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Regular Article

Prospects and constraints of post-cyclone housing reconstruction in Vanuatu drawing from the experience of tropical cyclone Harold

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Abstract

Vanuatu is one of the countries in the world most at risk from natural hazards. This Pacific island country is frequently struck by ferocious tropical cyclones, such as Cyclone Harold in April 2020, causing massive devastation to the housing sector; nearly 21,000 houses were destroyed and damaged by the cyclone. Drawing from the literature and communications with local stakeholders, five main thematic aspects were analysed: nature of the impact of cyclones on housing; key challenges for post-cyclone housing reconstruction in Vanuatu; cyclone-resistant construction approaches; post-Harold housing reconstruction initiatives; and key opportunities. Of particular significance is the dilemma posed by traditional versus ‘modern’ approaches to design and construction for post-disaster reconstruction. There are many guidelines available for cyclone-resistant housing, but they face barriers to dissemination and application, and whether they are necessarily appropriate in the cultural context of Vanuatu is examined. Vanuatu faces a difficult situation in the aftermath of Cyclone Harold in the midst of the COVID-19 pandemic, and it can be expected that the reconstruction will be a protracted process.

1. Introduction: context and scope

The nation of Vanuatu is an archipelago in the south-western Pacific Ocean consisting of over 80 islands, 65 of which are inhabited (see Fig. 1). Spread out over 650 km, some of the islands are remote and access is difficult and limited. About 75% of the around 300,000 population lives in rural areas and the urban population is concentrated in two main cities, the capital Port Vila and Luganville. More than half of the population lives on the three largest islands - Espiritu Santo, Malakula, and Efate. Livelihoods are reliant on subsistence agriculture and fishing, with tourism and exports of agricultural and forestry products driving the national economy [1–5]. Vanuatu is categorised as a ‘least developed country’ by the United Nations [6].

Due to its geospatial location in the south-eastern Pacific Ocean, Vanuatu is exposed to extreme weather events, most prominently tropical cyclones that occur at the rate of 23 events per decade, which are predicted to become worse under the effects of climate change [7]. Geological hazards including earthquakes and volcanic eruptions also add to the risk [8]. The 2002 earthquake caused damage exceeding US$2.5 million [9] and there are frequent earthquakes with tsunami risk, for example the 6.9 magnitude earthquake in 2016 [10]. Mount Yasur on Tanna island is a fully active volcano [11] and the Manaro Voui volcano on Ambae island poses great risk leading to regular evacuations [12]. Vanuatu is rated as the most risk-prone country in the world because of its high vulnerability, exposure and susceptibility to disasters, and the lack of coping and adaptive capacities [13]. This risk is most clearly evident from the ferocious cyclones that batter the nation. In recent times, Cyclone Pam in 2015 caused massive destruction and while yet to fully recover [14] when the final recovery projects were being completed, Vanuatu was struck again by Cyclone Harold in April 2020. Additionally, the ongoing COVID-19 pandemic created an extremely difficult situation, presenting severe challenges to initiating and implementing the response and recovery process.

As with many disasters around the world, the housing sector experiences the maximum impact [15] – in Cyclone Pam housing was the most damaged sector with 32% of the total damage costs [16]; an estimated 80–90% of buildings was decimated [17,18]. In the more recent Cyclone Harold, the housing sector has again been hit hard, with estimates indicating that nearly 21,000 houses have been damaged or destroyed [14,18,20] (see Table 1), affecting a significant proportion of the population (about 55,000 households) in Vanuatu [5]. Not evident from the condensed data in the table below, in the hardest hit Sanma province, 5 out of 11 council areas experienced damage to 100% of the houses. This paper therefore focuses on cyclones, one of the most serious natural hazards in Vanuatu, and the sector most impacted by cyclones, housing. There is a strong need for effective housing reconstruction in a context of such devastation, and also to understand how it can be built in such a way so as to be able to better

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withstand future cyclones, issues that are dealt with in this paper by exploring the challenges to and the opportunities for achieving resilience of housing to cyclones.

2. Overview of literature on housing reconstruction in Vanuatu

To discuss the key issues relating to housing reconstruction in Vanuatu, it is necessary to firstly understand the housing typologies there. Presented in different ways in the literature, three main typologies are prevalent [16,21,22]:

- Traditional housing is built primarily of organic building materials from palm trees, grasses, bamboo and timber, which is more common in rural areas and the outer islands (see Fig. 2). An estimate indicates that more than 40% of housing is of the traditional type [16], hence it is a significant typology in Vanuatu.
- Hybrid or semi-permanent housing is built of a mixture of organic/traditional materials and industrial (or ‘modern’) products, particularly corrugated iron (CI) sheet (see Fig. 3). Poorly constructed houses using industrial products also belong to this category. There is a wide variety of combinations of materials and construction within this typology. This type of housing is prevalent in low-income areas such as urban informal settlements and also increasingly in rural areas. An estimate from 2015 indicates that 30% of the housing stock is of this type [16], but with growing modernisation hybrid type housing can be expected to proliferate.
- ‘Modern’ or permanent housing is mainly evident in urban areas and is built of industrial products such as concrete block walls, CI sheet roofing and milled timber framing, with a level of formal professional involvement (see Fig. 4). An estimated 27% of the housing stock is of this type [16], but it is not clear to what extent building codes and other standards are followed for resilience to disasters.

The bulk of housing in Vanuatu is single or double storey and of the detached type; multi-storey apartments are generally rare. In rural areas, small villages and hamlets consisting of several buildings grouped together are common and individual isolated houses are rare. Houses generally consist of a building for sleeping with a separated kitchen and outhouse structure [22,23]. The house construction varies according to the region, often in response to various factors. Traditional housing is widespread throughout rural areas where natural and organic building materials are available and lend themselves to ease of construction and repair within the existing

Table 1

| Province | No. of houses partially damaged/completely destroyed | Percentage of houses affected |
|----------|------------------------------------------------------|------------------------------|
| Penama   | 4828                                                 | 45.5                         |
| Sanma    | 7261                                                 | 88.2                         |
| Malampa  | 2,835                                                | 20.3                         |
| Shefa    | 364                                                  | 2.0                          |
| Torba    | 9                                                    | No data                      |
| TOTAL    | 20,809                                               |                              |

Fig. 1. An island in the Vanuatu archipelago (source: Wolfgang Reindl from Pixabay).

Fig. 2. A traditional house, Pentecost Island (source: Murray Garde).

Fig. 3. A hybrid house; note the use of bamboo poles and rope to secure the CI roofing sheets against strong wind (source: Mathieu Gamba).

Fig. 4. A ‘modern’ house next to a traditional structure (source: Murray Garde).
skills. For example, in the southern Tanna Island because of the nearby volcanic risk, traditional housing allows ease of repair after volcanic eruptions [16]. However, when Cyclone Pam struck, such housing was severely devastated on the island [16], indicating the multiple hazards that pose a risk to housing in Vanuatu. In the northern islands, woven sago palm fronds locally called natanggura is widely used for roofing; in the southern islands that lack sago palm trees, wild grass and coconut palm leaves are used in traditional housing [21]. On some of the smaller islands because of limited space to grow sago and coconut palm trees for thatch and other organic resources, hybrid housing is common [16]. Similarly, in urban or peri-urban low-income and informal settlements with little access to natural building resources, hybrid housing is common [16,22], often because it is an affordable option compared to ‘modern’ housing. Nonetheless, hybrid housing represents a step up from traditional housing in terms of the financial means to afford CI sheet and other industrial products.

A key issue that is often raised in the literature is the resilience of traditional housing to cyclones compared to hybrid or non-engineered ‘modern’ type housing [21–27]. This was highlighted in a report produced after Cyclone Pam [19]. Other advantages of traditional housing underscored in the literature include its light weight posing a low risk to human safety during a disaster and local availability and skills [25,26]. However, there are studies that contradict such observations – as mentioned in a report also produced after Cyclone Pam, traditional housing experienced much more damage compared to other types of housing [28]; it is indeed hard to imagine to what extent a traditional bamboo and sago thatch house can withstand a Category 5 storm. Additionally, it was found that after the disaster industrial products such as CI sheets and concrete blocks were easier to procure than organic materials. Damage statistics after Cyclone Pam indicated that many more traditional houses were completely damaged compared to hybrid or ‘modern’ houses, but more hybrid or ‘modern’ houses were partially damaged than traditional houses [16], possibly a case of the CI sheet roof being lost with the other parts of the house remaining intact, offering an opportunity to rebuild the house by replacing or repairing the roofing in the short term with CI sheet available from local markets. Some of the studies that are sympathetic towards traditional housing also acknowledge the widespread damage by Cyclone Pam to both traditional and other types of housing [25,26], but point out an important fact that “the way they have been put together is more crucial” [26]. It was observed that in houses where connections between its parts had been lashed together with ropes instead of using nails, it allowed flexibility to move in the strong wind instead of coming apart [21,23] (see Fig. 5). Thus, the whole gamut of skills, knowledge and construction techniques inherent in traditional housing beyond only the use of organic building materials contribute to its resilience, making it recalcitrant to sustain it with its wide range of attributes in the present-day context of rapid social change.

There is no lack of literature on disaster resilient construction in the Pacific Island Countries (PICs) and it is even pointed out in one such publication that its “safe construction” guidance has been informed by traditional housing [25]. Many of these publications provide specific guidelines on roof construction, particularly with CI sheet, which are prone to be blown off and crumpled in cyclones (see for example [30,31]). The Shelter Cluster cautioned against inadequate construction with CI sheet in Vanuatu after the Cyclone Pam experience and provided specifications and fixing directions if it were to be used [20]. There are also suggestions for strategies for a comprehensive approach to allow building with traditional materials [25,26], but it is not clear how these strategies would be implemented and by which stakeholders; there is hardly any acknowledgement of the inherent barriers. There are already many guidelines and manuals on safer roof construction, and in Vanuatu such guidelines exist from the 1980–1990s [29,30]. However, implementing them is often a challenge, particularly in the outer islands, which is why the regular cycles of cyclones continue to devastate housing. Are these guidelines actually relevant for the socio-economic and cultural context of Vanuatu, or they too idealistic and not contextual? This is a question that deserves examination, as done in this paper.

3. Materials and methods: research strategy

This paper was initiated from a short article written by the lead author soon after Cyclone Harold [32], when in response to feedback received on the article the need emerged for a paper that explores in detail housing reconstruction after cyclones in Vanuatu. The paper has been derived from a desktop study and informed by online communications conducted under the Academic-Practitioner Collaboration for Urban Settlements – South Pacific (APCUS-SP) network where a number of the network’s members from Vanuatu and other PICs shared local insights and information. One of the paper’s authors is based in Vanuatu, which allowed gaining from local knowledge and also access to relevant documents and updates on the post-Harold housing damage and reconstruction process. Through this process, the views of experts in Vanuatu and the region was gathered, serving as valuable data that informed this paper. Internet searches by that yielded various documents and reports on Vanuatu relating to housing and post-disaster reconstruction augmented the above data.

Thematic analysis was conducted on the data from the collected literature and network materials, following the methodology developed by Caulfield (2019) [33]. The six-step thematic analysis process of (1) familiarisation, (2) coding, (3) generating themes, (4) reviewing themes, (5) defining and naming themes and (6) writing up was followed, though coding was not undertaken because it was not relevant for this particular piece of work. Step 3 (generating themes) was key to interpreting the collected data and analysing it to derive structure and content for this paper. Five main themes emerged as significant from the analysis: nature of the impact of cyclones on housing; key challenges for post-cyclone housing reconstruction in Vanuatu; cyclone-resistant construction approaches; post-Harold housing reconstruction initiatives; and key opportunities. While the data was tallied according to these themes, interrelationships between the themes was also explored. The analysis of these thematic aspects allowed identifying the possible future trajectory for building resilience of housing to cyclones in Vanuatu, drawing from the aftermath of Cyclone Harold.

4. Results: key thematic aspects

The following sections present the findings of the analysis of the above-mentioned thematic aspects.

4.1. Impact of Cyclone Harold on housing

Aerial photos taken after Cyclone Harold show widespread damage to houses with corrugated iron (CI) sheet roofs that were blown off and crumpled. However, in the same localities there are examples of CI sheet roofs
that survived (see Fig. 6a). The obvious reason would be that these houses were better constructed, perhaps following cyclone-resistant construction principles. However, there is a maintenance aspect to survivability – in the aggressive environment of Vanuatu with high humidity, heat, precipitation and salinity, maintenance poses difficulties; even if a house is well-constructed, lack of maintenance can make it suffer in a cyclone. A detailed study on the impact of the cyclone on individual houses would allow gaining a better idea, clearly an area for further research.

On the other hand, many houses with thatch roofs made of sago palm leaves were relatively undamaged, also seen from Fig. 6a. There are many such houses on the outer islands of Ambae, Maewo and Pentecost that reportedly survived the cyclone. Although these houses appear undamaged, small damages leading to leakage and structural weaknesses could perhaps be concealed, which requires detailed verification on the ground. Nonetheless, traditional housing has developed over a long time with a strong relationship to the local context, reflected in its adaptation to local hazards. This also reflects that such housing is easily built using locally available materials within the confines of traditional logistic chains. However, new pressures are evident in the present-day context and the position of traditional housing within it bears further exploration, as discussed in the next section.

An interesting example is an old ‘Quonset House’ in Luganville built by the American military during World War II, which has a vaulted curved roof of CI sheet that escaped relatively undamaged in Cyclone Harold (see Fig. 6b). Curved structures tend to be aerodynamic and often offer good resistance to lateral forces such as strong wind. Hence the curved metal roofing survived. Would this style be widely and culturally accepted in Vanuatu so that it could be an affordable ‘build-back-better’ solution? This is an option that bears exploration.

### 4.2. Challenges to housing reconstruction

The challenges relating to post-disaster housing reconstruction in Vanuatu are multifarious involving a diversity of issues and problems. These challenges are categorised below according to their key aspects:

#### 4.2.1. Institutional

As mentioned earlier in Section 2, there are many guidelines for resilient construction in Vanuatu, yet damage to housing by cyclones persists; there is an overall poor understanding of cyclone-resistant design and construction. The Vanuatu Building Code under the Building Act 2013 includes a section on ‘low-cost’ construction, but it applies only to the urban municipal areas of Port Vila, Luganville and Lenakel [21]. The guidelines are not adapted and/or not accessible to remote communities. Implementation of the Vanuatu Building Code is highly challenging throughout the dispersed islands of the archipelago. Even when the municipal or provincial council issues a building permit, there is often no follow-up inspections during construction. As reported from the field, a built environment professional in Port Vila pointed out that the building permit system currently operating in the country was like an income-generation scheme rather than a building control system. The general conditions of a lack of compliance systems, procedures with local government and trained personnel prohibit the widespread application of building codes and standards. A key issue is that the codes and standards are adapted from those in Western countries such as Australia and New Zealand, but Vanuatu, as in most of the PICs, has a highly corrosive environment due to humidity, precipitation and warmth; most structures do not last as long as structures built in non-coastal areas of Australia and New Zealand and require a higher level of maintenance. Building to code or to higher cost standards is difficult even under normal circumstances due to low incomes in this least developed country context and in the aftermath of a major disaster, financial resources are more limited than usual. The scale of the emergency means that systems become overwhelmed (government, NGOs, community and church groups, suppliers and building industry) and there are shortages of funds, materials and skills. The overall lack of a robust formal sector institutional framework combined with low incomes also means that there are very low levels of building insurance and understanding of it, thus the liability for financing reconstruction rests on the house owner. Even if there were higher levels of insurance, it would be problematic given the large and regular disasters, making insurance less profitable.

#### 4.2.2. Reconstruction governance

There is no government department responsible for housing. The Public Works Department (PWD) is the lead government agency for the Shelter Cluster, which is a coalition of agencies for emergency shelter and housing reconstruction co-led by the International Federation of Red Cross and Red Crescent Societies (IFRC). Under normal operations PWD is responsible for transport infrastructure and public buildings and not for housing, it is not a good fit after a disaster. Also, a lack of focus on the housing sector means that PWD is inadequately resourced to implement shelter response and reconstruction when required. The Building Act 2013 places responsibility for housing compliance with the Building Code of Vanuatu on the Ministry of Internal Affairs which devolves down to provincial and municipal councils – these agencies are more relevant for housing within their jurisdictions, not PWD.
4.2.3. Professional capacity

In terms of built environment professional capacity, a rough estimate indicates that in Vanuatu there are less than 20 university-trained building-related engineers and architects having more than 10 years’ experience and only half of them are active in a technical capacity. There are no nationally accredited professional body such as the Institute of Engineers of Australia or New Zealand or any such other. This results in the lack of ability to understand the principles of building design and undertake a lead design role. This has implications for design and supervision of complex structures in one of the world’s most disaster-vulnerable countries.

4.2.4. International connections

A system of ‘boom-and-bust’ has built up around the occurrence of disasters. Vanuatu is a small country with few tradeable goods and reliant on its tourism industry, where the national income depends on foreign investment and aid. After a major disaster there is generally a large investment by the international community into response and recovery, which translates into projects, jobs, income and the associated flow-on effects. In between disasters, the economy goes back to ‘normal’ and people and institutions can suffer from a lack of investment and less money going around. There are reports that in recent years on a number of occasions in infrastructure handover ceremonies, the client organisation thanked God for Cyclone Pam as it enabled the investment and delivery of a project to make life better for the citizens of Vanuatu. This ‘boom-and-bust’ nature of international funding support linked to disasters can reinforce the attitude of reconstruction until the next disaster rather than building for the long-term future.

With each disaster, expectations change as international organisations arrive to influence what people see as the norm and what potential assistance is available. Reconstruction is impeded by the fact that Vanuatu is a less-developed country with limited access to adequate cash reserves and limited public resources to provide assistance in large scale emergencies. Added to this, the international and local non-governmental organisations (INGOs, NGOs) generally provide strong assistance during the initial emergency response phase, but limited practical assistance in rebuilding privately owned housing. Some organisations provide shelter kits, consisting mainly of basic materials such as tarpaulin sheets and tools, but these are only sufficient for emergency repairs and short-term shelter needs, not for longer term building for resilience. Householders in Luganville with concrete block houses only receive toolkits to harvest and build with natural materials, which is of very limited use. Shelter kits are generally targeted to rural inhabitants, but hardly any to peri-urban or urban residents. Following from the experience of large disasters elsewhere when humanitarian agencies engaged in housing provision that had mixed results, there has been a move away from directly providing housing to less tangible support such as implementing education and training in building stronger houses. In the aftermath of Cyclone Pam many such training programs were delivered by well-meaning INGOS and NGOs across the cyclone-affected areas. However, it is not clear if this actually provided benefits in terms of resilient housing. With the situation of limited financial resources after a cyclone, people desire to have a roof back over their heads as quickly as possible after the destruction of their homes. They do not have the resources to purchase high quality tech screw guns that can fasten large numbers of roofing screws to their corrugated iron roofs. Furthermore, those roofs need to be anchored into the walls using resources that most households do not have access to.

4.2.5. Traditional versus ‘modern’ construction

A key challenge for housing in villages is the loss of traditional building material such as sago palm and bamboo for reconstruction. After Cyclone Harold, massive devastation to sago palm trees have been reported [14,19,34], which will require many years to rejuvenate to allow harvesting again for roofing materials, posing a constraint for reconstruction. Some villagers on Pentecost Island have seen total loss of all sago palm and bamboo groves and estimate it could take up to 10 years for regrowth to satisfy the demand of the whole island’s population. In such rural communities after the cyclone, skilled or unskilled labor is not easily available for reconstruction programs because people are busy rebuilding or repairing by themselves the place where they sleep and their kitchen, and mending their homestead gardens.

As a reflection of the state of change occurring in Vanuatu with rapid urbanisation [35], traditional materials such as thatch are becoming unpopular and industrial products are replacing them. Thatch roofing requires regular maintenance and replacement every 3–5 years, and can leak if not well-maintained, whereas CI sheet can last up to 10–15 years and offers better protection from rain. As people have access to more cash reserves and more people are pursuing non-agricultural livelihoods, they are interested in housing that lasts longer and provides better living conditions. But often people do not know how to build well with ‘modern’ materials, hence the damage to metal roofing that has not been secured properly to the structure, as well as thicker varieties of sheeting not being used. The urban context has its specific challenges where the cost of repairing or rebuilding houses is often the most significant one because of the need to purchase building materials, mostly industrial products, because unlike rural areas there are no local natural building materials to harvest for free. The availability of a community-based support system is usually lacking for mutual help in rebuilding. In the post-Harold context, many people in urban areas faced unemployment because of the COVID-19 pandemic, and therefore lack disposable income to purchase materials for reconstruction.

4.2.6. Urban context

Urban housing in Vanuatu is relatively expensive in terms of the local economy. A three-bedroom house with the required accompaniments costs between $25,000 to $250,000, and the longevity of the structure is linked to the amount of investment. The top end of the bracket involves a relatively well-experienced contractor building to a design developed by one of the (few) qualified architects and engineers in Vanuatu. The building is designed in accordance with the Building Code of Vanuatu or Australian/New Zealand standards to resist earthquakes and cyclones, built by experienced tradespersons using good quality products. These projects will often have some supervision particularly if the funding has been borrowed from banks when supervision and engineering signoff at the completion of the project is mandatory. The lower end of the pricing involves a design developed by semi-skilled draftspersons replicating a design prepared by somebody else. Often the house owner will employ relatives from their island of origin who may have varying levels of experience. The supervision and workers will be paid minimum (or below minimum wages) and the house owner will purchase materials as required to progress construction. Often these projects will move forward in fits and starts with progress when there is funding available and will slow down or stop when there is little or no funding. There is generally no professional supervision or inspections during construction.

4.2.7. COVID-19 scenario

A critical challenge in post-Harold reconstruction was the situation brought about by the COVID-19 pandemic when the attention of the government, NGOs and media became centred on it. Vanuatu had been highly vigilant with an early closure of borders and reportedly no infections [19,36], but the provision of humanitarian aid from overseas was problematic. Additional safety measures were required, which comes at a cost when resources for reconstruction were already stretched. It can be envisaged that the post-Harold reconstruction would perhaps be the most challenging reconstruction process undertaken so far in Vanuatu.

4.3. Cyclone-resistant construction approaches

A traditional meeting place, known as a nakamal, a community building and not a housing typology, is often built with cyclone-resistant features. There are regional variations [25], but a typical example of a cyclone-resistant nakamal consists of a low A-frame thatch roof structure with the rafters made from strong large pieces of timber embedded deep into the...
ground and the structural connections lashed together with rope. Being an important community building, they are usually built in an inland location, or a valley, with vegetation and hills providing protection from wind. *Nakamals* often serve as safe refuges during cyclones [25]. It is generally uncommon for houses to be built like a *nakamal*, and it might arguably prove culturally unacceptable to promote the design for housing; however, in the southern island of Tanna, houses built in such a way have been recorded, and reportedly after Cyclone Pam people were building more such houses [23]. This is an issue for further research.

There are examples of other non-residential buildings such as schools that are built to cyclone-resistant standards and offer useful lessons. Such buildings are also sometimes built in protected inland locations, using good quality materials and design principles. This is often because many such schools have a high level of investment by donor agencies that insist on proper design and construction which drives the improved quality of these buildings. There are two examples on the south of Pentecost Island impacted by Cyclone Harold, both of them school buildings. In the south-east village of Ranwas, a new school building funded and constructed by a joint British and ni-Vanuatu aid organisation, The Tanbok Project, survived Cyclone Harold because it was built with robust materials using a design built to withstand a Category 5 storm. The same was the situation at Bay Barrier on south-east Pentecost where a building of four school classrooms had been repaired after destruction by Cyclone Pam (see Fig. 7). This project was funded by the Byron Bay Rotary Club in Australia and local community builders were asked what they needed in order to make the building strong enough to withstand extremely destructive storms. The local building team reinforced existing concrete walls and anchored down the new roof with iron rods which extended into all concrete walls. The builders were given trade standard roofing screw guns rechargeable with solar power. The roofing screws were applied according to the Vanuatu Building Code (one screw every third corrugation rise and at the final lower edge, one screw on every alternate corrugation rise). Although these examples could serve as a model, it should be noted that many schools are built on land granted by the local chief and villagers, and can be land not useful for anything else and exposed to the coast depending on the location of the village.

An example of a reconstruction project by the Australian company NevHouse promotes prefabricated buildings made of recycled materials. In the NevHouse project on Tanna island fourteen structures including housing was built to Category 5 cyclone standard [36]. The resilience of these structures is yet to be known because Tanna island was not severely impacted by Cyclone Harold. The Nevhouse model never progressed for a number of reasons. Important questions arise regarding the local replicability of such structures, whether they can be manufactured in Vanuatu to make it a feasible option for the largely rural communities instead of being shipped in from Australia. Instead of supporting local construction, importing prefabricated buildings from overseas, where the only local input is labour, usually cannot offer a long-term sustainable solution. The cost of a NevHouse is also prohibitive in the Vanuatu context [37]. The main underlying question that emerges is how to respond to a large scale disaster. The approach whereby donor agencies in the aftermath of a disaster seek to maximise their own country’s involvement to be able to respond quickly and are driven by cost imperatives and a desire to control quality and the program, may have variable results, and depending on the situation, might not always have benefits. The NevHouse project illustrates the issues many other reconstruction projects in Vanuatu face – although they might be built to cyclone-resistant standards, they remain as isolated examples and cannot be mainstreamed in the socio-economic context of Vanuatu.

4.4. Reconstruction initiatives after Cyclone Harold

As mentioned earlier when discussing the reconstruction challenges, the COVID-19 pandemic has been an obstacle to the post-Harold response and recovery process, inhibiting the ability of international resources to enter Vanuatu to provide assistance and slowing down the response. At the time of writing this paper 2–3 months after the cyclone, the government and humanitarian organisations were heavily focused on the emergency response. By the end of June 2020, support provided by the Shelter Cluster member organisations consisted largely of training and emergency shelter assistance (tarpaulin sheets, shelter toolkits and repair materials), and distribution of non-food household items (kitchen kits, sleeping mats, blankets, clothing and solar lamps) [20] to tide through the emergency period until more long-term reconstruction could commence. A post-disaster needs assessment (PDNA) was expected to be undertaken in the near future, and more detailed concepts about reconstruction recovery could then begin to emerge to allow agencies to orientate their programs towards that objective. This is potentially an important area of research that can be revisited over the longer term.

In the interim in response to the massive decimation of sago palm trees in the many of the northern islands (see Section 4.2), local communities had harvested the damaged palm leaves and other building materials that could be salvaged to repair housing, but that not being sufficient to meet the need, humanitarian agencies were preparing plans to resource and transport sago palm leaves from less affected areas such as northern Pentecost and Malekula to support reconstruction in the affected areas and establishing a supply chain in these areas [34]. However, this plan relied on external funding from government and/or humanitarian organisations, and coordination and logistics were potential problems. Additionally, there are embodied energy costs associated with transporting the materials over long distances and the question thus arises about the sustainability of this approach. A cost-benefit analysis is required that takes into account not only the financial cost factor, but balances the benefits of early recovery with long-term environmental considerations.

While the government might have a desire to assist affected people to repair and rebuild their houses there would not be sufficient funding or resources available. As after Cyclone Pam, most international donor agencies may not consider housing as a policy priority and available funding will in all likelihood be targeted to public infrastructure such as health and education infrastructure. After Cyclone Pam there were some INGOs, mostly faith-based organisations, that supported affected people to construct new houses and this may happen again. However, the post-Pam projects were not that well-received locally as they were not tailored to the Vanuatu context and as mentioned above about the NevHouse project in Section 4.3., such projects were often not locally replicable.

4.5. Opportunities for resilient housing reconstruction

The aftermath of Cyclone Harold is an appropriate time to develop new resilience capacity through the rebuilding programs. Local residents know

![Fig. 7. A school building on Pentecost island built to a cyclone-resistant standard after Cyclone Pam survived Cyclone Harold's severe impact on the island (source: Murray Garde).](image-url)
best about their context and how they might plan best to minimise the damage these increasingly frequent destructive cyclones are inflicting on rural island communities. Construction with traditional materials is a skill that rural ni-Vanuatu (natives of Vanuatu) communities still possess, through it is in decline [23]. Such materials are normally available within a short distance in every village. Customary rules about who can access particular groves are in place and a grove can be shut down for regeneration periodically. Community workshops along participatory development principles that establish a bottom-up approach rather than an external ‘expert’-led top-down solutions would be appropriate at this time. This may also be a time to confirm the value of traditional architecture and explore ways for rural communities to access the materials no longer available locally. To date there has not been much thought given to the commercialisation of sago leaf roofing panel construction and treatment of organic materials for durability. There are numerous suppliers who supply sago palm roof materials into Port Vila, these businesses can be supported to improve capacity and encourage local industry. There is the opportunity to investigate traditional construction techniques and designs with local builders and tradespersons, and re-integrate them into the present-day situation. As an aid project, it would draw on existing skills and stimulate economic activity in rural areas.

The post-Harold situation provides an opportunity to identify and assist the most vulnerable households and communities through a thorough needs assessment, including the logistics of cost and accessibility of the affected communities. Traditional housing design can be supported by embedding resilient construction techniques and developing building skills to build stronger houses without changing the local design. It has to be understood that in Vanuatu in general, there is a low level of cash flow and a house is often built slowly over a year or so, and in a post-disaster disaster situation it may take longer. However, after the disaster houses need to be repaired as quickly as possible, requiring an expedited process of cash flow, at least to undertake the most urgent repair work. There is the opportunity for a reconstruction grant process where humanitarian organisations and the government could provide cash for repairing and rebuilding housing in resilient ways.

There are different needs in rural and urban settings and the government needs to establish an integrated preparedness and reconstruction system that recognises these different needs. There is the opportunity now for developing such a network system for future cyclones, consisting of pre-identified stakeholders in the housing field including Community Disaster and Climate Change Committees (CDCCCCs), provincial and municipal governments and mobile teams of local builders, carpenters, etc., so that it can be triggered right after a cyclone. In coordination with local hardware shops, preparedness measures should include stockpiling of traditional and ‘modern’ building materials that can be distributed after a cyclone to assist with the reconstruction process.

The main opportunity rests with the potential for government and other organisations to provide leadership on a national level in the post-Harold context and improve systems, staffing and resources to firstly respond to the initial emergency and provide assistance in the short term. The response can be integrated with the reconstruction in a holistic and seamless manner, and the recovery integrated with long-term development and mainstreamed into all government systems. There is the opportunity for capacity building of local construction workers through education and training on how to build a strong building and provide resources for this training to be implemented in a practical way, for example by assisting people to actually rebuild their homes and learn on the site. At the institutional level, resources and training can be provided to the existing CDCCCCs, municipal councils and government staff on compliance to and implementation of the Vanuatu Building Code. This can include providing additional resources to promote compliance to resilient construction standards and prioritising the training of building certifiers in the scholarship schemes supported by the government and donors agencies.

Importantly, it will be necessary to work in coordination with the local ‘Chiefs’, who hold significant customary authority at the local level. Establishing a builders’ society to mainstream building codes and regulations could bring ownership to building activities within Vanuatu. At this time during the COVID-19 pandemic, there is the opportunity for Vanuatu to be a more capable and resilient country and respond to the crisis without international assistance. While the post-Harold response could be considered very slow by some measures, the Government of Vanuatu, leading into the 40th Anniversary of Independence in late July 2020, is issuing the narrative that Vanuatu is leading the response and will ultimately provide greater strength and resilience to the country.

5. Discussion: understanding housing reconstruction in Vanuatu

It is important to understand the cultural dimensions that have a bearing on the constraints and prospects for housing reconstruction in Vanuatu identified above. A Western building professional may consider the damage of a house in a cyclone as a failure, but that is not necessarily how a ni-Vanuatu will perceive it. To understand why a building in Vanuatu fails it is necessary to understand more than how the building was designed and built; for one, when the house is viewed according to its context – rural or urban – it becomes clear why the situation is the way it is and how it might change to make the house stronger and last longer. Permanent housing construction is a Western concept that often does not have relevance in the Vanuatu rural areas - people there do not really think ‘permanent’ about their house. The outdoor cooking area in rural homesteads is a case in point; even houses that have a kitchen inside will still have an external cooking area. This is, in part, due to the available fuels (timber in most areas), but to a large extent is due to the fact that the cooking area is a central focus of family life particularly in tropical and subtropical cultures where life is predominantly lived outdoors. Reports from the field indicate that in many cases households build their kitchen before their house (the building they sleep in); for them it is more important because they spend more time in the kitchen and outdoors. Having a roof is a priority, but having a strong house that can withstand a Category 5 cyclone is often not, which is why many people rebuild a weak and poorly constructed house even after experiencing a cyclone. The expectation that a building would last 50–100 years and be built to resist all types of natural hazards is predominantly a Western idea. For people in Vanuatu, the forest and ocean provide everything and also take everything away. Thus, the idea that a structure, a house, will last a long time is an alien concept. Commonly in Vanuatu, once a house becomes unfit for habitation, the owners collect materials, often from nearby forests, and a new house is built alongside it. The householders continue to live in the collapsing house in the interim until the new house is ready to move into. This is can be considered as an example of sustainability - people only use what they need at the time they need it.

It is thus fair to suggest that ni-Vanuatu culture is not focused on long-term maintenance, at least not in the way perceived in Western culture. When something falls down, people build a new one. In urban areas, where the government is constructing facilities, particularly with donor assistance, there is now a motivation to increase maintenance funding and develop systems to make initial investments last longer, and the idea is growing, but in many areas asset management is still in development. The cultural approach to the built environment is also under pressure from the forces of climate change and urbanisation, and cannot be viewed as static. With cyclones becoming stronger and more frequent, the coping capacity of traditional systems has become extremely stretched, and continuing sea level rise poses a significant threat throughout the Pacific region. The urban drift in many countries in the world including Vanuatu is drawing people from rural villages into towns and cities where the social and economic structures are quite different. Vanuatu has among the highest urban growth rates in the South Pacific region [30]. Houses are transforming from natural materials to more Western-engineered products such as concrete block, milled timber and CI steel. However, most people who live in urban areas still have strong connections to their village and rural lifestyles on outer islands. People still see the major towns and cities as places where they live to earn money and educate their children, but their allegiance remains with their island of origin and this can inhibit long-term investment in urban centres where they spend the majority of
their lives. In the end, most people who spend their lives in Port Vila or Luganville still have the dream of returning to their village to live out their retirement.

Thus, a duality has emerged: On one hand, modernisation is being espoused through aspirations for international building standards, improved education and health, democratic governance and institutions, gender parity and global connectivity, accompanied by an expanding cash economy and increasing disregard for tradition especially among the younger generation. At the same time, there is the promotion of what is known in Vanuatu as ‘kastom’—the expression of traditional values, culture, agriculture, the arts, architecture and building construction, support for governance by customary local Chiefs and ambitions for national autonomy without international dependence. This dichotomy sometimes manifests itself in somewhat strange forms—there are examples of tourist resorts using imitation thatch made of plastic that display a traditional appearance, but do not have the maintenance requirements of actual thatch (see Fig. 8). Is this the future of traditional housing in Vanuatu?

Another frequent dilemma that often arises in developing countries such as Vanuatu is how the usually limited funding available after a disaster is utilised to maximise outcomes. To use a hypothetical scenario to illustrate the point: There are 200 disaster-affected households in a village without a house and $1 million funding is available. Would it be a good idea to build 200 houses at $5000 each, but the houses not built to resist large disasters and may only last for 10 years? Or would it be better to build 100 disaster-resistant houses at $10,000 each that will last for 20 years? If the second option is followed, not all the houses in the village will be lost in a cyclone, but a large number of households will not have a house at all. Adding to this scenario is the fact that there might not be adequate maintenance and even the better constructed houses may structurally fail in a major cyclone in 15 years due to the fact that the connections have rusted and the timber has rotted. This is a typical scenario confronting the government and humanitarian agencies after a disaster in their decision-making and aid allocation process, and often compromises have to be made after taking into consideration a wide range of factors beyond simply matching funding to need. In such a context, perhaps the approach to be followed is to focus on establishing evacuation centres or safe refuges so that lives are not lost in cyclones. Some traditional nakamals fulfil such a purpose effectively as discussed above in Section 4.3. Disaster resilience initiatives could build upon that experience as a basis for developing more widespread safe refuges. After a cyclone, affected households can be provided materials from a stockpiled supply so that they can rebuild their house (sleeping place) and kitchen.

6. Conclusion: the future of housing reconstruction in Vanuatu

This paper has highlighted the junction where tradition and modernity meet in Vanuatu in terms of the constraints and prospects for housing reconstruction after cyclones. When a disaster such as a massive cyclone strikes, those tasked with reconstruction will continue to be faced with reconstruction dilemmas. Perhaps the way out of this quandary might be a hybrid approach that combines the strengths of both traditional and ‘modern’ housing, and localised approaches designed to match the particularities of place, available resources, skills and aspirations.

There are many questions that need addressing if tropical storms of the magnitude of Cyclone Harold are going to be become more frequent in Vanuatu. The basic question, ‘what survived the cyclone and what did not’ would be the launching pad. Further, what aspects of ni-Vanuatu cultural practice and built environment contribute to resilience and how might they be strengthened? What is the vision of communities for their future? What is the science of climate change saying about the possible future frequencies of cyclones? Many such questions would need to be considered to chart the pathway for a resilient Vanuatu.

Considering the effects of climate change, a cyclical ‘destruction and externally funded reconstruction’ process is not sustainable. Making matters worse is COVID-19 and the consequent widespread economic disruption. The loss of income from tourism due to COVID-19, a sector that previously contributed nearly half of Vanuatu’s Gross Domestic Product (GDP) [37], is yet a further disaster. A narrative driven largely by Covid-19 is that of self-reliance. With the borders closed, the country is maximising reliance on internal leadership and the well-known self-reliance that geographically isolated Pacific Island countries have always fostered [20,21,25]. This is occurring within the wider efforts to improve systems, which are contributing to gradual improvements in Vanuatu.

To improve resilience, drawing on the opportunities discussed in this paper, at the government level it would require strengthening capacity and establishing a separate Department of Housing responsible for housing reconstruction. It would require coordination with the Ministry of Internal Affairs, municipal and provincial governments and NGOs to improve housing stock in Vanuatu and coordinate reconstruction after cyclones, utilising existing cultural systems and designs. Multi-stakeholder engagements would allow builders and suppliers to work together with government agencies and NGOs to stockpile materials and commercialise natural building materials. A multi-pronged approach is required involving detailed assessments after major disasters, support for planning for cyclones and climate change impacts, building strong community relationships, continued education and awareness-building and improvement of asset management and a maintenance culture.

Reconstruction will take place ultimately in an ongoing and long-term timeframe. In a high-level policy forum of Pacific leaders, it was estimated that it may take more than 10 years for recovery from Cyclone Harold, while the prospects for recovery from COVID-19 are uncertain [38]. The cyclones Pam and Harold, both category 5 storms, were only five years apart. This may become the new normal—an ongoing process of reconstruction and preparation for the next destructive tropical storm through housing and infrastructure upgrades and adaptations. Investment by the government and other agencies in the housing sector would be required to allow benefits to the people of Vanuatu by building resilience and reducing the need for massive investment after cyclones, although this would be long-term process of generational change.

Author contributions

The paper was conceived by Iftekhar Ahmed, who wrote the original draft and finalised the paper for submission. He was responsible for developing the methodological approach, undertaking the literature review, seeking and collating information from different people, data analysis and incorporating the inputs of the co-authors into the paper. Ted McDonnell provided initial inputs through the questionnaire, as well as organising information from people based in Vanuatu. McDonnell also reviewed the draft manuscript, undertook some editing and provided significant text and commentary that were incorporated into the paper. Both authors have read and agreed to the published version of the manuscript.

Fig. 8. Plastic thatch roofs in a resort (source: Iftekhar Ahmed).
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The authors declare no conflict of interest.

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