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# Integrating Teaching and Learning with Inter-Disciplinary Action Research in Support of Climate Resilient Urban Development

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**Abstract:** The capital cities of the South Pacific are experiencing rapid urbanisation pressures as increasing numbers of people migrate to the primary cities either in search of employment and greater access to healthcare and education, or as a consequence of environmental ‘push’ factors. However, the limited capacity of municipal Governments to respond to the scale and pace of change is leading to a growth of informal settlements in peri-urban locations. Factors of exposure, sensitivity, and adaptive capacity combine to make these informal settlements the most vulnerable areas to natural hazards. In response to this critical urban resilience agenda, this paper looks at how participatory action research is providing inter-disciplinary scientific support for the implementation of urban resilience and climate actions in Honiara, Solomon Islands. Adaptation measures involve a combination of hard and soft actions; as well as activities designed to strengthen local capacity to respond to contemporary resilience challenges. Addressing the adaptive capacity component, this paper also highlights the opportunities for Australian universities to integrate teaching and learning with action research to achieve a substantive real-world impact in the Pacific region, as well as illustrating the capacity strengthening benefits that can be achieved through sustained engagement and collaborative partnerships with local organisations.

**Keywords:** climate actions; urban climate resilience; sustainable urban development; capacity building; SIDS

## 1. Introduction

A combination of urbanisation and a changing climate present significant challenges for many fast-growing cities in the Global South [1–3]. This is particularly the case for small island nations in the South Pacific, where a changing climate will impact primary cities characterised by geographical isolation, high levels of exposure to natural hazards, rapid urbanisation, and growth of informal settlements, deficits in urban infrastructure, and a lack of institutional capacity to respond [4,5].

This paper looks at ongoing activities to enhance the climate resilience of Honiara, the capital city of the Solomon Islands. It has been the subject of an ongoing UN-Habitat programme of vulnerability assessments and climate adaptation planning activities since 2012 framed by their ‘Planning for Climate Change’ guidelines [6]. This highly participatory programme of action research, led by an Australian university since 2014, has helped identify key vulnerabilities and priority resilience actions

at community, ward, and city levels; and provided the evidence base for a new UNFCCC Adaptation Fund project called 'Climate Resilient Honiara', administered by UN-Habitat. For a review of this journey, see reference [7].

The main aims of this paper are two-fold: firstly, to showcase the inter-disciplinary characteristics of the applied research programme that are necessary to effectively address the complexities of urban climate resilience in the Pacific region [4,8], and secondly, to explore the role and opportunities for teaching and learning to act as a valuable complementary approach to action research. This involves contributing to shared learning [9], local capacity strengthening [10], and community-led climate adaptation [11,12].

## 2. Methodology

The development of climate actions and activities in Honiara has been underpinned by participatory action research and a place-based approach [13,14]. The strong emphasis on participation and bottom-up analysis has proven to be extremely valuable as it has enabled local voices to introduce their own perspectives of community vulnerabilities and priority needs, as well as allowing them to be actively involved in the co-design of climate actions and capacity building activities. It has also ensured that the future implementation of local actions will be more cognisant of community-level structures, and hence more likely to be locally 'owned' and sustainable in the longer-term [12,15]. In support of this 'bottom-up' agenda, the project team regularly engages with a range of national and city Government, Non-Government, and local community actors.

The applied research programme in Honiara has evolved over time, moving beyond vulnerability assessments and climate adaptation planning towards the introduction of different disciplinary expertise to inform the design, implementation, and maintenance of resilience actions and activities at multiple scales across the city (academic skill sets include: climate adaptation, community surveys, spatial mapping, civil and environmental engineering, urban planning and design, architecture and resilient buildings, landscape architecture, land administration, etc.). Indeed, an inter-disciplinary perspective has been vitally important to better understanding the complexities of rapid urbanisation and the impacts of a changing climate, as well as to contribute different forms of disciplinary expertise to potential 'pro-poor' interventions at community and ward levels. For instance, community profiles of case study informal settlements are being developed using multiple data sets (a combination of household and settlement surveys, as well as LiDAR and geospatial data) to better understand 'who' and 'what' are present in these fast-growing areas. It is intended that this 'bottom-up' information will not only contribute to various project components (such as the design and implementation of water and sanitation engineering solutions) but will also support the Ministry of Lands, Housing, and Survey (MLHS) with land use planning, settlement upgrading, and relocation initiatives.

The applied research agenda has also been framed by an integrated assessment perspective, with explicit consideration of climate change adaptation, disaster risk reduction, and development agendas [16], as well as pro-active and long-term engagement with respective communities of practice in both Australia and Solomon Islands.

The following sections of this article first set out the background context for the urban climate resilience project in Honiara before elaborating on some of the key project components, including commentary on inter-disciplinary collaboration from the personal perspectives of different disciplinary experts engaged on the project. The paper then concludes by highlighting the potential opportunities for academic teaching and learning to be better integrated with this university-wide programme of applied research, in support of both actions and local capacity building.

Indeed, it is argued that sustained engagement between Australian and Solomon Island universities, local decision-makers, civil society organisations, and community members helps to facilitate knowledge exchange and acts to strengthen the capacity to adapt. This form of 'social learning' also provides a diversity of local stakeholders with additional information and the technical knowledge needed to design, implement, and manage climate resilience actions [17], thereby reducing the need

for continued outside assistance. This presents an alternative and longer-term collaborative approach to climate resilience projects in the Pacific region (and elsewhere) that are typically consultancy-led and short-term in nature.

### 3. Climate Action Planning

The UN-Habitat Cities and Climate Change Initiative (CCCI) is an attempt to promote urban climate change adaptation and mitigation activities in developing countries. As part of this agenda, CCCI is in the process of developing climate change assessments and strategies in over 300 cities in the Asia-Pacific region by following stages that are set out in *Planning for Climate Change: A Strategic, Values-based Approach for Urban Planners* [6]. A number of climate vulnerability assessment reports from the first phase of this process are available publicly, with those in the Pacific Region shown in Figure 1.



Figure 1. UN-Habitat climate change vulnerability assessments in the Pacific [18].

In the Honiara case, the 2014 vulnerability assessment was updated and extended by a second phase of work, which led to the endorsement and publication of the Honiara Urban Resilience and Climate Action Plan (HURCAP) [18]. Whilst the original intention of this phase was to develop a climate adaptation plan, it became evident during early stakeholder engagement processes that climate change was only one of multiple stressors affecting local vulnerabilities (see Figure 2), and that explicit consideration needed to be paid to current-day development issues and exposure to a range of natural hazards, including earthquakes and tsunamis (due to the Solomon Islands being located in the Pacific ‘Rim of Fire’).

Consequently, addressing immediate development needs was strongly reflected in the broader urban resilience and climate action plan, which attempted to integrate climate adaptation, disaster risk reduction, and urban development goals. This integrated approach was based on the understanding that the implementation of urban resilience actions will not only reduce contemporary community exposure and sensitivity to multiple shocks and stresses, but will also result in a more solid socio-economic foundation for longer-term climate change adaptation efforts.

HURCAP activities involved close working with stakeholders to first identify local priorities at community, ward and city levels; and then to translate these into high-level objectives. These were then grouped and presented under 10 thematic category headings. At the community level, HURCAP focused its attention on three vulnerability ‘hotspot’ settlements that had been identified in the original vulnerability assessment [19]. However, it also recommended that another two areas also be profiled and assessed for climate vulnerabilities. As shown in Figure 3, the three settlements

subject to HURCAP community consultations were Ontong Java (hotspot 1), Kukum Fishing Village (2), and the Aekafo Planning Area (3). The two settlements identified for climate action planning in a follow-up phase were White River (4) and Gilbert Camp (5). Each of these informal settlements suffers from water supply, flooding, erosion, sanitation, drainage, and waste problems to varying degrees.

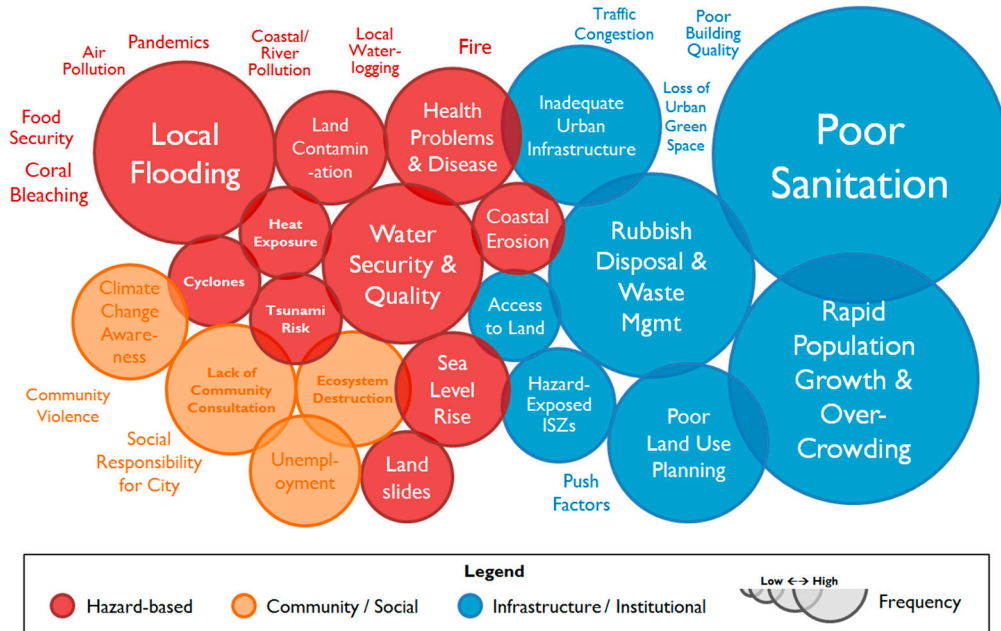


Figure 2. Issue identification by local stakeholders by break-out group frequency and category [18].

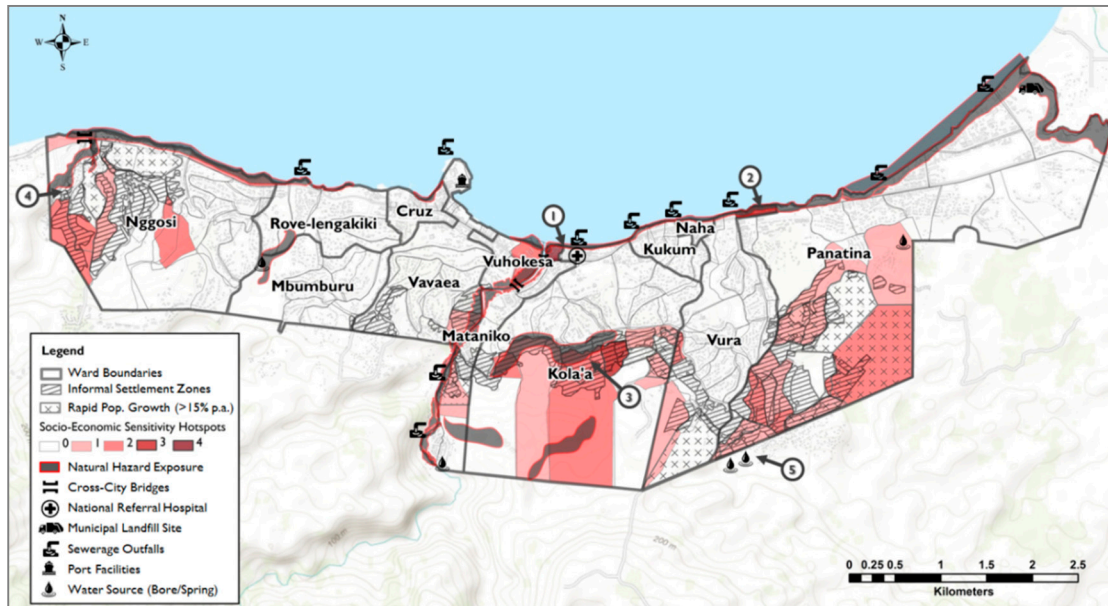


Figure 3. Vulnerability Hotspots in Honiara [18].

#### 4. Climate Resilient Honiara Project

As previously noted, the HURCAP formed the basis for a successful application to the UNFCCC Adaptation Fund in 2018. In year one of a four-year programme, actions and capacity building activities for the Climate Resilient Honiara project are now being targeted at community, ward, and city levels (since January 2019). The portfolio of actions, in addition to completing climate action plans for all five case study settlements, includes: comprehensive community profiles, local engineering solutions,

climate risk communication with women and youth groups, urban organic farming, climate resilient spaces (hard and soft), and recommendations for responsible land administration in peri-urban areas. Capacity strengthening efforts include: community awareness raising, 'Planning for Climate Change' training with ward councilors, and the development of short professional training courses based on local needs. A selection of these project components is now expanded upon.

#### 4.1. Community Profiles

A foundational component of the Climate Resilient Honiara project was to develop community profiles of settlements that are considered to be the most vulnerable to climate-related impacts. While there are a number of ways to define a community profile, the project subscribes to the definition by [20] (p. 6), whose work on profiling is seminal in development studies:

*"A comprehensive description of the needs of a population that is defined, or defines itself, as a community, and the resources that exist within that community, carried out with the active involvement of the community itself, for the purpose of developing an action plan or other means of improving the quality of life of the community."*

Community profiles are commonly used to provide input to a broad range of actions and planning processes. For the Climate Resilient Honiara project, they provide the necessary detail at household and settlement levels not only to inform climate resilience actions, but also to provide data to support Government settlement upgrading and resettlement programmes (important in the context of rapid urbanisation and the growth of informal settlements). The aim was therefore to develop a survey that could be used as a reference point for subsequent work packages in the project (e.g., climate action plans, community-level engineering interventions, open space and landscape design, urban organic agriculture, and responsible land administration). The community profiles will also serve as an input to other awareness raising and capacity building activities.

The design of the survey was influenced by multiple factors: extant literature on climate vulnerability and urban resilience, existing datasets, previous surveys conducted nationally (around 20 different relevant surveys were conducted between 2005 and 2018 either by Government or by NGOs), consideration of participant burden (given the numerous surveys previously conducted in Honiara, and how best to balance time vs. knowledge production), cultural sensitivities around certain topics (such as land ownership), and the skill level of local surveyors and how they could be supported by using innovative data collection platforms. Further considerations related to what types of data might be collected and produced as part of the profiling exercise (it became apparent that multiple social-spatial relationships would need to be identified), and how profiling outputs might be useful to other stakeholders/projects in Solomon Islands.

The community profiling assessment aims to interact with every household within each targeted settlement, rather than the more typical (and less resource-intensive) focus group approach, hence eliminating sampling issues [21]. It was also recognised that while the project used administrative boundaries and zone names assigned by the MLHS to identify settlements, these do not always align with how resident communities self-identify as a 'community', and also that disparate communities may co-exist within one settlement.

Site visits in early 2019 provided a means of directly engaging with communities in terms of local issues and needs; as well as with local government and non-government stakeholders who hold relevant data or may be interested in the project's outcomes. The design aspect of the survey also had to grapple with the intrinsic intersectionality of climate change [22], especially with the types of knowledge the survey hoped to capture around social relations (e.g., gender, ethnicity, socio-economic status, etc.) and how this might translate to resources, vulnerability, and perceptions around decision-making and the co-production of climate actions.

The community profiling survey was designed as a two-level exercise targeting both households and settlements.

#### 4.1.1. Household-Level Survey

The household-level survey is comprised of seven categories of questions:

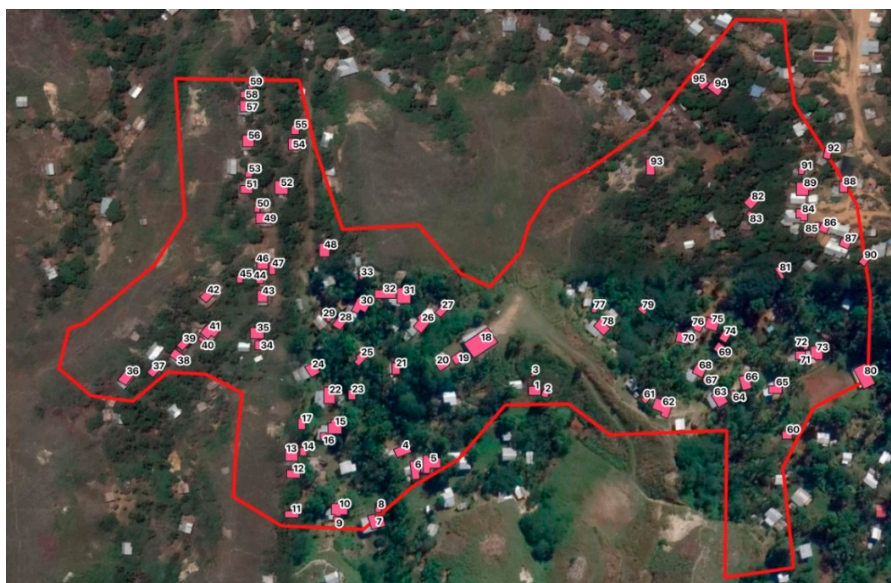
1. *Household characteristics*: describes the people who usually live in the household in terms of age, sex, ethnicity, language, religion, mobility, migration purpose, and duration of settlement.
2. *Livelihood (economic and food) characteristics*: describes the household's food and economic security conditions in terms of the ratio of working household members, sources of income, place of work, livestock, and fishing activity.
3. *Housing characteristics*: describes existing housing conditions including age of the house, floor area, improvements to house, number of rooms, floor material, and priorities for improving housing.
4. *Utilities characteristics*: describes the household's access to services; including drinking water source and quality, toilets, drainage, waste disposal, and power and water connections.
5. *Land tenure characteristics*: describes existing land tenure arrangements (as the household understands it); including land owner identification, type of land use agreement, disputes, perception of tenure security, and whether the household has received an offer of a grant to convert it into titled land.
6. *Climate change and disaster preparedness characteristics*: describes the household's experience of climate-related hazards, disaster preparedness, and adaptation strategies.
7. *Housing stock characteristics*: visual survey of the condition of the housing stock including materials used, condition of housing, height above ground, slope, water sources, toilets, and the nearest communal space.

#### 4.1.2. Settlement-Level Survey

The settlement-level survey seeks to document the physical attributes that are important for vulnerability assessments such as accessibility and the physical assets associated with water resources, waste disposal, and community spaces (e.g., churches, schools, shops etc.). For the climate action plans and engineering interventions, it is useful to associate these characteristics with a location.

However, accessing reliable and up-to-date spatial data for the settlement areas was not a straightforward task, and to the project team's knowledge the most recent dataset was a 2017 LiDAR dataset acquired by the Ministry of Medical and Health Services (MHMS) to inform the planned relocation of the National Referral Hospital. While negotiating access to the LiDAR data, the project team produced early spatial index maps derived from Google Earth. This imagery is based on 2019 Landsat data and provides the most recent freely available aerial imagery of the case study settlements. Available polygons of informal settlement zones obtained from the MLHS were then overlaid onto the imagery. Visible building footprints were digitised and assigned a number for enumeration (an example is shown in Figure 4). Survey questions were then coded into the open form standard, XLSForm, to ensure that the survey would not be compromised when using different survey software packages.

The size of the case study settlements (typically around 2 km<sup>2</sup> to 4 km<sup>2</sup>) and the lack of heavy tree cover also suggest that Unmanned Aerial Systems (UAS)—commonly referred to as drones—could also be a possible source of data acquisition, especially if local organisations were trained in data capture and processing. The scope for deploying UAS for humanitarian applications in Honiara is part of ongoing discussions with Solomon Islands Government and local academic stakeholders.



**Figure 4.** Spatial index map prepared for one of the target settlements (source: School of Science, RMIT University).

#### 4.2. Local Engineering Solutions

Priority issues identified by local communities include water supply, sanitation, flooding, drainage, and waste management. Findings from the 2019 site visits, and the rapid engineering assessments that were carried out, will be supported by the settlement-level surveys which will estimate current water demand and supply. The survey will also identify available surface and groundwater sources. Analyses of the quality of these sources will help to identify appropriate treatment options.

One of the important observations made during the field visit was the lack of maintenance of existing facilities. Training to design and operate simple disinfection units e.g., sand and carbon filters will be carried out, as well as generating disinfectants such as chlorine using simple electrochemical devices. In this regard, opportunities to collaborate with Solomon Water are being explored. Training will include designing and installing effective harvesting of rainwater using appropriate first flush systems, and maintaining rainwater tanks. Collaborative working with Solomon Water and Honiara City Council is important to ensure that the design and installation of proper storage tanks and drinking water distribution systems is locally supported, and sustainable in the longer term.

Consideration of sanitation interventions also requires an understanding of local cultural practices. For instance, the communities that were visited preferred separate communal toilets for men and women who were visiting the settlement (visiting relatives use community facilities rather than using toilets that belong to the hosts). Options such as individual septic tanks to small wastewater treatment systems are available, but a clear consensus is needed from all community members for successful implementation. The settlement survey will also help to identify proper locations for septic tanks so that they do not contaminate local groundwater sources. Community wastewater treatment plants will help to treat not only black water (wastewater from toilets) but also grey water (wastewater from kitchens and baths), with a possibility for the water to be reused if required.

Solid waste management is another important aspect of sanitation. The communities have practices such as reusing food wastes as animal feed or composting them to some extent. While small anaerobic digesters could be installed to generate power for the communities, their feasibility needs to be evaluated as providing continuous feed to anaerobic digesters and maintaining requires effort and appropriate training. If small community wastewater treatment plants are constructed, then the sludge produced by the plant as well as the organic wastes (such as food wastes) can become the feed for anaerobic digesters; hence making the operation more feasible. Collecting all other solid wastes

and either recycling them or disposing in landfills should be an immediate action to protect streams and coastal waters.

Stormwater management (SWM) can help to prevent flooding and provide safety to the coastal communities as well as those living in downstream areas. Appropriate SWM will help to attenuate peak flows as well as delay its arrival downstream, thereby allowing communities to prepare or evacuate. For instance, Ontong Java has a new flood warning system which will help to evaluate the effectiveness of existing SWM systems. However, the dumping of solid wastes in rivers and streams (as is common in inland locations) exaggerates erosion and leads to greater movement of sediments, the blocking of stormwater canals, and a decrease in hydraulic capacity. Developing appropriate pools and ripples, as well as retention ponds, would therefore contribute to improved SWM. Proper collection systems that drain the stormwater from the communities should also be considered.

Implementation of engineering actions in 2020, targeting WASH, waste management, drainage and flooding, will be undertaken in collaboration with the Solomon Islands National University (SINU), relevant local NGOs, and members of local communities.

#### 4.3. Climate Resilient Buildings

The site visits in February 2019 were also attended by university staff with backgrounds in architecture, building design, and civil engineering. For the two coastal settlements (Ontong Java and Kukum Fishing Village) overcrowding was found to be a major issue, with the blocking of cooling sea breezes leading to increased heat in the settlements. The spatial layout of houses therefore needs to be reconsidered with a greater account of passive housing principles i.e., the promotion of cross-ventilation so that occupants are better able to take advantage of prevailing breezes. Some of the problems associated with overcrowding could potentially be overcome by increasing density vertically. At the moment, most houses rest on stilts with daytime activities taking place under the house; the coolest area during daytime hours. It therefore makes sense to build houses with the living areas and kitchens on the lower levels and the sleeping areas upstairs. Other considerations include the fact that most houses were single rooms with kitchens typically outside the house, toilets and bathrooms were either communal or did not exist at all, and some of the houses had separate sleeping areas for male teenagers.

Another disadvantage of having the houses so close to each other is that this poses a fire risk. Since the kitchens use open fires with sawdust or wood (or other fuels such as kerosene), it would be difficult to put out any fires once they had started. Therefore, kitchens need to be designed with materials that can either be isolated or else have the ability to contain the outbreak of fires. Kitchens are typically not part of the living space, so culturally such options may be locally acceptable.

Care also needs to be taken when specifying housing materials so that inappropriate materials such as metal sheeting are not used (this stores and radiates heat, leading to very high interior temperatures when compared to outdoor temperatures). Materials used for buildings in all the settlements are largely scrap, so in some respects they are—by necessity—reusing materials (and therefore embracing circularity principles to some extent). However, most scrap materials are not reliable as wall, roofing, or floor materials because they do not provide the necessary material strength. One alternative consideration would be to assess the feasibility of other reused materials for construction (e.g., conversion of plastics to useful materials, given that all Pacific nations have a problem with plastic waste).

Best practice guidelines for resilient housing are to be derived in consultation with local experts. This will involve an analysis of traditional housing, materials, and construction techniques; as well as discussions with government officials to better understand the future availability of building materials. Building codes and regulations will also need to be considered (building codes are currently planned but have not yet passed as legislation). The intention is to assess existing housing typologies to tailor existing designs for resilience, hence retaining indigenous knowledge while at the same time making housing more adaptable and resilient. Future action will design and construct model houses



as examples that demonstrate appropriate material use, siting and placement, and use of appropriate construction techniques. Local experts, e.g., SINU academics and vocational students, will be involved with the development of the guidelines and demonstration projects.

The housing guidelines will also be transferable to a model evacuation centre; albeit at a bigger scale (the use of materials, site access, orientation, and other such basic design principles will not change). Involving community members in the planning and development of evacuation centres will help to promote local ownership of the centre and help to ensure ongoing maintenance. For the project, research is currently underway to determine the locations where evacuation centres are most needed, the use of appropriate materials, and techniques for planning, design, and construction of a pilot evacuation centre. This provides a good example of inter-disciplinary working within the project, with GIS, hazard, and spatial planning experts informing the location of evacuation centres to be designed by architects and engineers. The geospatial maps will also assist with master planning settlements away from high risk areas and support a phased approach to new construction in Honiara over time.

For communities that are already struggling to address a range of issues with limited time and budgets, one approach would be to consider which existing structures could be used for multiple functions, and to use this as the initial pilot. For example, in Aekefo Informal Settlement, the existing church also doubles up as a community centre and could be further adapted to act as an evacuation centre during extreme events. The functional requirements for this existing structure will be informed by a needs assessment of what the community requires in an evacuation centre. For instance, the structure not only needs to be cyclone resistant, provide protection from inclement weather, enable easy access for residents, to be large enough to accommodate the numbers of people to be evacuated, and provide basic sanitation facilities, but also needs to account for the privacy and safety of women.

Moving forward, implementation partners will include the Ministry of Environment, Climate Change, and Disaster Management (MECCDM), SINU, Honiara City Council (in particular Ward Councilors), and members of local communities.

#### 4.4. Nature-Based Solutions

Natural ecosystems, and the services they provide, are extremely important for human wellbeing. They not only provide us with the food, water, and raw materials to meet our basic needs, but they also contribute broader societal benefits such as preventing erosion, providing protection from floods, regulating local climates, ensuring the continued health of soils, sustaining cultural sense of place, etc. These multitude of benefits are known collectively as ecosystem services (see Figure 5) and provide the basis for community resilience and well-being through a range of provisioning, regulating, cultural and supporting services [23]. More recently, the International Union for Conservation of Nature defined nature-based solutions as actions to protect, sustainably manage, and restore natural or modified ecosystems, which address societal challenges effectively and adaptively, while simultaneously providing human well-being and biodiversity benefits [24].

Ecosystem services are particularly important to the people of the South Pacific, who continue to rely overwhelmingly on resources from the land and sea for subsistence food and cash income; as well as for social and cultural value [25]. Furthermore, nature-based solutions can play an important role in enhancing local climate resilience through cost-effective actions. Such options are commonly referred to as 'ecosystem-based adaptation' (EbA) [26]. However, rapid urbanisation, the informal growth of settlements, and the constraints imposed by the municipal boundary means that there is ever-increasing pressure on existing open space in Honiara's urban and peri-urban environments; with much of the remaining space also being in poor condition.

To support local EbA efforts, an academic team of landscape architects, designers, and urban greening experts visited the city to support Honiara City Council with their urban greening efforts. This engagement took place in the context of the recently published Greater Honiara Urban Development Strategy and Action Plan which sets out a Masterplan goal to establish a "network of green

and open spaces, to include linear river parks, [a] botanical garden, national parks, and a city waterfront” [27] (p. 28).

<u>Provisioning services:</u> <ul style="list-style-type: none"> <li>▪ Food</li> <li>▪ Fuel</li> <li>▪ Medicine</li> <li>▪ Water</li> <li>▪ Raw materials</li> <li>▪ Ornaments</li> </ul>	<u>Regulating services:</u> <ul style="list-style-type: none"> <li>▪ Prevention of pests and disease</li> <li>▪ Air quality regulation</li> <li>▪ Soil regulation; prevention of erosion</li> <li>▪ Water purification and regulation of water flows</li> <li>▪ Climate regulation</li> <li>▪ Flood protection</li> </ul>
<u>Supporting services:</u> <ul style="list-style-type: none"> <li>▪ Pollination</li> <li>▪ Soil fertility</li> <li>▪ Biodiversity and habitat</li> <li>▪ Soil and biomass formation</li> <li>▪ Nutrient cycling</li> </ul>	<u>Cultural services:</u> <ul style="list-style-type: none"> <li>▪ Recreational experiences</li> <li>▪ Spiritual, religious, ceremony</li> <li>▪ Cultural diversity and inspiration for art</li> <li>▪ Education and knowledge</li> <li>▪ Aesthetic value</li> </ul>

Figure 5. Ecosystem services [15].

As part of a ‘nature-based solutions’ agenda, the project team is engaging with Honiara city Council, in particular a new Beautification Committee, to support the development of an urban greening strategy and action plan. This will involve landscape designs for climate resilient open spaces and also greening of the Kukum Highway (driven primarily by the Pacific Games in 2023). The team is also engaging with the SPREP-led EbA project ‘Planning for ecosystem-based adaptation in Honiara, Solomon Islands’ to provide design guidance and scientific support for their three case studies: Barana and Queen Elizabeth Park management plan and information centre, Mataniko River bank rehabilitation, and the development of a Botanical Gardens management plan [28]. In addition, an urban design studio was held with recent graduate students from the Solomon Islands National University to vision a ‘Livable Honiara’.

## 5. Integrating Teaching and Learning with Inter-Disciplinary Action Research

The preceding sections have presented examples of participatory action research that is being carried out to firstly identify priority urban climate resilience actions at community and ward levels, and then to co-design solutions with relevant local stakeholders. A selection of these will be implemented in 2020 in collaboration with local partners. This section now expands this research-led narrative by exploring the potential for teaching and learning (T&L) to be integrated with action research, as well as its role in strengthening local adaptive capacity.

For instance, having access to spatial data is a fundamental platform for informed climate change planning and actions. However, data for Honiara has proven difficult to access in digital formats, data provenance is difficult to determine due to a lack of metadata, and there are generally low levels of geospatial literacy. Given these limitations, this presents a clear opportunity for T&L to improve local GIS competence. In addition to GIS techniques, the community profiling activity presents an opportunity to develop the capacity of operational staff on survey methodologies that collect a combination of socio-economic and spatial data, as well as subsequent analysis and mapping of data to represent and map socio-spatial thematic relationships. Spatial data analytical methods could also help local stakeholders become better equipped at developing evidence-based policies. There are at least two government ministries where such training would be relevant and welcomed—MLHS and MHMS; as well as statutory organisations such as Solomon Water. However, consideration needs to be given as to how training would be delivered, e.g., via open-source QGIS software or proprietary

software like MapInfo Pro (which is used by MLHS), as ongoing licensing fees might be a barrier to mainstreaming these skills.

If the project deploys UAS as a data capture mechanism, this would present further opportunities for introducing T&L components; including the design and development of both hardware and software that is fit-for-purpose in climate-related urban surveillance. The challenge would be to assess how this might intersect with local capacity (e.g., with the surveying profession) who might already utilise UAS and may prefer targeted short courses (e.g., UAS for land administration). There are also opportunities to work with SINU to develop UAS-related teaching materials that complement their existing surveying curriculum.

Many of the challenges facing vulnerable and marginalised communities, including those in informal settlements in Honiara, are often inter-related and complex to solve. Urban planners and designers need to collaborate with engineers to incorporate appropriate engineering and technology designs into local decision-making processes. The Climate Resilient Honiara project emphasises the importance of co-designing solutions and therefore the need for introductory engineering capacity building of local stakeholders in key themes. The project's engineering contingent proposed that academics compile training modules on essential topics such as designing, maintaining and operating timber bridges, rain water harvesting systems, water treatment units, water storage tanks, septic tanks, small wastewater treatment systems, anaerobic digesters, solid waste recycling systems, and landfills. Additionally, modules on environmental science such as water quality analyses and groundwater management will enable Honiara to improve the water quality from the catchment to the tap. Basic engineering knowledge will empower communities to take ownership of resilience actions, while working with relevant authorities. It will also allow community members to not only participate in the design and development of various projects but also to be employed in the implementation phase. The capacities that are built in engineering and environmental science will, over time, also provide opportunities for developing more substantive interventions in the longer term e.g., integrated water management initiatives.

The project is assessing the existing land administration system, and the complexity of land tenure issues that might affect the implementation of climate resilience actions. This assessment includes research into the capacity of the MLHS and the surveying education institutions, the geodetic network, as well as existing approaches to land administration (e.g., the process of upgrading from Temporary Occupation Licenses to Fixed Term Estate titles). As part of this evaluation process, there is an opportunity to engage with the Surveying Department of the SINU was identified (they offer a land surveying diploma). After a joint meeting in February 2019 to discuss their capacity development needs, and scope opportunities for student-led activity, one of the outcomes was a desire for local surveying students to be involved with the implementation of actions in the field. To support this, a new Memorandum of Understanding between SINU and RMIT University has been signed to promote: (i) the exchange of faculty and staff members, (ii) research collaboration, (iii) participation in seminars and academic meetings, (iv) exchange of academic materials and other information, (iv) capacity development of SINU staff, and (v) potential student mobility opportunities. In more immediate terms, youth are being involved in household and settlement survey activities, and further support for SINU through educational resources and course development will be explored in 2020.

To further promote T&L contributions to the project, a short training workshop will be held at SINU in early 2020 to carry out training in GIS risk mapping, urban planning, and land administration. These are skill sets that will contribute to more effective and strategic urban resilience planning for the city. Given the low levels of capacity at SINU at present, the workshop will reach beyond the university and also include MLHS and Honiara City Council (HCC) professional staff (SINU is a young university, having been opened in 2013. Prior to 2013, most of the training needs in the country were met by training institutions offering vocational education. SINU now has five main schools, reflecting the programs offered by the university: the School of Education and Humanities, School of Natural

Resources and Applied Sciences, School of Nursing and Allied Health Sciences, School of Business and Management and the School of Technology and Maritime Studies).

Other areas of alignment between the two universities are the programs for building and construction which are part of the School of Technology and Maritime Studies (STMS) in the Institute of Technology. The Institute of Technology (ITech) offers trade courses in carpentry and joinery, plumbing and allied trades, electrical, mechanical, marine engineering, and surveying and drafting. From a buildings and construction perspective, design, planning and use of materials and ongoing maintenance are all critical. Some of the potential areas for collaboration involve design and construction elements, scenario planning, use of appropriate materials, and future proofing for extreme events. However, the SINU courses are offered at vocational levels only (Certificate, Advanced Certificate, and Diploma levels) and there are no Bachelor-level programs. This has implications for the development and implementation of the national building code, as well as local capacities for planning and building more generally. Furthermore, SINU is self-accredited and this limitation will need to be addressed for professional degrees such as construction management.

Knowledge exchange and mutual learning is also possible through potential joint student activities in Honiara's informal settlements. This will be facilitated through site visits involving a group of students from the engineering, planning, and construction management disciplines at RMIT University, in collaboration with local students and NGOs (to support this, students will be supported through New Colombo Plan funding). This would enable the integration of local knowledge and scientific best practice to derive the best practical housing and settlement infrastructure outcomes for the urban poor, as well as providing students the opportunity to productively engage with a 'living laboratory'. Such applied experience will allow students to better understand the multi-disciplinary expertise that is needed to address the breadth and depth of challenges in vulnerability hotspot settlements, as well as encouraging cross-cultural learning. T&L can also have a role to play when engaging more broadly with women and youth groups in the city.

The project team are also collaborating with ICLEI—Local Governments for Sustainability and have jointly facilitate training on disaster risk reduction (DRR) and climate change adaptation (CCA) with newly elected Ward Councilors. The CCA training draws from the UN-Habitat Planning for Climate Change guidelines and the activities are designed to help to strengthen the adaptive capacity of the Councilors, and by extension the local communities they represent.

Finally, a key city-level deliverable for the Climate Resilient Honiara project is the development of a short professional course that is to be designed to address the needs of Solomon Island Government staff, to be held in Melbourne. Attendees will be drawn from key Ministries such as MLHS, MECCDM, and MHMS, as well as officials from HCC. This will be a direct opportunity for lecturing staff based in Melbourne to engage with Solomon Island Government officials and provide training that further contributes to capacity strengthening; ultimately leading to more informed urban policies and management practice. The course will be designed based on local needs that are identified during multiple field visits, but is likely to include elements of urban planning and design, land administration, GIS, climate resilient buildings, nature-based solutions, basic engineering, etc.

## 6. Conclusions

Addressing the myriad of real-world problems faced by the urban poor in fast-growing cities in the Pacific is a challenging task. Future climate change will act to amplify many of the problems that they already face. As has been highlighted in this paper based on Honiara, efforts at equitable climate resilient urban development benefit not only from an inter-disciplinary approach but also one that is founded on new ways of cooperation between academics, Government organisations, statutory bodies, NGOs, and a wide range of local stakeholders. Trust and commitment to collaborative working between the various actors involved is needed. However, these are traits that need to be established and built on over a period of time, emphasising the value of long-term engagement and the creation of spaces for mutual learning (project team members have been working in Honiara since 2014).

Whilst still in the first year of a four-year programme, the Climate Resilient Honiara project showcases the potential for participatory and inter-disciplinary research to directly support the co-design and implementation of resilience actions at the community and ward levels (these will commence in year 2 of the project). Furthermore, as the research activity across project components progresses, this will open up new opportunities for T&L to further contribute to local capacity strengthening. Indeed, T&L has a pivotal role to play in supporting the development of local urban plans and actions, given the weak formal governance institutions that exist at the city-scale.

The signing of an MoU between RMIT University and SINU is a valuable first step in encouraging collaboration and learning between two academic organisations in Australia and the Pacific. As well as encouraging staff and student involvement with local project actions, RMIT University will support course development for diplomas that align with SINU's existing areas of expertise e.g., land surveying and construction management. Moving forward, the MLHS has also expressed its intent to establish a national planning association, and asked SINU to contribute to this agenda by developing and running a new diploma in urban planning with support from RMIT University. Again, this is an opportunity for cross-organisational partnership working between Australia and Solomon Islands. In addition to academic collaboration, two other direct project actions are the training and capacity building activities with Solomon Island Government officials (improving GIS skills has been identified as a priority) and Ward Councilors at the sub-city level (disaster risk reduction, climate resilience planning, and involvement with the location and design of evacuation centres).

Whilst the primary focus of the project is on delivering outcomes for informal settlements in Honiara (actions and capacity strengthening) it would be dismissive to ignore the impact of two-way knowledge sharing and the benefits this brings to staff at RMIT University. Taking engineering as an example, in the forward to the iconic 2010 report 'Engineering: Issues Challenges and Opportunities for Development' the Director-General of UNESCO, Irina Bokova, stated: "Now and in the years to come, we need to ensure that motivated young women and men concerned about problems in the developing world continue to enter the field in sufficient numbers". As engineering is an industry that requires tertiary education recognised by professional associations to practice in Australia, it is the responsibility of universities to appropriately prepare students for their roles and responsibilities when applying engineering knowledge and technology. This in turn requires academics to understand the issues facing the Global South, and to be able to account for this in course teaching material and curricula.

What is clear from the Climate Resilient Honiara project experience to date is that Australian university partnerships with our Pacific Island neighbours, in a development space that has traditionally been the preserve of consultancies, have the potential to bring multiple benefits to both sides. Long-term engagement through such projects allows trust to be built with local stakeholders, actions to be co-designed with technical support from the university (integrated with local traditional knowledge), the necessary local networks to be formed that support, implement, and maintain resilience actions, and enable knowledge sharing and training that strengthens local capacity to respond to current and future urban resilience challenges.

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