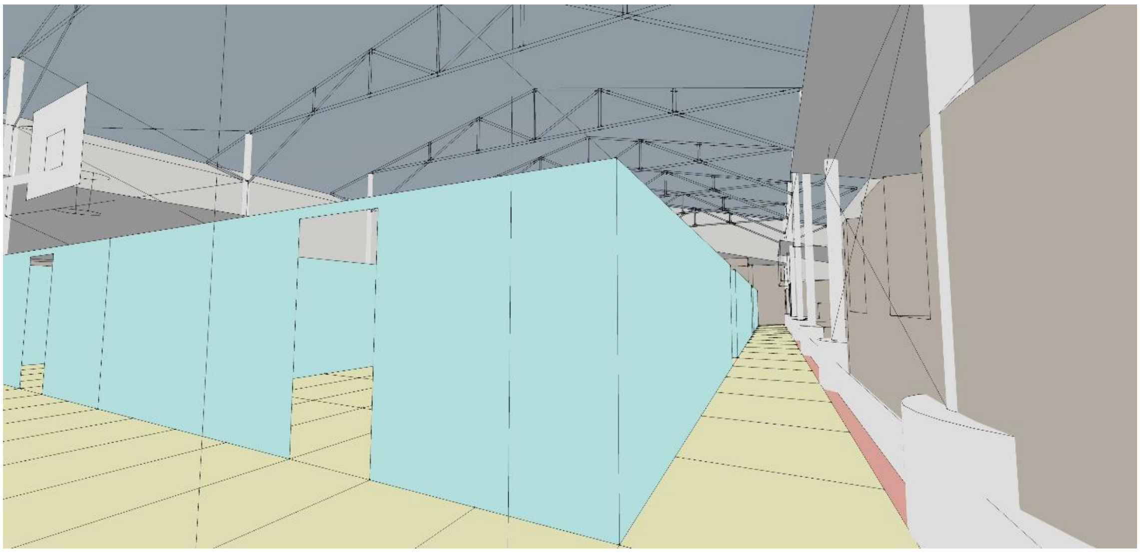

Figure 20b: Internal view - partitions

Figure 20: 3D overview of pilot concept design of a big multi-functional hall

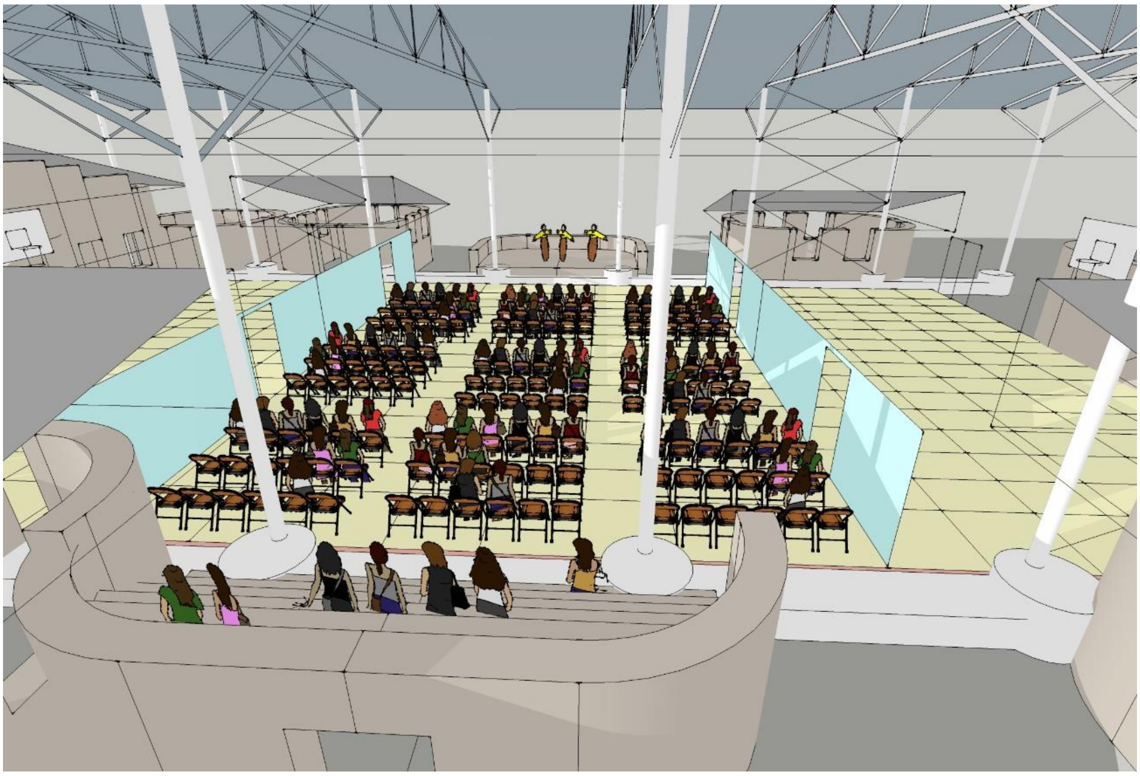

Figure 21: Community function within the evacuation centre (multi-purpose hall)

The concept design would be adapted to address local site conditions in Jabros and Aekafo-Feraladoa. A detailed study would be required to assess local conditions and design loads. Moreover, structural analysis would also be required to design the facility appropriately.

10 Community training: reducing vulnerability to disasters

Solomon Islands, and particularly Honiara, has often been impacted by a range of natural hazards, primarily floods and cyclones. These natural hazards cannot be stopped from occurring, but certainly their impact could be reduced significantly by taking appropriate steps (QRA, 2019). Vulnerability of building stock is the fundamental cause of damage resulting in financial losses and human casualties. Furthermore, it has consequences in terms of increased demand for emergency services, medical aid, and temporary shelters.

Resilient building design is one of the best ways to reduce risks from natural hazards. To minimise damage caused by extreme events, considerations for planning, design and construction are to:

- Understand risks;
- Identify vulnerabilities;
- Understand load distributions;
- Adapt the design;
- Improve construction techniques; and
- Support informed material choices.

During the field visits it was recorded that most of the locals build their own houses. Locals are skilled carpenters and acquire basic skills throughout their childhood. There is clearly a demand from local communities to gain training and guidelines to improve the strength and quality of their own houses. The purpose of proposed training and guidelines is to share innovative, practical, and affordable solutions for more resilient buildings (Figure 22). The guidelines will be based on lessons learned from past events, consultation with the building industry, appropriate building codes, and knowledge gained through research.

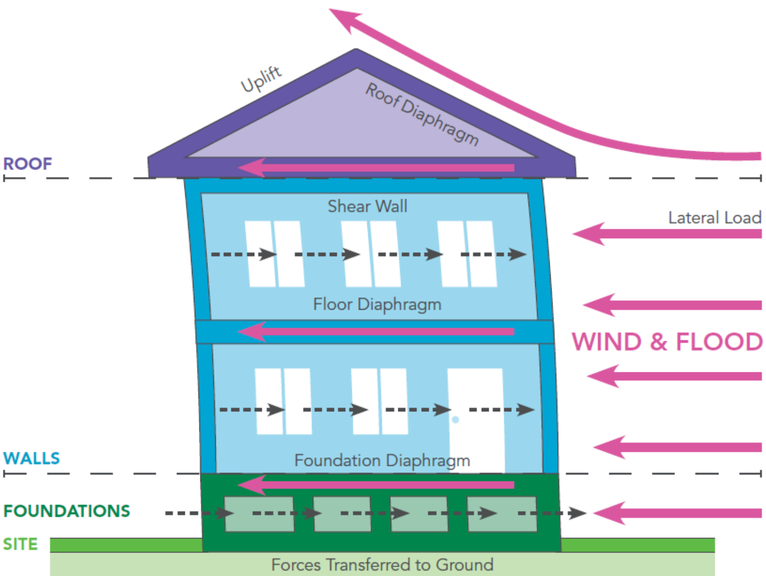

Figure 22: Wind and flood load distribution (Source: Federal Alliance for Safe Homes, 2016)

The training will cover strategies for:

- **New construction:** to ensure newer construction meet building code requirements and does not result in increasing vulnerable building stock;
- **Substantial renovation:** to ensure benefits from renovation to improve building resilience;
- **Existing building stock:** to strengthen and retrofit existing buildings to reduce vulnerability and future risks; and
- **Build back better:** to make communities stronger and more resilient following a disaster event by building stronger, more resilient constructions.

The training will be suitable for building industry professionals, national and local Government, and technical groups formed as part of the CDCs. It will provide clear guidance on resilient design principles, strategies, construction details, materials, and the expected benefits and costs of resilient design.

Incorporating resilient building design can significantly reduce the effort, cost, and time to return people to their homes and workplaces following a disaster.

11 Conclusions

Solomon Islands, and especially Honiara, has been subjected to natural hazards in the past, and its exposure will continue in the future. As part of Climate Resilient Honiara project, this report has focused on hard infrastructure in the form of evacuation centres.

Site visits, preliminary spatial mapping, review of existing information and best practice has resulted in concept designs and a proposed action plan for initial work in 2020 and beyond. The concept designs are a starting point to engage further with the community to determine further detailed design, not just in terms of the physical outcome of the evacuation centre but also for considering operational issues such as maintenance.

The analysis has also confirmed that there are no suitable buildings or available locations for new build in the settlements of Ontong Java, Kukum Fishing Village or Wind Valley. Options outside these settlements will need to be identified and assessed. Both Jabros and Aekafo-Feraladoa have potential suitable land for new build. As a church and community centre are partially completed in Aekafo-Feraladoa, it is proposed that this is the subject of retrofit / upgrading actions. Jabros was determined to be the best option for a new build as they have available land located centrally, have existing plans to build a multi-purpose community centre, and have a highly-skilled community, including a technical committee as part of the local Community Development Committee.

Key considerations informing the proposed action plan portfolio are presented in the next section.

12 Proposed action plan portfolio 2020 – 2022

Proposed actions have been categorised as 1) development of an updated evacuation centre plan for Honiara, 2) retrofit / upgrade, and 3) new build. Build materials will be sourced locally where this is possible, with the implementation of actions involving HCC, NDMO, Ministry of Infrastructure and Development, community members, SINU (construction management), and local NGOs.

Evacuation centre plan:

1) An audit of existing designated centres, their facilities and capacities, and an assessment made of their structural integrity to withstand an extreme event;
2) A detailed spatial risk assessment of the locations of buildings currently nominated as evacuation centres;
3) Identification of safe, optimal, areas for new community centres - taking into account hazards, population densities, and access - which can be used as evacuation centres at times of emergency; and,
4) Assessment of evacuation centre options outside the settlements of Ontong Java, Kukum Fishing Village, and Wind Valley.

Retrofit / upgrade:

Retrofitting and 'train the trainer' activities to take place in both Aekafo-Feraladoa and Jabros.

1) Site visit for community consultation, audit and technical assessment;
2) Preparations for retrofit and training (done at RMIT); and,
3) Community-based training (eventually, the training component can be done for all 5 settlements).

New build:

This action is proposed for Jabros community.

1) Detailed site analysis;
2) Confirm land tenure assessment (budgeted for in the land administration component of the CRH project);
3) Appropriate final design of multi-functional community centre (co-designed with community members) ready for implementation; and,
4) Training and retrofitting of existing community buildings;
5) New build by the technical committee members, supported by MID, SINU and others.

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