Detailed
Shelter Response Profile

TONGA

Local Building Cultures for Sustainable and Resilient Habitats

Final draft version
November 2019

Shelter Cluster Tonga
ShelterCluster.org
Coordinating Humanitarian Shelter

↑ Island in Vava'u group. CC- Alessandro

↓ The rise of sea level is causing several problems: damage to buildings and infrastructure, loss of land for cultivation and salinization of well water. House in Ha'apai group. © Caritas

Cover images (from top to bottom):
View of a *fale* with palms roof and walls, what can be considered a Disaster Risk Reduction measure. CC (Creative Commons)- cfleizach
View of a house in Tongatapu with the shape of traditional oval *fale* and CGI sheets in roof and walls. CC- Leo Gaggl
A timber house with CGI sheet roof on concrete stilts in Tongatapu. CC- Leo Gaggl

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FINAL DRAFT

To be circulated in-country for consultation with key shelter institutions and partners for validation, and to support filling information gaps as noted throughout the document

FOREWORD

Validation in-country is recommended (Shelter Cluster Tonga).

INTRODUCTION TO THE COUNTRY

The Kingdom of Tonga is a small confederation of islands in the South Pacific Ocean surrounded by several groups of islands, among which stand out Fiji to the northwest and Samoa to the northeast. Tonga is located at a distance of 2000 km northeast of New Zealand

Tonga is a constitutional monarchy and is one of the few states in the world never to have lost its sovereignty, having always been governed exclusively by its people. There are 5 administrative divisions: Tongatapu, ‘Eua, Ha’apai, Vava’u and Ongo Niua. Tongan and English are commonly spoken in the country.

The archipelago has a tropical climate and is one of the smallest countries in the world in area (about 750 km^2, ranking 174th) and population (106,398 people, ranking 183rd). Its population density is quite high, with 139 people/km^2.

There are about 170 islands. Those to the West (Tongan Volcanic Arch) are all of volcanic origin while the eastern islands are nonvolcanic and are formed by coral limestone and sand.

Over the last 20 years, per capita GDP has grown by around 1 percent per year. Current GDP is US$591 million and current gross national income is US$5,900 per capita (CIA World Factbook, 2017 est.).

Tonga faces many of the geographic and structural challenges common to countries in the Pacific region. Its remoteness, combined with its small size, geographic dispersion, and limited natural resources, provides a narrow economic base and imposes additional costs of trade and transportation. These factors mean that domestic markets tend to be too small for industries to benefit from economies of scale. Tonga is highly dependent on remittances from abroad (estimated at around 30 percent of GDP) and donor aid flows. Agriculture, fishing, and tourism account for most export earnings.

HIGH VULNERABILITY

According to the 2018 World risk report, Tonga ranks as the 2nd country most at risk of disaster in the world. In any given year, Tonga is likely either to be hit by a major natural hazard or to be recovering from the impact of a previous one. Natural hazards include mostly frequent cyclones, volcanic activity, extreme earthquakes, tsunami risks and El Niño. Floods and droughts are also common.

Between 1875 and 1978, there were 41 damaging tropical cyclones; 24 earthquakes of magnitude 7.0 or above on the Richter scale; 7 periods of severe drought; 9 volcanic eruptions and 3 known tsunamis; a total of 83 recorded events, or one every one and a quarter years (Lewis, 1982).

Between 1950 and 2005, natural disasters cost Tonga 14.2% of its GDP during disaster years (Magee, 2016). For instance, Tropical Cyclone Ian in 2014 resulted in total damages and losses valued at approximately US$50 million (11% of annual GDP).

Tonga continues to become more vulnerable to external shocks due to the effects of climate change (rising sea levels, warming seas, and increasingly extreme rainfalls), being a small island developing state with limited resource base, and this vulnerability is compounded by the natural calamities.

Finally, the increasing urbanisation and monetisation of the society is perceived as leading to a deterioration of traditional support systems. The current traditional safety net such as sharing is proving to be less effective in addressing shocks which affect communities and the country as a whole. On the other hand, new support systems are becoming crucial: for instance the diaspora whose remittances represent 30% of the GDP.

Situation of Tonga (up) and Administrative divisions (right)
CC- Wikimedia Commons

Traditional *fale*, house with thatched walls and roof.
CC- Jen Crothers

Sources: Government of Tonga (2018), IMUNA, COP 23, UNICEF (2011) , Magee (2016), Lewis (1982), World Bank (2011), CIA World Factbook, Secretariat of the Pacific Community and Tonga Department of Statistics (2014)

ADAPTED LOCAL BUILDING CULTURES

Tongans have always used clever and innovative solutions to build their habitats, with evolving know-how and adapting solutions. Tongans have traditionally lived in houses called *fale* mainly built using wood for the structure, thatch for roofs and walls and ropes for tying the different elements. *Fale* were the main type of construction found in the islands until the arrival of industrial materials. A study developed in 1958 by Kennedy showed the majority of the houses were built with thatch for both walls and roof in four out of the five divisions of Tonga (all but Vava'u). Wood or iron walls and iron roofs were already used in about one half of the houses of the country. These materials have continued to gain ground over thatch materials ever since and today, the practice and the knowledge on traditional *fale* has almost disappeared and *fale* are rare.

According to the Secretariat of the Pacific Community and Tonga Department of Statistics (2014), concrete or timber floors are present in almost all houses. The vast majority of external walls in the country are constructed using timber or concrete blocks. The *fale papa* or square wooden house has become the most common house of Tongans: 61% of the houses had timber walls in 2011. The same source indicates that 31% of the houses had concrete block walls. Finally, CGI sheets roofs dominate in the islands (95% of the households). These changes show the adaptation of Tongans to new conditions as the arrival of industrial materials and the influence of European styles in the preferences of Tongans regarding housing.

The evolving building cultures in Tonga present a wide range of hazard resistant practices and great adaptation to climate conditions. Moreover, Tongans have developed good strategies for maintenance and for disaster preparedness. These assets along with some existing weaknesses are covered in chapter 5.

USE OF THIS SHELTER RESPONSE PROFILE

This Shelter Response Profile aims to provide a basic understanding of the context and key issues, to inform strategic planning of humanitarian shelter responses, and the design of individual shelter projects which take in to account and promote existing good practices offered by Local Building Cultures (LBC) and Building Back Better/Safer activities.

In response to the climate, hazards and cultural needs, different local building cultures have developed over time, resulting in a variety of context-specific solutions imbued with local coping mechanisms. The information on LBC is presented in this document for the entire country, as no significant differences have been found between the administrative divisions.

The focus is on the local building practices and materials that support Building Back Better/Safer and leverage people's capacities for self-recovery. At the same time dangerous or inefficient practices are highlighted and recommendations given for sustainable and resilient shelter practices.

In order to concretely illustrate the idea of drawing inspiration from LBC to realise a successful housing project, examples of housing projects and architectural designs are presented in chapter 6, including basic information on unit costs and building techniques used. This chapter shows houses inspired by traditional models, which have adapted over the passage of time in response to present-day constraints, emerging possibilities, and to suit the evolution of lifestyles. MISSING, TO BE UPDATED IF INFORMATION IS AVAILABLE.

The information in this booklet is designed to support shelter practitioners to make informed choices when preparing and developing their shelter response projects, but might need to be complemented by further field studies to ensure that local specificities are well taken into account in each project location (see recommendations pp. 50-51).

House with timber framed and clad walls and CGI roof sheeting on Kapa Island. Vava'u group.CC- clr_flickr

Concrete block house with CGI roof sheeting in Tongatapu.
CC- Leo Gaggl

1. Introduction

1.1. Why local building cultures are important today

All over the world, societies have managed to produce, adapt and develop their habitat according to their needs, interests, aspirations, preferences and abilities, making the best use of locally available materials. Strategies developed take advantage of natural resources to protect the inhabitants and structures against the destructive forces of nature and have always generated rich and varied knowledge at local levels.

(Re)discovering the intelligence of local architectures and analysing their associated practices is often very useful in the process of designing disaster resistant architectures in accordance with build back better/safer principles, which adapt to the evolution of contemporary lifestyles, respect the local environment and culture, and conform to the technical and economic capacities of local populations.

Relying on, or at least drawing inspiration from local knowledge, know-how, construction processes and traditional means of organisation has proved very effective, as it favours:

- The implementation of solutions, and suggestions of improvements which are well adapted to local ways of life;
- The possibility to shelter many people quickly and cost-effectively in structures which are well adapted to seasonal patterns, cater for cultural practices, and support livelihoods;
- Large-scale and long-term replicability of solutions and improvements which are more accessible to communities due to their often low-cost, and low, or local-tech nature;
- A positive impact on local economies as local skills and materials are fully promoted, while also taking into account environmental concerns linked to the construction industry;
- Greater acknowledgement and promotion of the community's role in their own sheltering process (with shelter agencies supporting this process), resulting in increased participation in decision-making and project implementation processes, and leading to more appropriate long-term shelter solutions. This in turn leads to greater learning opportunities for shelter agencies;
- Empowerment of local populations through the recognition of the value of their existing capacities for building and the enhancement of their resilience over time.

To develop a disaster resistant architecture adapted to current local ways of life, it is important to involve the affected population and the local professionals and decision makers from the very beginning of the recovery phase. If rebuilding is often necessary and can be very demonstrative and convincing, promoting pertinent repairs when possible may help reaching this goal. This way, the connection between relief, recovery and development is enabled and so, the long-term benefit of a shelter project is ensured. In addition to the provision of shelters, higher levels of resilience within the project area are reached.

1.2. Key concepts

Building cultures

A building culture is the intangible dimension of a construction or a settlement produced by humans to live, work, thrive, etc., and is strongly connected with its environment. It includes assets related to each phase of the building life cycle: design, construction, use(s), maintenance, replacement, extension, adaptation, etc., which are often related to social, economic and environmental aspects as well as cultural aspects, including symbolic and representation systems.

The genesis and evolution of building cultures are closely linked to their environment and to the specific history of each territory. This is the reason why they are so diverse across the world and why several building cultures can co-exist within a single territory.

Vernacular habitat

Vernacular habitat is characterised by the use of local resources to respond to people's needs and to local climatic conditions. It is therefore closely linked to the site where it is built. It often results from reproductions, improvements and on-going adjustments or adaptations over time and may sometimes include also external inputs and imported solutions. Such structures, mainly built through manual labour and found on or beyond the outskirts of commercial centres, often rely on strong links between the inhabitants and their families and neighbours and may evoke feelings of belonging and pride within the community.

Precarious habitat

The term "precarious habitat" covers different realities depending on the specificities of the places and the factors that generate it: economic difficulties, the effects of climate change such as sea level rise or natural hazards. It characterises houses or shelters built predominantly by low-income families or by those who, without a land property title, prefer to limit their investment to lightweight structures that are relatively easy to dismantle or repair. These structures are primarily found within peri-urban areas where absence of a formal land tenure agreement often correlates with a negative perception and with high risk, hazardous (disaster prone areas) and precarious living conditions that expose houses to frequent damage and destruction. This inherently leads to the need to constantly rebuild, strengthen and repair housing structures, which may reinforce the inhabitant's knowledge on what works and what does not, with technical solutions that are often constrained by their available resources.

Despite these challenges, their proximity to cities and the opportunities they offer (educational, income, recreational, etc.) result in a strong attachment to these habitats. This leads to creative design solutions, including elements of comfort, spaces for income generating activities, or external spaces of socialisation that do not exist in more formal habitats.

Globalised habitat

Around the world, building is increasingly influenced by "global trends" and a growing interest in the reproduction of international solutions and in industrial materials such as cement, steel and CGI sheets. These are often used in the place of more traditional materials (such as thatch) without considering that changing one element of the construction can affect the way the structure performs as a whole, possibly compromising structural safety, thermal comfort and other important features of the building. Therefore, one of the challenges of the Local Building Cultures (LBC) approach is to be able to take on board such tendencies and ensure that expectations are met when proposing designs for the construction of shelter projects.

In post-disaster situations, some shelters are intended to be temporary structures made of short-lasting materials with designs that meet basic needs of the affected population. These short-term shelter solutions often become permanent structures for families who lack the possibility to repair or improve them as they can be difficult to modify due to their prefabricated nature, or the materials, skills and financial resources required are not available locally.

1.3. Information used for this document and history of the collection

Information and data collection

This document was elaborated after a dedicated literature review (see chapter 7) and thanks to information collected during and after a number of experiences by the authors and their partners in Tonga. This document should be seen as a draft for further consultation with Tongan academics, shelter experts, and communities.

History of the series of shelter response profiles

This publication is part of the series of documents: "Local Building Cultures for sustainable and resilient habitats". Several documents have been produced between disasters (Fiji, Ecuador, Haiti, Bangladesh and now Tonga). The profiles are useful as preparedness tools which can inform the strategic direction of responses and the design of individual shelter programs. Moreover, two profiles have been elaborated for situations of both conflict and disaster (Ethiopia, Democratic Republic of Congo).

1.4. Suggestions for use / Audience

The organisations behind this document have been working for several years on the elaboration and the dissemination of an identification method for local building cultures (LBC), especially in regard to their contribution to Disaster Risk Reduction (DRR). The aim is to facilitate the identification of the strengths and weaknesses of LBC and the opportunities they offer, in order to promote them – in an adapted version if necessary – in housing reconstruction or improvement projects.

To achieve this, it is important to consider that affected populations live in environments that are often shifting due to several factors such as climate change, urbanisation processes, globalisation and the evolution of social attitudes as local practices are challenged. Still, it is advised that the solutions proposed are found locally and to keep innovations limited to improve the likelihood of their continued adoption by communities, and thus to contribute to long-term sustainable development and increased local resilience.

This document introduces reference data on local building cultures and local sociocultural resilient strategies. These references are to be considered as a basis for the development of sector response and project-specific strategies of the Shelter Cluster Tonga and its partners, and also as a macro-level analysis with a first set of conclusions. Context and details will differ from one place to another and stakeholders will benefit from further analysis (field studies) of each selected project area in collaboration with local actors in order to make comprehensive and accurate decisions.

1.5. Articulation of this profile with the work plan of the Shelter Cluster

As a first step, the final draft of this document will be circulated in-country for consultation with key shelter partners for validation, and to support filling information gaps as noted throughout the document.

Going forward, this profile will help to inform the development of sectoral response and project-specific strategies of the Shelter Cluster Tonga and its partners for contingency planning exercises, and future responses.

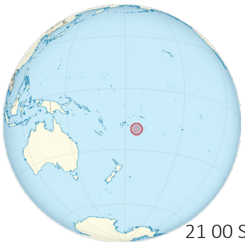
This will become a key resource of the cluster and exist as a living document so that information gathered from field studies during future responses will contribute to future revisions of this document.

2. Country profile

2.1. General description

Sources: CIA World Factbook, FAO, World Bank, The Kingdom of Tonga, Climate portal, Wikimedia, Protected Planet

A. Location



©Wikimedia
21 00 S, 175 00 W

Tonga is an archipelago of about 170 islands (36 inhabited), located in western Polynesia, in the South Pacific. It lies on an imaginary line approximately 800 km in length from north to south. The country consists of three major island groups and a small group: Tongatapu & 'Eua in the south, Ha'apai group in the centre and Vava'u group in the north. The small Niua group is located 200 km north of Vava'u.

Surrounding countries and territories include Fiji and Wallis and Futuna (France) to the northwest, Samoa to the northeast, Niue to the east (state in free association with New Zealand), and Kermadec (New Zealand) to the southwest.

B. Physical and topographical data

Area: Land: approximately 750 square kilometres. Water: approximately 700,000 square kilometres in the southern Pacific Ocean.

Elevation: lowest point: Pacific Ocean 0 m. Highest point: Kao Volcano on Kao Island 1,046 m above sea level.

Terrain: mostly flat islands with limestone bedrock formed from uplifted coral formation; others have limestone overlying volcanic rock. The western islands (Tongan Volcanic Arch) are all of volcanic origin; the eastern islands are non-volcanic and are formed by coral limestone and sand.

C. Climate

The climate is tropical. The warm season is from December to April (with temperatures rising above 32 °C) and the cool season from May to November. (with temperatures rarely rising above 27 °C). Lower temperatures are more frequent in southern Tonga than in the north.

Rainfall: The annual rainfall is between 1,700 to 2,970 mm from Tongatapu in the south to the northern islands closer to the Equator. It rains throughout the year, with a peak in the months of February and March.

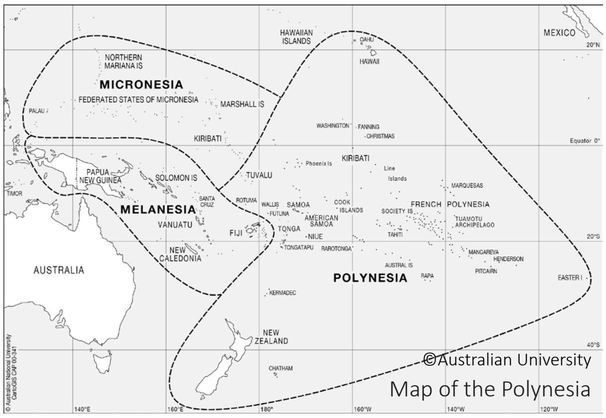
D. Protected areas

The World Database of Protected Areas (link in page 9) includes 22 Protected areas in Tonga. Protected areas are important biodiversity hotspots, as well as being the source of livelihoods and natural resources used for housing for the local communities. There are: 1 Marine Reserve, 1 Nature Reserve, 3 National Parks, 1 Sanctuary, 6 Reserves, 7 Multiple Use Conservation Areas and 3 other protected areas.

16% (122 km²) of the land area as well as 2% (10,055 km²) of the marine is protected.

E. Administrative data

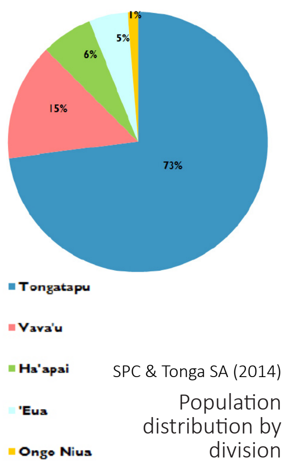
Tonga is the last constitutional monarchy among the Pacific Island countries. There are 5 administrative divisions: Tongatapu, 'Eua, Ha'apai, Vava'u and Ongo Niua.



©Australian University
Map of the Polynesia

©GraphicMaps.com
Map of Tonga

CC- Wikipedia Commons
Administrative divisions



SPC & Tonga SA (2014)
Population distribution by division

Sources: Government of Tonga (2018), CIA World Factbook, World Bank, UNHCR, UNICEF, ILO, World Atlas, Knoema, Reliefweb, Secretariat of the Pacific Community & Tonga Statistics Department (2014), MAGEE (2016)

2.2. Demographic, cultural and socioeconomic data

A. Demographic data

Total population: 106,398 (about 70% on the main island of Tongatapu).

Population density: 142 people/km²

Human Development Index (HDI): 0.726 (high)

Life expectancy: 73.2 years

Fertility rate: 3.03 children born/woman

Infant mortality rate:

10.9 deaths/1,000 live births

Median age: 23.3 years

Age structure:
0-14 years: 33.26%
15-24 years: 19.69%
25-54 years: 34.69%
55-64 years: 5.81%
65 years and over: 6.56%

Net migration rate:
-17.9 migrant(s)/1,000 population

Urban population: 23.1%

Rural population: 76.9%

Rate of urbanization:
0.71% annual rate of change

Major urban areas:
Nuku'alofa, (capital city, Tongatapu): around 30,000.
Neiafu, (Vava'u): 4,320
Haveluloto, (Tongatapu): 3,417

B. Languages

Tongan and English (official languages).

Tongan spoken by 96.1% of the population.

English spoken by 88.1% and of the population.

1.7% speak other language

1.7%, none

C. Ethnic groups

Tongan: 97%

Part-Tongan: 0.8%

Other: 2.2%

D. Religion

Protestant: 64.1%

Mormon: 18.6%

Roman Catholic: 14.2%

Other: 2.4%

None: 0.5%

Unspecified: 0.1%

E. Education and Health

Literacy rate: 99.4% (can read and write Tongan and/or English)

School enrolment rates (6–14 year-olds): 97.8%

Population aged 15 and older with:
Secondary education: 74.6%
Tertiary education: 16.1%
Vocational/professional qualification: 9.6%

Health expenditures: 5.2% of GDP (2014)

Physicians density:
0.52 physicians/1,000 population (2013)

Hospital bed density:
2.6 beds/1,000 population (2010)

Obesity (adult prevalence rate): 48.2% (2016)

Major infectious diseases:
Active local transmission of Zika virus by Aedes species mosquitoes has been identified (as of August 2016).

F. Economy

Currency unit: Pa'anga (T$). 1 US$ = 2,28 T$

GDP (purchasing power parity): $591 million (2017 est.)

GDP - real growth rate: 2.5% (2017 est.)

GDP - per capita (PPP): $5,900 (2017 est.)

GDP - composition, by sector of origin: agriculture: 19.9%; industry: 20.3%; services: 59.8%

Labour force: 33,800 people

Unemployment rate: 1.1% (2011)

Population below poverty line: 22.5% (2010 est.)

Inflation rate (consumer prices): 7.4% (2017 est.)

Public debt: 34.1% of GDP (2015)

Distribution of family income - Gini index: 37.60 (2015)

Other information (CIA World Factbook):
Tonga has a reasonably sound basic infrastructure and well developed social services.
The country remains dependent on external aid and remittances from overseas Tongans (estimated at around 30% of GDP) to offset its trade deficit.
Agricultural exports, including fish, make up two-thirds of total exports.
Tourism is the second-largest source of hard currency earnings following remittances. (53,800 visitors in 2015).
Tonga must import a high proportion of its food, mainly from New Zealand.

G. Access to information

Telephones - fixed lines
10% of population (2016)

Telephones - mobile cellular
75% of population (2016)

Internet users
40% of population (2016)

Radio access
1 state-owned and 5 privately owned radio stations; Radio Australia broadcasts available via satellite.

A 2013 survey (excluding inhabitants of the most remote areas) revealed that radio is the most popular way to receive tropical cyclone (TC) broadcasts (93% of respondents), followed by TV (57%).

TV access
1 state-owned TV station and 3 privately owned TV stations. Satellite and cable TV services are available.

72% of Tongan households owned a television in 2008. (Tongan Statistics Department, 2008).

H. Transportation

Airports: 6 (1 with paved runway)

Roadways: 680 km (184 km paved)

Major seaports: Nuku'alofa, Neiafu, Pangai

To find out more

On sections 2.1. and 2.2.

Tongan Statistics Department
https://tonga.prism.spc.int/

CIA world factbook
https://www.cia.gov/library/publications/the-world-factbook/geos/tn.html

World Bank
https://data.worldbank.org/country/tonga

World database of protected areas
https://www.protectedplanet.net/country/TON

Unicef
https://www.unicef.org/infobycountry/Tonga_statistics.html

2.3. Natural hazards, environment and climate change impacts

Sources: Government of Tonga (2018), Reliefweb, OCHA, Preventionweb, Significant Earthquake Database NOAA-USA gov, Wikimedia, COP 23, Lewis (1982), Kennedy (1958)

A. Natural hazards

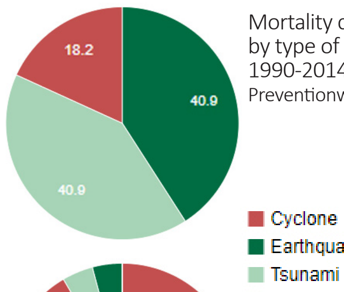
According to the 2018 World risk report, Tonga ranks as the the 2nd country most at risk of disaster only after Vanuatu. This study reveals levels of exposure to risk that are very high.

Natural hazards are mostly related to frequent cyclones with heavy winds, rain, and storm surge. The location of the country in the Pacific Ring of Fire where boundaries of tectonic plates meet is at the origin of volcanic activity- in the 1940s / 1950s eruptions almost emptied the islands of Nuiafo'ou and others, (Kennedy, 1958)- and of severe earthquakes and tsunami risks. Floods and droughts are also common.

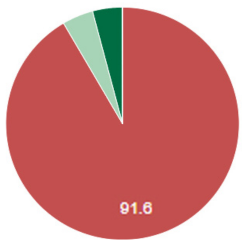
Attempts to discern consistent regional variations within the Tonga islands of the occurrence of cyclone and earthquake have been inconclusive (Lewis, 1982). Although there is periodically an emphasis of risk for one island sub-group or another, overall over longer time periods, no sub-regional allocation of specific risk has so far been made.

Tropical cyclone season: The tropical cyclone season currently runs from 1 November to 30 April, though tropical cyclones can form and affect Tonga outside of the season.

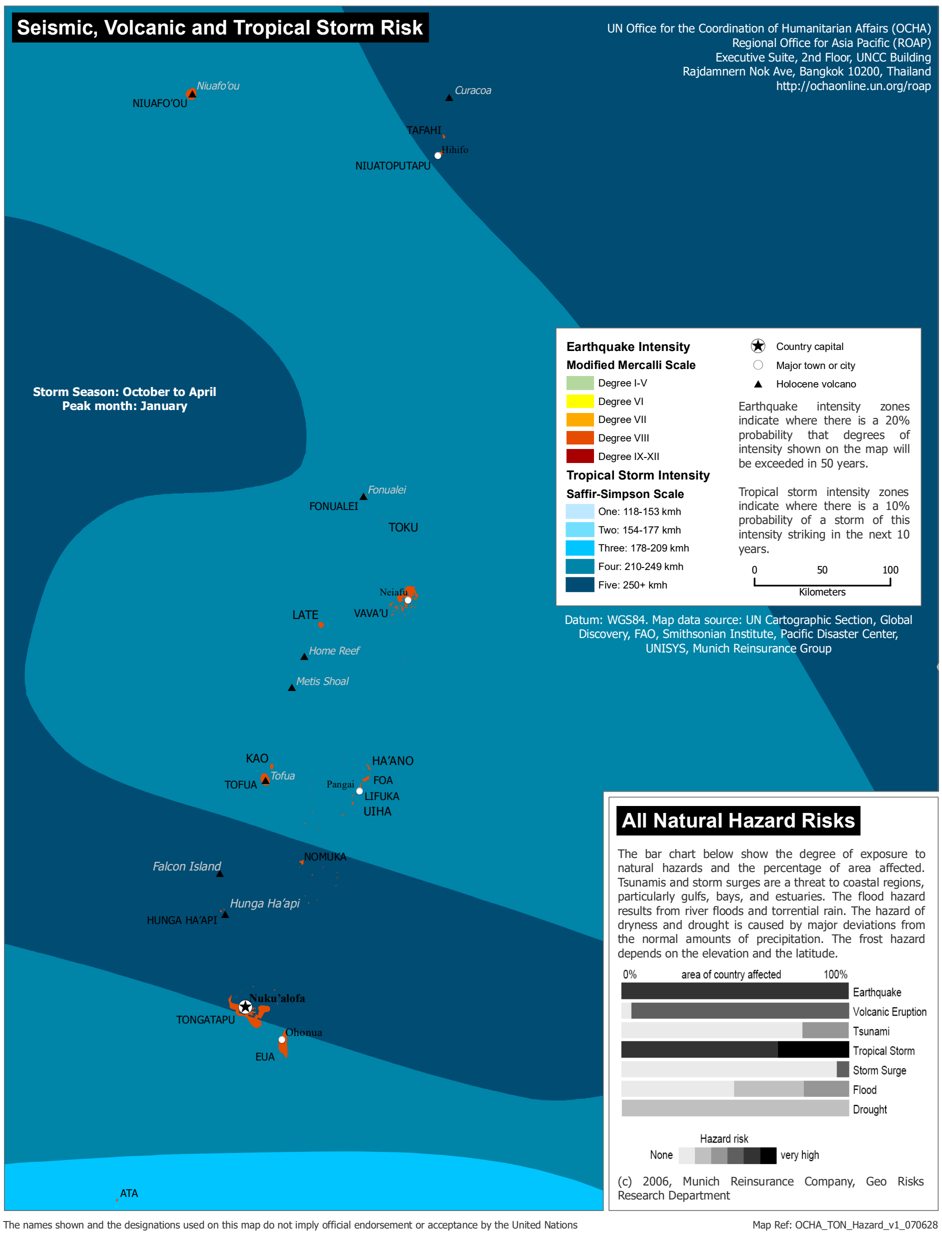
- ☑ Cyclones
- ☑ Earthquakes
- ☑ Floods
- ☑ Volcanism
- ☑ Tsunamis
- ☑ Droughts



Mortality caused by type of disaster 1990-2014. Preventionweb



Combined economic losses by type of disaster 1990-2014. Preventionweb



CC- UNOCHA Regional Office for Asia Pacific
Tonga : Natural Hazard Risks (2007)

To find out more

Reliefweb
https://reliefweb.int/disasters?country=233#content

World risk report 2018
https://weltrisikobericht.de/wp-content/uploads/2019/03/190318_WRR_2018_EN_RZonline_1.pdf

Global risk data platform
http://preview.grid.unep.ch/

Shelter cluster Tonga
https://www.sheltercluster.org/pacific/tonga

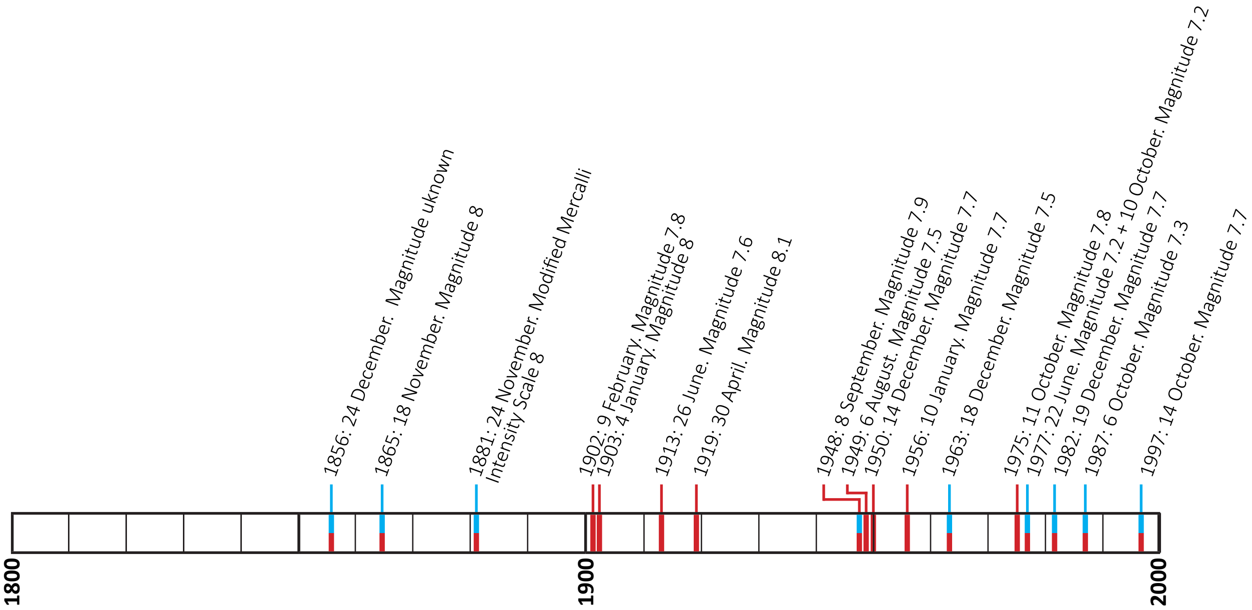
Humanitarian response
https://www.humanitarianresponse.info/fr/operations/tonga

UN OCHA
https://www.unocha.org/office-pacific-islands/tonga

COP 23
https://cop23.com.fj/tonga/

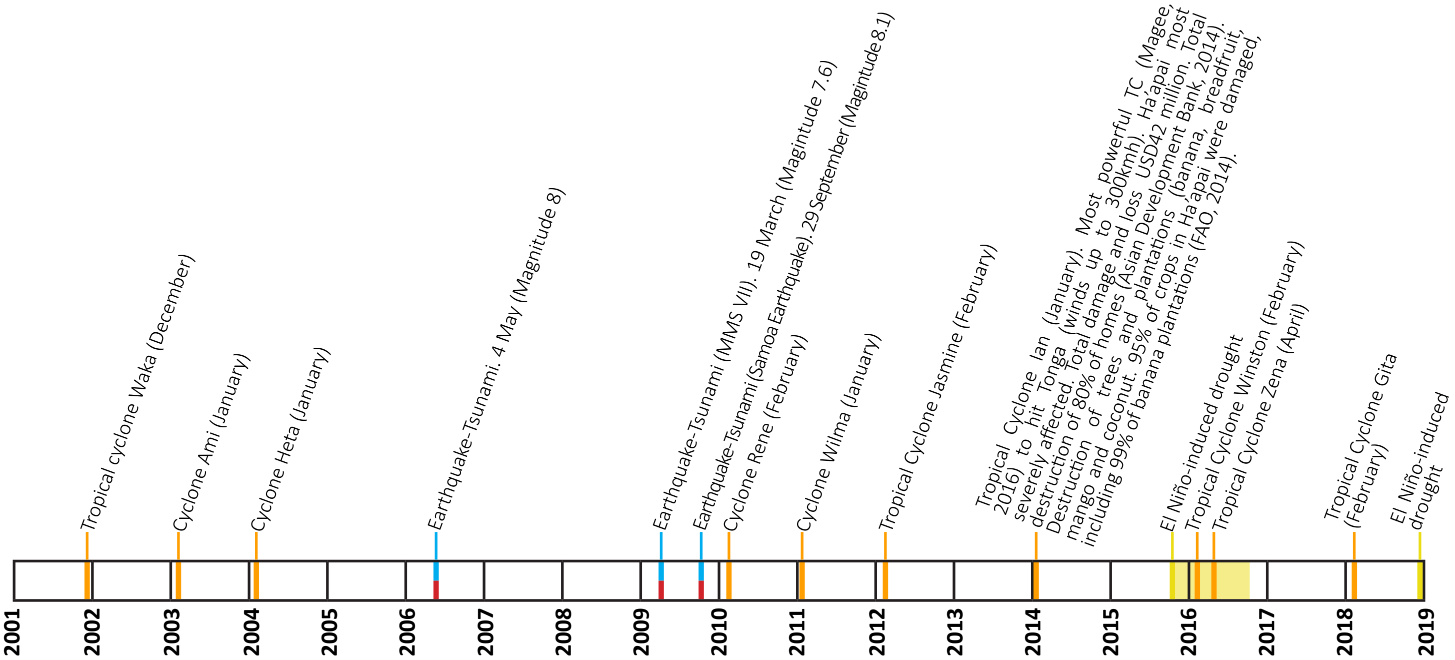
B. Timeline of registered earthquakes (before 21st century)

This timetable shows the impact of earthquakes in Tonga over the last two centuries, according to available data.



C. Timeline of natural disasters (21st century)

Within the first 18 years of the 21st century several natural hazards have affected Tonga: 10 cyclones, 2 droughts and 3 earthquakes with associated tsunamis.



LEGEND

- Cyclone, tropical storm or strong winds
- Drought
- Earthquake
- Tsunami

D. Climate change and environmental issues

Climate change impacts in Tonga are critical. The following are the main challenges faced by the country (COP 23):

- **Sea-level rise.** The sea level has risen 6 mm per year (above global average), threatening agriculture and settled areas. Most of Tonga's population is settled at sea level, while mountainous terrain is challenging to adapt for human habitation. Some Tongan communities have been forced to relocate to other islands as their settlements have been breached by rising seawater. This also necessitates routine rebuilding of roads and paths to lift them above the rising seawaters and more frequent storms and associated storm surge.
- **Warming and acidification of seas.** These aspects are threatening subsistence fishing as well as coral reef ecosystems.
- **Increased extreme rainfall.** More frequent and more extreme rainfall is expected to occur, threatening subsistence agriculture and human habitation.

In **response** to these threats, the Government of Tonga has approved the National Strategic Development Framework 2015-2025, which includes a Joint National Action Plan for Climate Change Adaptation and Disaster Risk Management, whose main goals are:

- strengthening integrated risk management to enhance climate and disaster resilience;
- lowering carbon emissions, and;
- strengthening disaster preparedness, response, and recovery.

Climate change impacts are critical in Tonga. CC- Jen Crothers

Houses in Tongatapu in flooded area. © IFRC

↓ The sea level is rising. House and coastline in an island in the Ha'apai group. © Caritas

2.4. Relevant social and cultural factors

Source: Evans (2001)

A. Social organisation principles in Tonga

Three principles inform exchanges in Tongan society in the household and beyond it (Evans, 2001): *'ofa* (love and generosity), *faka'apa'apa* (respect), and *fetokoni'aki* (mutual assistance). These conventions are central in Tongan social organisation, even though a certain freedom exists in how people act.

***'OFA*:** means love and generosity. For instance, the noble should have *'ofa* toward their people. Nobles can demand material goods from their people but should treat their people generously and fairly. A noble meeting *'ofa* demands things only occasionally, and only for specific events for which they are customarily entitled to get support from their people.

***FAKA'APA'APA*:** means respect. For example, as the brother/sister relationship was and is of central importance in kinship brothers have *faka'apa'apa* toward their sisters. This is expressed in a relationship of avoidance between brother and sister, and social deference of the brother to the sister. It is also expressed in ceremonies where gifts are offered from brother to sister. Sisters are *'eiki*, (higher rank), and are treated as such by their brothers. Nobles are also *'eiki* to the commoners so they are treated with *faka'apa'apa*, what means social deference and material provision of gifts.

***FETOKONI'AKI*:** means mutual assistance and generalized reciprocity. It is often part of the Tongan way of behaving or *angafakatonga*. So, it is often opposed to *angafakapalangi* (the European way) or *angafakapa'anga* (the way of money). All social ties should be expressed through it. Neighbours, fellow church members, friends, should practice it. To practice *fetokoni'aki*, is to show mutual *'ofa* (love and generosity). To fail to do so brings out pity and contempt.

B. *Famili, Káinga* and *'api*

***FAMILI*:** *Famili* is the most significant term within the Tongan kinship system (Evans, 2001). *Famili* is an action group which supplies members' households with goods or labour when needed. The *famili* is essentially a localized group, most of whose members live in the same place.

There are several meanings of the term:

- any nuclear family;
- the members of an individual's natal household;
- blood relatives, more correctly known as *káinga*;
- the totality of an individual's kin (blood relatives or not);
- members of the group of relatives with whom someone works most closely (in crafts or agricultural production, in preparation of special events, in cooking...), or to whom someone could ask for help (money or other needs).

***KÁINGA*:** The terms *káinga* and *famili* are different even if they overlap. Membership in the *káinga* is about genealogical relationships, while membership in the *famili* is defined by participation in its activities regardless of kin ties, even if they usually exist. Unlike the *famili*, whose members mostly live in the same place, *káinga* ties transcend local boundaries.

***'API*:** *'Api* is more or less equivalent to household. It refers to a group of people that live in the same residence, usually situated on a single town allotment, either in a single building, or in a clustered group of buildings. Relationships within an *'api* are characterised by common consumption (common cooking), and some elements of cooperative production. It is usually but not always headed by a man.

Even though *'api* does not directly mean nuclear or extended family, most of them do. Most *'api* are formed around primary kinship bonds, but may also include distant kins and non-relatives.

C. Communication habits

Any relevant information on how to adequately communicate in Tonga.

Further consultation in-country is recommended (Shelter Cluster Tonga).

3. Housing, land, preparedness, post-disaster and construction

3.1. Housing, land and property

Extracted from: Lawyers, A., Australian Red Cross & IFRC (2018), Evans (2011), McKay (2009)

A. Legislation and administration

Main laws for housing, land, building and planning are the following:

- Constitution,
- Land Act 1927,
- National Spatial Planning and Management Act 2012,
- Building Control and Standards Act 2002.

In Tongan legislation, land is classified as real property, while buildings are classified as chattels.

B. Legal tenure types

Tonga does not have a dual system of customary ownership and registered ownership. Land acquisition may be a long process and is not practical in the context of a disaster or crisis.

The most common types of tenure are:

Crown land: It is owned by the government.

Hereditary estate: It is a life interest held by a Noble (called *tofia*) or Chief (*matapule*) and passed down from father to son. Estates are not held by women.

Town allotment: It is a life interest held by a Tongan (rarely by women) and used for residential purposes. It is passed down from father to son. Normally located on a hereditary estate but may be located on Crown land.

Tax allotment: It is the same as town allotments but used for agriculture instead of residential purposes.

Lease: A lease may be granted over Crown land, hereditary estates or allotments. It may be transferred or sub-leased. Unlike allotments, it may be held by foreigners and it is more commonly held by women. The maximum duration is of 99 years for leases of hereditary estates and town allotments and of 20 years for leases of tax allotments (agriculture).

Sub-lease: It is similar to lease but it is not required to be registered if it is made for 3 years or less.

Permit: It is similar to leases but the landholder retains greater degree of control as permits cannot be transferred or sub-leased.

Tenancy agreement: It is a written agreement which may be registered (but is normally not). The majority of tenancy agreements are not legally enforceable. Some tenancy agreements are verbal.

Licence: It is a verbal permission to use land and/or housing. A licence is commonly granted to family or friends. It is not capable of being registered and it is very difficult to enforce, as it requires court case and evidence of landholder's conduct.

A man or woman can only be next in succession if they were born in wedlock.

To find out more

On section 3

Lawyers, A., IFRC/Australian Red Cross (2018)

Housing, Land and Property profile, Tonga

https://www.sheltercluster.org/sites/default/files/docs/2018_03_23_guidance_hlp_law_in_tonga.pdf

UNICEF (2011)

Monitoring resilience in Tonga

https://www.unicef.org/pacificislands/Tonga_Outcome_Edited_final.pdf

McKay, J. (2009)

Poverty Housing in the Developing Nations of the Pacific Islands

https://www.habitat.org/sites/default/files/ap_HFHAP_Pacific_Report.pdf

C. Informal access to land

There is a problem of lack of sufficient land in the country due to several factors (McKay, 2009):

- The growing population in urban areas generates social tensions because landlessness and land-poverty are increasing. In Nuku'alofa, land is limited and as a consequence informal settlements have been developed;
- There is land held by Tongans having migrated to other countries that is not used;
- Every male over 16 years old was traditionally entitled to 8.25 acres of agricultural land and a small allotment to build a house by the local noble. Nowadays, in many zones of the country (particularly in cities) there is not sufficient land to support this custom.

This lack of land creates the need of informal arrangements in order to gain access to land, such as (McKay, 2009):

- Many people enter into informal tenancy arrangements;
- People are forced to use farm-poor land, while fertile land is sometimes unused;
- Illegal sell/purchase of land.

Purchase of land: The purchase of land is strictly illegal (barred in the Land Act), but it exists even though there is no data about the extent of this practice. This market has increased particularly in Tongatapu (Evans, 2001), while in other areas it may be less common. In fact, "the flow of people into Tongatapu from elsewhere has created a situation in which increased pressure on land is accompanied by large numbers of individuals without the kinship connections to acquire land either permanently or temporarily" (Evans, 2001).

D. Eviction, expropriation and relocation

Eviction

There are no laws against forced evictions. However, case law establishes:

- a landowner cannot evict a licensee if they have promised the licensee that they would be able to use the land for a certain period;
- a landowner cannot evict a squatter who has unlawfully resided on their land for a period of 10 years or more;
- the Government is required to give consideration to the interests of squatters before granting leases or other interests over Crown land.

Expropriation

The Land Act allows the Government to acquire land for public purposes compensating landowner for their land, buildings and crops. The Crown must provide a landholder 30 days' notice and the landholder has a right to appeal in Court.

Relocation

As there is no legislation concerning relocation, relocations are developed on a case-by-case basis by the government in conjunction with funding agencies in the case of a disaster. In response to Tropical Cyclone Ian in 2014, the government developed a 'Resettlement Policy Framework' consistent with the World Bank's principles on involuntary settlement.

E. Women

Women cannot own estates and rarely own allotments. They do not have a legal entitlement to occupy the land but can hold leases. They commonly live on estates or allotments owned by their husbands or male family members, so they rely on the goodwill of men, informed by social norms and expectations.

The rules of succession for hereditary estates and titles are stated in the Constitution. The main rule is that the holder of a hereditary estate is succeeded by his eldest son. The eldest daughter can inherit if there are no sons or descendants of sons. If there are no daughters or descendants of daughters, the eldest brother or descendants succeeds to the hereditary estate, followed by the eldest sister and descendants. If a woman is next in succession, she is entitled to occupy the hereditary estate, but the estate and title will pass through her to the next male in succession. If there is no heir to succeed, the land reverts to the Crown.

Concerning allotments, there are some differences. If an allotment holder dies without leaving any male heir, an unmarried daughter of the holder will inherit a life estate in the allotment. If there are two or more unmarried daughters, they will inherit jointly. Upon the death of a male holder of an allotment, his widow will have a life estate in the allotment. Unlike a male, a widow who inherits an allotment cannot mortgage or lease it. An allotment may only be held by a male Tongan. To sum up, an allotment can be held by a man, but a woman can only have a life estate.

The life estate of a daughter or a widow terminates upon their marriage. Their life estate will also terminate upon proof in legal proceedings of her having committed fornication or adultery.

The number of women leasing land and/or housing is increasing, with approximately 20% of leases now held by women.

F. Vulnerable groups

Non-Tongans

Ethnic minorities (foreigners) can hold leases and permits, but they cannot hold estates or allotments. The main ethnic minority in Tonga is the Chinese, (2% of the urban population), whose members often have tenancy agreements, which are generally not legally enforceable.

Landless people

It is lawful to occupy land without the owner's permission until the owner starts formal eviction.

Informal settlers

As of March 2017, there are no longer any informal settlements in Tonga, as in 2015 the government legalised the last informal settlement in the capital city Nuku'alofa, named Patangata, by granting 30-year leases to the head of each family occupying the settlement.

3.2. Preparedness and post-disaster institutional strategies

Sources: National Emergency Management Office (NEMO), Shelter Cluster Tonga, Lewis (1982), Magee (2016)

A. Preparedness

Development and preparedness are key for the reduction of the effects of hazards and of the need for post-disaster assistance. Tongan authorities already started working on this line several decades ago.

In 1978, a project to recommend measures for disaster mitigation was undertaken by the Government of Tonga under the auspices of the Government of the UK (Lewis, 1982). The construction of small wharves, wells, water-catchment systems, and the provision of small boats, fishing equipment, generators, and local radios, started to be considered essential for the reduction of vulnerability to earthquakes and cyclones. Moreover, these small-scale projects were designed to be project managed and implemented through village and cooperative institutions.

B. The National Emergency Management Office (NEMO)

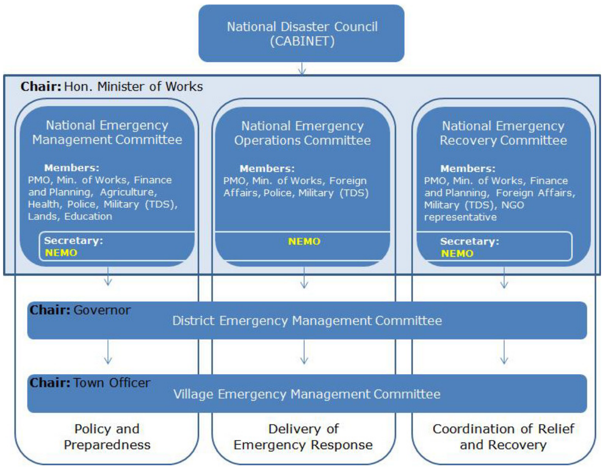
The National Emergency Management Office (NEMO) was established under the Emergency Management Act 2007, being responsible for the emergency management in the Kingdom of Tonga.

1. Vision : Safer and more resilient community to effects of natural hazards and climate change induced events.

2. Mission : To build a capacity of the Tongan community by developing and implementing appropriate and effective Disaster Risk Management policies, planning and program to address current and emerging threats from disasters.

3. Values

1. Putting the community first
2. A safer community for all
3. Sustainable disaster preparedness and disaster response program
4. Teamwork
5. Respecting and valuing each others contributions
6. Communicating openly and honestly
7. Accountable and transparent "modus operandi"



Structure of Disaster Management in Tonga. NEMO

C. Government laws and publications

Tongan government publications

- Emergency Management Act 2007. https://tonganemo.files.wordpress.com/2011/08/emergencymanagementact20071.pdf
- Joint National Action Plan on Climate Change Adaptation and Disaster Risk Management (2010-2015). https://tonganemo.files.wordpress.com/2011/08/tonga-joint-national-action-p-disaster-risk-management-1-3mb.pdf

National Emergency Management Committee publications

- National Emergency Management Plan. https://tonganemo.files.wordpress.com/2011/08/national-disaster-plan.pdf
- National Tsunami Plan Draft 2. https://tonganemo.files.wordpress.com/2011/08/tonga_national_tsunami_plan-2nd-draft.pdf
- Standard Operating Procedure for National Emergency Coordination Centre. https://tonganemo.files.wordpress.com/2011/08/sop-for-tonga-necc_-nov-09.pdf

National Emergency Management Office

- Disaster Assessment Manual. https://tonganemo.files.wordpress.com/2011/08/disaster-assessment-manual_dec-09.pdf

Communication before disasters

According to a 2013 survey cited by Maggie (2016) radio is the most popular way to receive tropical cyclone broadcasts (93%), followed by TV (57%). Broadcasting updates through radio provides a cost-effective, participatory method of communication and a necessity in delivering warnings. Other responses included tracking information on the internet (20%) or receiving text messages from mobile network providers (12%, majority of men).

These methods are dependent on having mobile signal, owning a mobile phone and access to electricity to charge it, and having network/internet access which may not be suited to the more rural outlying islands (not included in the survey). The majority of respondents (57%) reported they needed more Tropical Cyclones information to be better prepared and many mentioned that previous warnings often came at the wrong time, or came too late, preventing the necessary preparation. They mentioned the need to adapt the message to each village/community as their needs can vary, depending on geographical location and the available services.

D. Key messages for Building Back Safer (Shelter Cluster Tonga)

Designed for the Philippines, but also applicable to many parts of the Pacific, the 8 Build Back Safer Key Messages were developed through a consultative process with shelter agencies and government as a part of the Typhoon Haiyan / Yolanda response in the Philippines and can be seen as a minimum checklist of disaster risk reduction construction techniques for owner-driven self-recovery in non-engineered, non-architecturally designed lightweight structures that most shelter agencies were dealing with.

The primary goal of the 8 Build Back Safer Key Messages was to ensure common understanding amongst shelter cluster members around simple accessible advice to families on how they can improve their makeshift shelter or simple home no matter how minimal their budget. Rather than promoting a one-off perfect solution that is simply unaffordable for most of the affected population, the messages provide advice for the owner driven incremental approach that the majority of the affected community is engaged in.

To find out more

National Emergency Management Office

https://tonganemo.wordpress.com/

Shelter Cluster Tonga

https://www.sheltercluster.org/pacific/tonga

Government of Tonga (2018)

Post Disaster Rapid Assessment Tropical Cyclone Gita // February 2, 2018

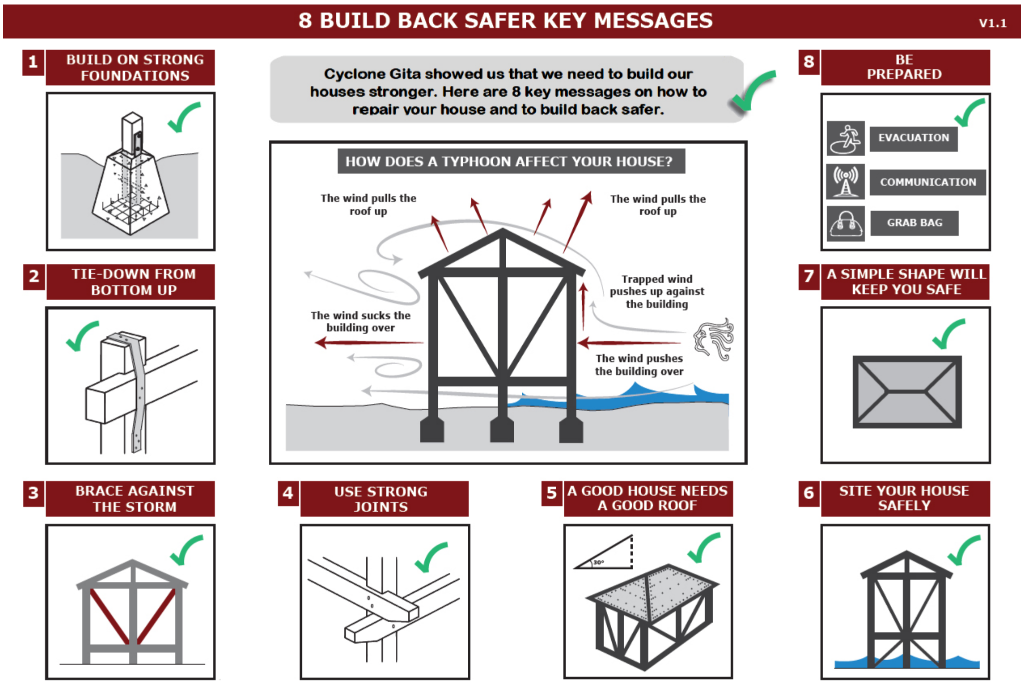
https://www.preventionweb.net/publications/view/59594

These key messages were translated into Tongan and introduced in Tonga during the 2018 TC Gita response.

Currently, key messages are not available for masonry construction, but given that concrete is a common material in Tonga, many households would benefit from such guidance.

For best results, these messages should be delivered to householders by construction trainers, using physical models, or through the construction of model houses in their communities.

1. **Build on adapted foundations/wall bases**. They are very important as they anchor a house to the ground. Foundations/wall bases systems adapted to the building's structure and ground conditions is paramount for durability and for protecting a house from humidity, specifically in case of flooding prone areas.
2. **Tie-down from bottom up**. In a typhoon a house can be sucked apart or blown away by the wind so it is necessary to tie every part of the building right through to the ground.
3. **Brace against the storm**. Strong bracing stops a house being pushed over or pulled apart by the wind. Bracing needs to be strong against being crushed along its length or pulled apart. Brace shall be done between the strong points of a house.
4. **Use strong joints**. A house is only as strong as the weakest joint. Every joint should be built so it can't be pushed or pulled apart.
5. **A good house needs a good roof**. The way of designing and building a roof is critical to protect a house against strong winds and rain. Build a roof the right shape and pitch, and well nail down.
6. **Site the house safely**. Identify the hazards in a given location and build in protected zones where their potential effects are inexistent or are less powerful.
7. **A simple shape will help keep safe**. The shape of a house is important to reduce damage in strong winds or earthquakes. Often simple designs (compact and symmetrical) present advantages.
8. **Be prepared**. Preparedness is critical because it is the main way to reduce the impacts of a disaster. Thus, it is important to start taking actions and prepare before the hazard comes, rather than having to react in a post disaster situation.



Shelter Cluster Tonga
ShelterCluster.org
Coordinating Humanitarian Shelter

Shelter Cluster Tonga (2018)

Sources: Tonga Shelter Cluster, Government of Tonga

3.3. Organisations involved in shelter, housing and disaster preparedness

National authorities

Ministry of Meteorological, Environment, Information, Disaster Management, Energy, Climate Change and Communication

- National Emergency Management Office https://tonganemo.wordpress.com/ : Its mission is to build a capacity of the Tongan community by developing and implementing appropriate and effective Disaster Risk Management policies, planning and program to address current and emerging threats from disasters.

  It is responsible for the coordination of the Emergency Shelter and Non-Food Items Cluster. https://www.sheltercluster.org/pacific/tonga

National Emergency Operations Committee

It is responsible for coordinating the response in the event of a disaster. It is supported by:

- District Emergency Management Committees (DEMC) There is a DEMC for each of the five districts: Ha'apai, Vava'u, Niuatoputapu, Niuafo'ou and 'Eua.
- Village Emergency Committees (VEC).

Ministry of Lands, Survey and Natural Resources

It is responsible for land administration.

- National Spatial Planning Authority: responsible for administering planning law.

Ministry of Infrastructure http://infrastructure.gov.to/

It is responsible for the coordination of the Reconstruction Cluster.

Ministry of Agriculture, Forestry, Food & Fisheries

International Organisations in Tonga

- International Federation of the Red Cross and Red Crescent Societies. IFRC does not maintain a presence in Tonga, but supported NEMO as co-lead of the Emergency Shelter and Non-Food Items Cluster.
- UNDP. http://www.pacific.undp.org/content/pacific/en/home/countryinfo/tonga.html

Universities & training centres

- Tonga Institute of Science and Technology. https://tist.to/
- Tupou Tertiary Institute. http://www.tti.to/index.php
- Unuaki-'o-Tonga Royal University of Technology
- Tonga Maritime Polytechnic Institute

Main agencies and NGOs with shelter actions

- Tonga Red Cross Society. https://www.facebook.com/tongaredcross/ - https://www.ifrc.org/en/what-we-do/where-we-work/asia-pacific/tonga-red-cross-society/
- Church of the Latter Day Saints (LDS) Tonga.. https://pacific.lds.org/to
- MORDI Tonga. https://www.morditonga.to/
- Caritas Tonga. https://caritas.org.nz/where-we-work/pacific/tonga
- Salvation Army. https://www.salvationarmy.org.nz/centres/tonga
- OXFAM. https://www.oxfam.org/en/countries/tonga
- Tonga National Youth Council (TNYC). http://www.pacificyouthcouncil.org/tonga.php
- ADRA. https://adra.org/
- Live and learn. https://livelearn.org/projects/wash-recovery-resilience-tonga
- Tonga Community Development Trust - (TCDT). https://www.tcdt.to/index.html
- Tonga National Council of Churches (TNCC). https://www.oikoumene.org/en/member-churches/pacific/tonga/tncc
- Habitat for Humanity does not maintain a presence in Tonga but supports Caritas Tonga. https://www.habitat.org/where-we-build/asia-pacific
- CARE does not maintain a presence in Tonga but supports MORDI and Live and Learn. https://www.care.org.au

COMPLETE THIS LIST WITH OTHER ORGANISATIONS. MODIFY THE LIST IF IT IS NOT RELEVANT

Construction of a *fale afa* house. © Shelter Cluster Tonga

3.4. Construction sector

Sources: Charmaine (2013), Government of Tonga (2002)

A. Social aspects of the construction process

CONSTRUCTION

According to Charmaine (2013), construction in Tonga is owner-driven and based on one's ability to find funds and materials, to transform ideas and aspirations into a house, and to obtain support from relatives and labourers.

Construction in Tonga is a social process that begins with a first discussion between owner and builder. Next the owner will spend the necessary time to find the capital and the labour usually in his/her own community. The owner will also begin to search for building materials, which s/he will obtain either from the island of Tongatapu, from overseas (remittance of building materials from kins), or to a lesser extent from locally available resources. The materials are gathered little by little in the construction site (Charmaine, 2013).

Once all materials have been carried to the site, the design phase will start, involving the owner, the builder and the labourers. This design depends on the possibilities of assemblage of the available materials. Until recent times no architectural professionals were involved, and builders addressed design and structural questions as the project proceeded (Charmaine, 2013).

Further consultation in-country is recommended (Shelter Cluster Tonga).

MAINTENANCE

Maintenance in Tonga has a broad definition including general cleaning, repair, and refurbishment; but also and particularly the extensions to an original house due to new needs of the family (Charmaine, 2013).

Further consultation in-country is recommended (Shelter Cluster Tonga).

B. Seasonal patterns and construction

Further consultation in-country is recommended (Shelter Cluster Tonga).

Timber framed construction with CGI roofing is quite feasible in the rainy season, but precautions should be taken with site management and securing of materials in case of sudden strong winds.

C. Units of measurement

Further consultation in-country is recommended (Shelter Cluster Tonga).

Reconstruction of a house after Cyclone Gita. © Tonga Red Cross

Wood for construction. © Shelter Cluster Tonga

Construction of a *fale afa*. © Shelter Cluster Tonga

Repair works on a school on 'Eua island. © Shelter Cluster Tonga

3. Housing, land, preparedness, post-disaster and construction

D. Regulations in the construction sector

The construction sector is legislated in Tonga by the following regulations:

BUILDING CONTROL AND STANDARDS ACT (2002)

Extracts from the Act:

Buildings concerned by the Act:

Any temporary or permanent building in the entire country (or having the function of a building) regardless of whether it is temporary or permanent, movable or immovable is concerned by the Act.

Any structure associated with the building is also concerned by the Act. This includes but is not limited to:

- retaining walls more than 1.5 metres high;
- fences and free standing walls more than 2 metres high;
- masts more than 6 metres high;
- tanks of 5000 l or more capacity on the ground and tanks of any size if above ground and their supporting structures;
- grandstands;
- septic tanks, and other such treatment facilities; and
- earthwork;

Erection of a building includes:

- new constructions;
- re-erection of a building;
- reconditioning of a building;
- making of any structural alteration, addition or repair to a building excluding non-structural maintenance work; and
- removal either in part or in whole of a building from one place to another;

Building Controller:

There shall be a Building Controller who shall be the Director of Works and shall be responsible for:

- issuing all permits for buildings as prescribed by Regulations;
- advising the Authority as to the practicality and range of the Code and projected Regulations made under this Act;
- reporting to the Authority on the operation of the Regulations and Code; and
- examining applications received by the Division (Government) for exemptions from specific provisions of the Code.

Building Permits:

Every person intending to erect a building shall first obtain a building permit from the Building Controller as prescribed by the Regulations. The Building Controller shall require the payment of a prescribed fee before issuing a building permit.

Exemptions from building permits:

A building permit shall not be required for the following:

- traditional Tongan buildings limited to a plan area of not more than 25 m², and substantially using traditional methods and materials of construction;
- any scaffolding, false work, timbering or other temporary construction work in respect of building maintenance;
- any tent or marquee not exceeding 360 square metres in plan area;
- a mast, pole or radio or television aerial, that does not exceed 6 m in height;
- a caravan, vehicle or chattel whether fixed or movable when used at a site for not more than 30 days during any 6 months; and
- minor repairs whether structural or otherwise.

TO FIND OUT MORE

Government of Tonga (2002)

Building Control and Standards Act

http://www.paclii.org/to/legis/num_act/bcasa2002288.rtf

Various buildings throughout the country.

CC- Jen Crothers

Stop-work notice:

When any person is erecting or has erected any construction without the required building permit or in breach of the Code or any building permit, the Building Controller shall issue a stop-work notice.

Notice of Compliance:

A notice of compliance requiring a person to comply with this Act may be issued by the Building Controller where a person has constructed contrary to the provisions of this Act or omitted to construct in accordance with this Act.

Demolition:

- The Building Controller shall issue in writing a notice to demolish any construction which has been erected subsequently to the operation of this Act without the required building permit. The Building Controller may require the demolition of any construction erected before or after the operation of this Act if in his opinion it constitutes a public danger.
- A person who receives a notice of demolition shall demolish such construction within the period specified in the notice.
- The Building Controller may demolish the construction if a person who receives a notice under subsection of demolition does not demolish the construction within the period specified in such notice. The cost of any demolition carried out by the Building Controller shall be paid to the Division by the person served with a notice.

BUILDING CODE REGULATIONS (2007)

According to the Government of Tonga, the Code is omitted in the online revised edition because of its size and incompatible bi-lingual presentation. Copies of the Code may be purchased from the Ministry administering the Code.

Further consultation in-country is recommended (Shelter Cluster Tonga). What about the building code regulations? Are they available? Existence of other regulations? Are they applied?

Various buildings throughout the country.

4. Description of local habitat

4.1. Households description and access to housing

Sources: UNICEF (2011), Lawyers, A., Australian Red Cross & IFRC (2018), Asian Development Bank, FAO, UNDP, World Bank, McKay (2009), Secretariat of the Pacific Community & Tonga Department of Statistics (2014), Evans (2001), Government of Tonga (2018), The World Factbook, Charmaine (2013)

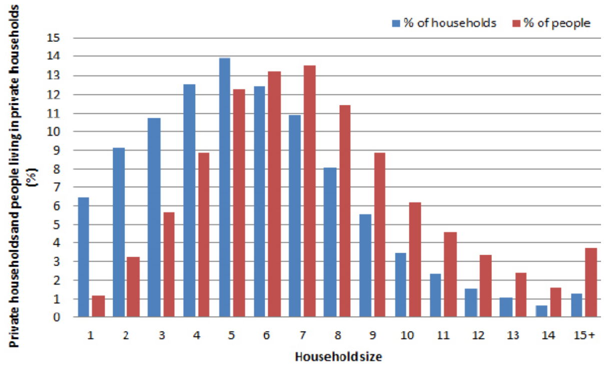
A. Household composition

The number of private households in 2011 was 18,033. 101,969 people lived in private households, while 1,074 people lived in 73 non-private households or institutions.

Most heads of households (78%) in Tonga were men (13,982) with 22% (4,051) being women.

The average household size was 5.7 people. The most common household size was 5 (14% of the households), while the highest proportion of all people lived in households with 7 people (13.5% of the people). 22% of the population lived in households of 10 or more people, and almost 4% of the population lived in households of 15 or more people. Just over 1% of the population lived in single person households.

Household members: 69% nuclear family (couple plus children); 15% adopted children or grandchildren of the household head; 11% other relatives; less than 2% non-relative.



Distribution of households and population living in private households, by household size (2011). SPC & Tonga SA (2014)

B. Overview of the economic situation at household-level

In 2015, 22.1% of the population lived below the national poverty line, compared to 22.5% in 2009, and 16.2% in 2001.

With reference to the international poverty line, in 2009 (most recent data), only 1.1% of the population lived with less than 1.90 US dollars, while 8.9% lived with less than 3.20 US dollars and 31.9% with less than 5.50 US dollars.

The Gini index (0 representing total equality and 100 total inequality) in the country is also stable. It was 37.50 in 2009, and 37.60 in 2015. The country ranks 81st out of 166 countries in terms of equality.

In 2018, with a Human Development Index (HDI) of 0.726 (high human development), the country ranked 98th out of the 189 countries measured.

According to the UNICEF (2011), meeting the basic needs was not a major concern for Tongans in the past thanks to remittances and help from both the extended family and community network. Nowadays, the increasing monetisation is giving rise to economic difficulties for many families who struggle to meet daily needs, particularly cash requirements. This need of cash is present even in remote villages and outer islands (‘Eua, Ha’apai, the Niuas and the outlying islands of Vava’u) for school fees, utilities, essential store goods, or social or church obligations.

Poverty in Tonga is mainly seen in rural areas, but the migration from the outer islands to urban and crowded conditions in Tongatapu is a phenomenon that is growing and increasing urban poverty. People are moving away from the security of the mutual support that they would have in their home islands.

Ha’apai island group is the least developed division, having a GDP of about 40% below the country average. In these groups of small islands, access to basic goods and services, marketing opportunities and movement of small boats between islands are limited. In Vava’u island group, people have to bear the additional costs of transporting produce to and from Tongatapu.

View of a street in the capital city of Nuku’alofa, Tongatapu. CC- Jircas

Fale afa house in Tongatapu. © Shelter Cluster Tonga

REGION	POOR HOUSEHOLDS (%)	TOTAL HOUSEHOLDS	HOUSEHOLDS LIVING BELOW THE POVERTY LINE 2015/16
Tongatapu	16	13,096	2,095
Nuku’alofa	14	4,175	585
Rest of Tongatapu	17	8,921	1,517
Other Islands	47	5,102	2,398
NATIONAL AVERAGE	25	18,198	4,550

Poor households in Tonga. Government of Tonga (2018)

C. Access to housing

Remittances from relatives working and living overseas and *toli* (wages earned by Tongans working overseas seasonally) are the most effective way to access large amounts of money quickly to build a house in Tonga (Charmaine, 2013). Families who do not have these links or opportunities face disadvantage in housing access as they often self-build with non-quality materials or take longer to build, first attaining education and securing local employment and bank loans. According to Charmaine, this last option is very challenging.

According to Charmaine (2013) monetised and more customary forms of economy are blended and influence the form and fabric of houses. There are several economic activities that contribute to the production and maintenance of domestic housing in Tonga:

- Remittances: money and/or materials sent from overseas by relatives.
- *Toli*: seasonal work migration for Tongans who are unable to gain a permanent work permit. The money earned abroad represents a considerable amount In Tonga and it is sometimes used for building purposes.
- *Fale koloa*: it is a small store positioned at the front of the main house.
- *Koloa* making: the business of *koloa* making comprises of several textile work and it works usually in a collective of three or more women. This economic activity brings together subsistence, market activities and remittances and is motivated by textile exchanges.
- Selling agricultural crops.
- *Puaka*: rearing and selling of pigs.
- Bank loans.
- Foreign aid.
- Local employment.
- Community work, often through the church.

Some new financial products are emerging locally, such as bank loans for low-cost housing. Further research needed on this subject is needed.

Further consultation in-country is recommended (Shelter Cluster Tonga).

Street market. CC- Jen Crothers

Pigs breeding for selling or *puaka*. CC- Jircas

D. Notions of costs for low-cost housing

1 US$ = 2,28 T$ Pa'anga (May 2019)

In 2009, about 23% of the households in the country lived in "poverty housing" (McKey, 2009) because of the lack of affordable housing for low-income households and for migrants from other islands.

Further consultation in-country is recommended (Shelter Cluster Tonga).

E. Available budget for housing

It is difficult to estimate the available household budget for housing.

A study about the cost of living in Nuku'alofa (expatistan.com) states that a monthly rent for a 45 m² furnished studio in a so called "normal" area (non-expensive) costs 1,000 Pa'anga (437,6 US$). The same source states that in the same area the monthly rent for a 85 m² furnished apartment would cost 2,000 Pa'anga (875,2 US$).

Taking into account that the average household size in Tonga is 5.7 members and that about 32% of the population live with less than 5.5 US$ per day, an average family of 5.7 members living with 5.5 US$ per day would have 940,5 US$ a month. This means that the cost of renting a small apartment of 45 m² would count for almost half of the monthly income and the cost of an 85 m² apartment for almost the total available budget for the month.

Further consultation in-country is recommended (Shelter Cluster Tonga).

4.2. Access to water, sanitation and other services

Source: Secretariat of the Pacific Community & Tonga Department of Statistics (2014), CIA World Factbook, EVANS (2001)

WATER

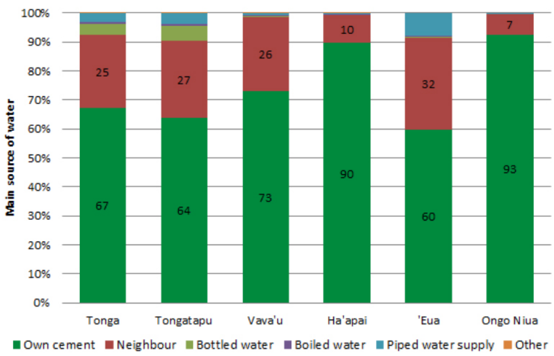
According to Lewis (1982), most of the Tonga islands are atolls of insufficient height above sea level to contain fresh water lenses. Conversely, those islands which are raised to higher elevations have hitherto resisted the drilling of wells due to their height and hardness of rock structure. Potable water supplies have invariably been from roof catchment collection and storage tanks of cisterns on and in the ground.

Improved drinking water source (2015)**:**
Urban: 99.7% of population / Rural: 99.6% of population

Private households by drinking water source (2011):
67% cement tank for drinking water; 25% from a neighbour; 4% bottled water (only significant in Tongatapu); 3% piped water.

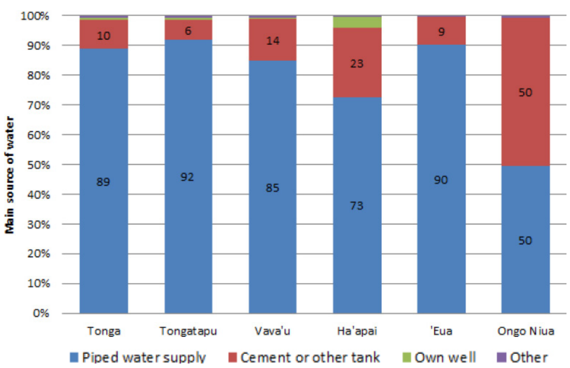
Private households by water source apart from drinking (2011):
89% piped water; 10% cement or other tank.

Water supply is an issue in the islands. Harvesting of rain water is the main source of water for drinking. © Caritas



Proportion of private households by division and the main source of **drinking water** in 2011.
SPC & Tonga SA (2014)

Watter tank from AusAID in a house in Nuku'alofa.
CC- Connor Ashleigh- AusAID



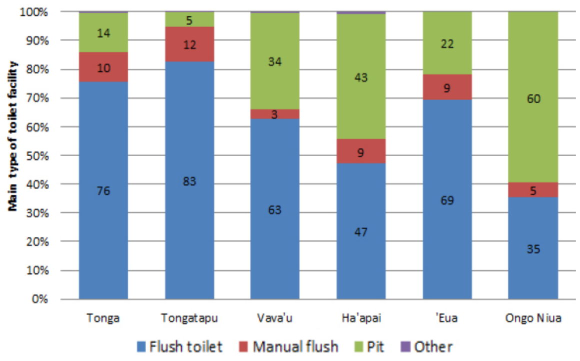
Proportion of private households by division and the main source of **water apart from drinking** in 2011.
SPC & Tonga SA (2014)

Community water tank in Ha'apai. © Caritas

SANITATION

Improved sanitation facility access (2015)**:**
Urban: 97.6% of population / Rural: 89% of population

Private households by main toilet facility (2011):
76% flush toilets; 10% manual flush; 14% pit.



Proportion of private households by division and main **toilet facility** in 2011.
SPC & Tonga SA (2014)

Toilet facility. CC- You never try you never know

ELECTRICITY

Access to electricity (2012)**:**
Urban: 100% of population / Rural: 83% of population

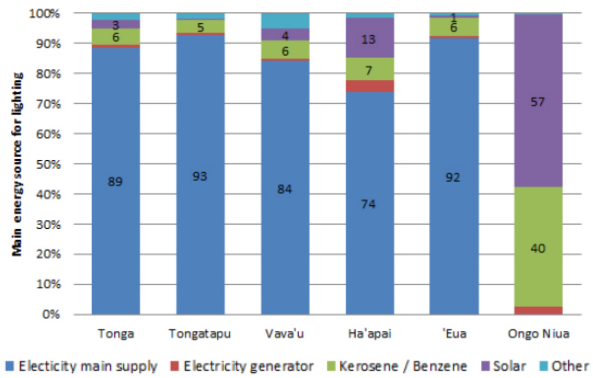
Private households by main energy source (2011):
89% electricity main supply; 6% kerosene/benzene; 3% solar.

FUEL FOR COOKING

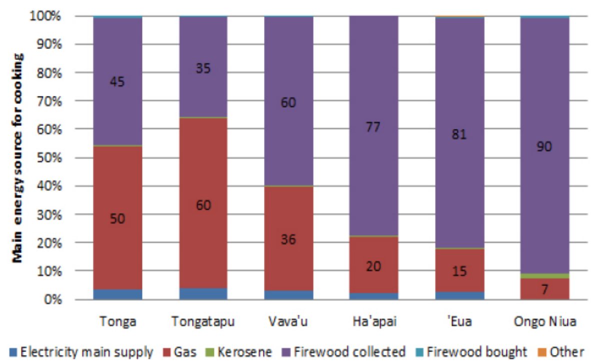
50% gas; 45% firewood collected; followed by electricity main supply, kerosene and bought firewood.

MAIN MODE OF WASTE DISPOSAL

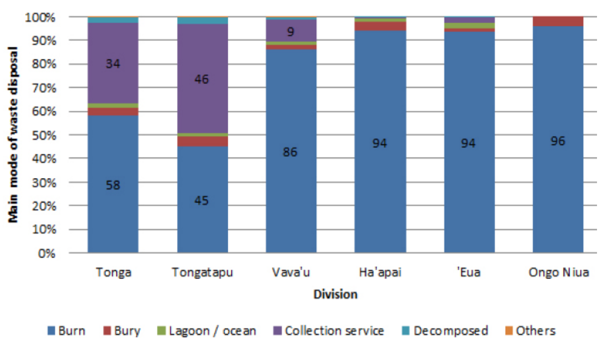
58% burning; 34% commercial collection; followed by buried, lagoon/ ocean or decomposed.



Proportion of private households by division and the main source of **electricity** in 2011. SPC & Tonga SA (2014)



Proportion of private households by division and the main source of **fuel for cooking** in 2011.
SPC & Tonga SA (2014)



Proportion of private households by division and the main **mode of waste disposal** in 2011.
SPC & Tonga SA (2014)

4.3. Available construction materials

A. Use of materials

SITUATION AROUND 1958

The materials used for the construction of houses have greatly varied over the last decades.

According to Kennedy (1958) in 1958, the majority of the houses were built with thatch for both walls and roof in four out of the five divisions of Tonga (with the lowest proportion of 29% in Vava'u, and the highest of 68.5% in 'Eua). Thatch was also used for walls or roofs in 6% to 18% of the houses (with iron or wood in the other parts of the building). Wood or iron walls and iron roofs were used in about half of the houses in both European and Tongan styles.

PRESENT SITUATION

Today, the vast majority of external walls in the country are constructed using timber and concrete blocks. CGI sheets roofs dominate in the islands. Concrete or timber floors are present in almost all houses.

Thatch

Today, thatch has almost disappeared in housing construction. Only a small proportion of external walls and roofs are built with this material. These households are mainly concentrated in Ongo Niua and Ha'apai.

Timber

The percentage of private households with timber floors in their dwelling declined from 23% in 2006 to 20% in the 2011 census. The proportion of private households occupying dwellings with timber floors ranged between 34% in Vava'u and 12% in 'Eua.

The use of timber for external walls has decreased between the 2006 and 2011 censuses (from 65% to 61% of the households). This trend occurs in all divisions except for Ongo Niua, where concrete block and metal sheet clad external walls have been replaced with timber clad during reconstruction of dwellings damaged in the 2009 tsunami. In Ha'apai, 81% of the households lived in dwellings with external timber walls, compared to 50% on 'Eua.

Today, timber is prevalent in walls and roofs, but is a limited resource in Tonga. The loss of native timbers has led also to a loss of traditional construction technologies, skills and knowledge. This includes knowledge on selection of timbers for particular parts of the building (structural and non-structural, etc) and how they must be detailed to minimise potential decay and resist the forces of nature. The limited forest resources consist of (Nona, 2016):

- Natural hardwood forests. They can only supply a small and decreasing part of the domestic timber demand because of over-exploitation and depletion by clearing for shifting cultivation. It is estimated that only 4,000 acres (around 16.2 km²) remain of natural hardwood forests. It has been proposed these remaining forests be categorised as national parks due to their biological diversity.
- Exotic plantation forests and coconut plantations. Extensive coconut plantations are the largest timber resource and will continue to be the major source of domestic timber production.

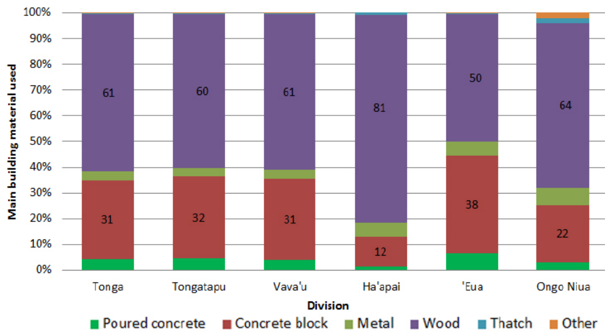
Source: Secretariat of the Pacific Community & Tonga Department of Statistics (2014), Government of Tonga

Building Materials: Tongan Houses*

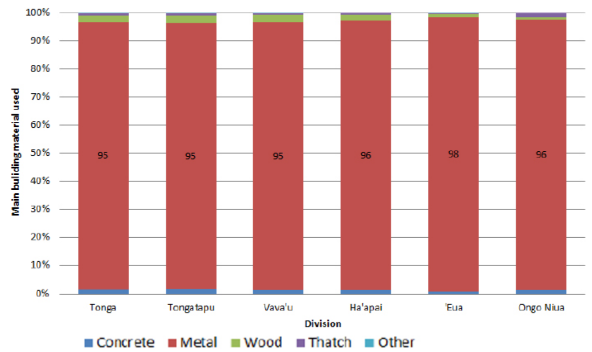
	Tongatapu	Vava'u	Ha'apai	'Eua	Nuiatoputapu
Wood; Iron Roof (European Style)	30	48.5	31.7	11	13.3
Thatched Walls and Roof	44.6	29	37	68.5	66.6
Thatched Walls; Iron Roof	2.4	3.1	8.9	6.4	1.2
Wood or Iron Walls; Thatched Roof	13.6	3.4	3.4	9.3	16.7
Wood or Iron Walls; Iron Roof (Tongan Shape)	9.4	16	19	4.8	2.5

* Percentage numbers of houses on each island

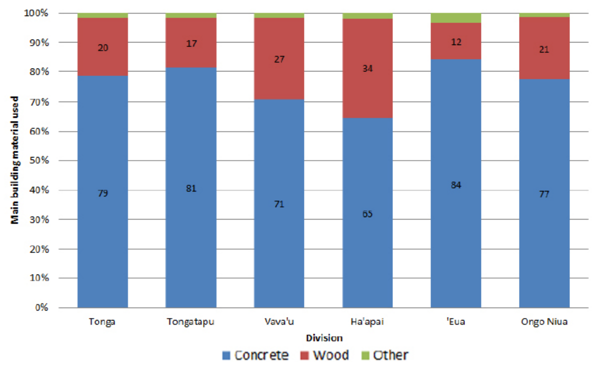
Proportion of houses by division and construction materials circa 1958. Kennedy (1958)



Proportion of private households by division and the main type of material used for the **outside walls** of dwellings in 2011. SPC & Tonga DS (2014)



Proportion of private households by division and the main type of material used for the **roofs** of dwellings in 2011. SPC & Tonga DS (2014)



Proportion of private households by division and the main type of material used for the **floors** of dwellings in 2011. SPC & Tonga DS (2014)

During tropical cyclones, lots of trees fall due to strong winds, what often represents a high potential for reconstruction purposes. Selection is paramount for ensuring that adapted species are chosen and valorised in useful sections.

Is this done in Tonga or is it feasible? Further consultation in-country is recommended.

Bamboo

No information found. Further consultation in-country is recommended (Shelter Cluster Tonga).

Stone

It is not a commonly used material nowadays, apart from aggregates for concrete.

Not much information found. Further consultation in-country is recommended (Shelter Cluster Tonga).

Concrete

Since 2006, the percentage of private households occupying dwellings with concrete floors increased by 3% so that by 2011 to 79% of all private households in Tonga.

Between the 2006 and 2011 censuses, concrete blocks increased as a material used for external walls (from 27% to 31% of the households) compared to 12% in Ha'apai and 38% on 'Eua.

Today, Tonga has local quarries specialising in the manufacture of concrete blocks, thus meeting the demand for this growing market. Concrete-block construction relies on local sand and aggregates, which are non-renewable (Charmaine, 2014).

Metal (CGI)

Between the 2006 and 2011 censuses, the percentage of private households occupying dwellings with metal roofs increased from 93% to 95%. Metallic roofs count for more than 95% in all the divisions.

Metal is also used for walls cladding (about 5% of the households) and for structure in some cases, particularly in some verandas.

REMITTANCES OF INDUSTRIAL MATERIALS FROM OVERSEAS

Charmaine (2013) states that sometimes cement and reinforcing steel is sent to Tonga from overseas relatives to help the family build a house. Other materials sent from overseas include corrugated metal sheets for roofing, timber, and doors and windows including hardware.

Farmer's house with a mix of materials near Nuku'alofa (Tongatapu). CC- Jircas

House with corrugated (CGI) roof sheeting and wall cladding in Vava'u. CC- clr_flickr

House built with concrete blocks in Tongatapu. CC- Leo Gaggl

Houses with mix of materials and typologies in Niuatoputapu Island. © sailblogs

B. Pressure on building materials

The projected increase in per capita income is expected to alter the mix of housing types with more and more families being able to afford a house built with industrial materials. Therefore it is predicted that the demand for concrete blocks and reinforced concrete structures in the coming years will increase dramatically. This may alleviate the deforestation issue, but will exacerbate the impacts of sand mining such as riverbank erosion and the dependence on international markets.

After a disaster, rebuilding efforts generally increase the rate of resource extraction for building materials. This degrades the environment and increases risk with greater erosion, deforestation, landslides and floods. This may also deprive communities of essential livelihood resources and put people, infrastructure, and ecosystems at greater risk of future disasters (WWF, 2018).

Wooden structures require large quantities of wood, and this can have a significant impact on the local environment, exacerbating existing deforestation problems.

C. Commonly used materials: impacts, benefits and best practices

Source: Most of the content has been contextualised for Tonga adapted from WWF, 2016:
Environmental Guide To Selection Of Common Building Materials.

MATERIAL	IMPACTS	BENEFITS	BETTER PRACTICES
THATCH	• Even if almost not anymore used in the country, natural or farmed vegetation might be used in thatching. Without proper management, negative impact on forests and natural vegetation may occur. • Household or small-scale industrial material. • Material needs seasoning. • Many types of thatch are a bi-product of agriculture (coconut leaves etc) so would go to waste if not used for thatching or animal feed. • Has a limited lifespan, due to its susceptibility to rot and insect infestation, but certainly local methods to increase its lifespan may exist (e.g. smoking by indoor fire).	• No requirement for quarried materials. • No firewood or energy requirement. • Can support indigenous livelihoods and valorise local knowledge. • Does not harm the environment since it is biodegradable. • It may contribute to local economy, through livelihoods for local communities. • Thermal comfort.	• Use local knowledge where still available. • Use basic building designs. • Support local livelihoods and industries. • Consider fire risk in planning and design since thatch is combustible.
TIMBER	• Extraction can cause forest destruction, landslides, land degradation, and habitat destruction and can increase flood risk, flash flooding and droughts and a downward spiral of increased hardship. • Transport can further damage forests and rural roads. • Where processing takes place, poorly managed mills cause solid-waste pollution, noise and air pollution. • Using toxic chemicals for treatment causes environmental and health hazards. • Attempts to control illegal logging have been known to cause conflicts with local forest communities.	• A renewable resource, if well managed. • Encourages community self-reliance as it makes self-building possible. Wood reduces the economic dependence on the construction materials market, preventing indebtedness. It may contribute to local economy, through livelihoods for local communities. • Community forestry projects can reduce human/wildlife conflict and provide sustainable livelihoods to neighbouring communities. • Thinnings from new established forests can be utilised for firewood within two years with construction timber available within 3-4 years of establishment after an initial investment of species development of 4-5 years.	• Do not overdesign/overspecify where possible, conduct proper structural design and calculate timber needs accordingly. • Minimise cutoffs. • Treat timber properly to ensure its long-term durability. There are certainly several recipes to treat timber that may vary locally depending on the availability of products. • Minimise the use of timber for formwork, prefer reusable modular formwork instead. • Encourage timber reuse (e.g., door and window frames, roof members). • Chemically treated timber cutoffs should be considered hazardous and never be used as firewood.

What about bamboo and other materials?

Further consultation in-country is recommended (Shelter Cluster Tonga).

MATERIAL	IMPACTS	BENEFITS	BETTER PRACTICES
STONE	• Extraction of rock from quarries involves blasting. Quarries cause noise, dust, air pollution, habitat destruction and vibration if not properly managed. • Unplanned rock quarrying can cause landslides and hydro-geological impacts. Without planning and protection blasting leads to occupational hazards. • Transport may affect rural roads. • Extraction may leave large pits which can cause health hazards. • Stone construction in zones that are prone to earthquakes, should be carried out with care.	• Stone has been used for thousands of years in foundations and momumental buildings in Tonga. • Local stone does not require transportation and does not create pollution and waste. • Recyclable, even if no renewable. • Great variety of solutions, which allows for high levels of comfort if combined with knowledge on the bioclimatic conditions of each site. • Effective regulator of temperature (thermal inertia) in indoor spaces, which increases comfort. • Stone construction may encourage community self-reliance as it makes self-building possible when locally available. It reduces the economic dependence on the construction materials market, preventing indebtedness when self-harvested. • Building with stone can stimulate local activity by favouring production, processing and trade at the local level.	• Make use of local knowledge and local building cultures where possible. • Use good packaging/loading practices when transporting. • Design and construct properly to ensure long-term durability. • Only use in areas where stone can be extracted without causing hazards or environmental impacts.

CONCRETE	• Requires cement, quarried and mined materials (e.g., sand, rock chips and gravel). River sand or river gravel extraction contribute to river bank erosion and displacement.
	• Often illegally extracted.
	• Extraction of sand erodes channel beds and river banks, increases channel slopes and leads to changes in channel morphology. This may cause:
	  • undercutting and collapse of river banks;
	  • loss of adjacent land and/or structures;
	  • upstream and downstream erosion;
	  • downstream changes in patterns of depo-sition;
	  • destruction of riverine habitats.
	• Extraction of rock from quarries involves blasting. Quarries cause noise, dust, air pollution, habitat destruction and vibration if not properly managed.
	• Unplanned rock quarrying can cause landslides and hydro-geological impacts. Without planning and protection blasting leads to occupational hazards.
	• CO2 production, impacts on climate change. Cement production is very polluting.
	• Revenues concentrated on a few people.
	• Transport can damage rural roads.
		• More resilient to extreme weather, flooding and earthquakes if correctly designed and implemented.
		• No firewood required, although the construction of many concrete structures requires timber scaffolding and supports often made with plywood sheeting.
			• Use alternatives to concrete/ mortar, e.g., earth walls.
			• Use prefabricated concrete items to control the provenence of gravel and sand.
			• Never dispose of concrete in the environment. It can be:
			  • reused on-site/off-site for construction purposes (e.g., fil-ling),
			  • safely transported to a sanitary landfill.

METAL (CGI SHEETS & STEEL)	• Manufacturing process requires large quantities of steel, zinc and other metals. May contribute to negative mining impacts. • Manufacturing takes place in large scale factories using energy intensive processes. Factories can cause severe air and water pollution, if poorly managed. Manufacturing processes may release toxic heavy metals. • CO2 production, impacts on climate change. • Transport can damage rural roads. • Dangerous in cyclones. The main problem is the potential uplift of CGI sheets due to strong winds and improper fixations that may cause injuries and loss of lives. • Cause discomfort and health issues (CGI sheets). • Edges can be very sharp, so carrying and handling sheets of CGI can be dangerous, and thick gloves should be worn to protect the hands. • Revenues concentrated on a few people.	• CGI sheets are easy to carry and lightweight so even light structures can easily support them. • CGI sheeting is valuable and can be sold if dwellers need to raise funds, for example in a disaster or post-disaster context.	• Use optimum design calculations to minimise cut wastes. • Use certified products and avoid implementing in corrosive environments (e.g. seaside). • Avoid contact with ground or high levels of moisture if using on wall panels. • Encourage reuse of uncorroded sheets from old buildings.

4.4. Local affordable or self-built housing

Sources: Nonu (2016), Kennedy (1958), Lewis (1982), Benardo (2001), Charmaine (2014), Vrolijks (1998), Secretariat of the Pacific Community and Tonga Department of Statistics (2014)

A. Vernacular housing

In the Tongatapu group of islands, there are very few traditional *fale* remaining. The Vava'u and Ha'apai groups still have some traditional *fale*, as well as some *fale* that are a mix of traditional and modern styles.

The temporary structures known as *falehunuki* continue to be built for funerals and weddings.

The *fale*

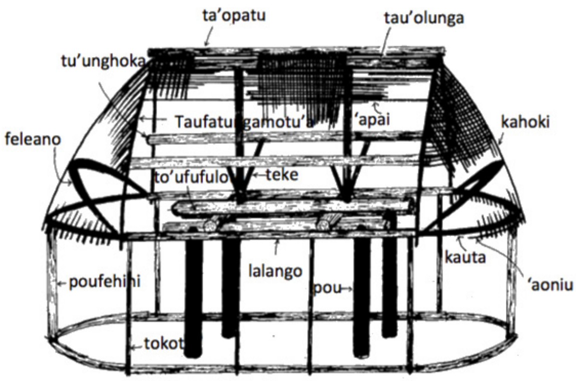
The *fale* was traditionally the house of Tongans. Meeting houses and spiritual buildings were also built with the same principles. Today, the practice and the knowledge on traditional *fale* has almost disappeared and *fale* are very rare. Even though this building culture is not very much used by Tongan people anymore, it belongs to their history and so it contributes to clarify certain aspects of contemporary architecture in Tonga and of the use of spaces by Tongan people.

In Tonga, everyone belongs to a *fale* as the term also refers to family. Each *fale* had the *pou* (the main structural post or main posts), very symbolic as the *pou* represented the ancestors. A *fale* is also strongly connected to the neighbouring *fale* and the social hierarchy is strongly correlated to the size of each *fale*.

<u>Parts of the *fale*</u>:

- The foundation is made by digging the earth and setting large stones underground in the places were the main support posts or *pou* would stand. The *pou* is placed on these stones. More stones are then used to hold it in place and the foundation is backfilled with compacted earth.
- *Pou* (meaning to support and hold) are the main structural posts, made of timber from local trees such as *toi*, *toa*, *koka* and *tavahi* (the last two species are endemic to Tonga), depending on the availability in each place. Coconut trees are never used for the pou because they rot quickly when they touch the ground. *Pou* are usually independent from the wall system. The size of the house depends on the number and the size of the *pou*. A residential *fale* has four *pou* while meeting houses and spiritual buildings often have more.
- *Tokotu'u* are the side columns located around the perimeter of the *fale*. They are used to hang vegetal walls as well as to support the horizontal structure that supports the roof. *Tokotu'u* are made of strong enough timber from *kuava, fau, milo, tavahi, tamano, toa*, etc. The *tokotu'u* used to be placed at the same time as the walls.
- The *toka* and the *lalango* formed the horizontal beam structure. Coconut trees, *niu*, *toa* or any other available straight hard wood is used for this purpose as there is no contact with the soil therefore no risk of rotting. Other structural parts of the beam system require more flexibility (some needed to be curved). Coconut, *kuava*, *fau*, and mangroves are used for this purpose. Some small trees (*kaho*, *fehi* or *siale*), are used for the short beams in the structure. Lashing using coconut fiber named *pulu* is used when needed to join elements of timber together to create longer members.
- *Pola* are the exterior walls which are made of natural fibre mats, mainly made of coconut leaves, etc. Coconut leaves (sometimes sugarcane leaves) are used to create the mats when they are green, as they are flexible enough for weaving without breaking. The walls are temporary and so are replaced from time to time.

Fale in Niuafo'ou island in 1967. CC Garth Rogers & Wendy Pond



Parts of the structure and construction elements of a *fale*. © Paula Tuivailala

Present house built with fiber materials. CC cfleizach

Tongan *fale* in Falehau. Niuatoputapu Island. © Anna Strum

- The roof is made with the same principles and materials as the exterior walls.
- The interior walls are made using *lauhala* mats from *hala* trees. The decoration indicated the status of the owner.
- The ceiling is open and sometimes covered with *tapa* cloth, made by peeling and pounding the inner bark or *tutu* of the paper mulberry tree (*hiapo*).

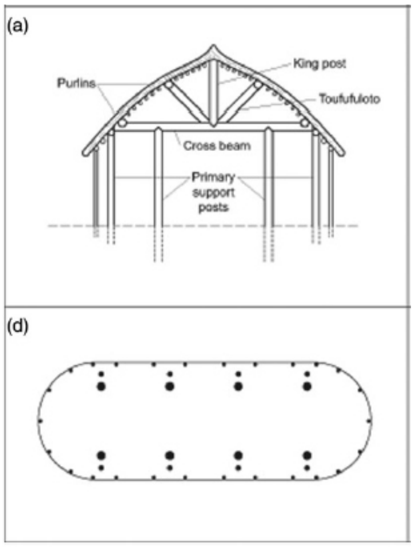
The *falehunuki*

Falehunuki are temporary structures composed only of a roof structure without walls. The form is rectangular or oval in shape, and it is built using only locally available resources.

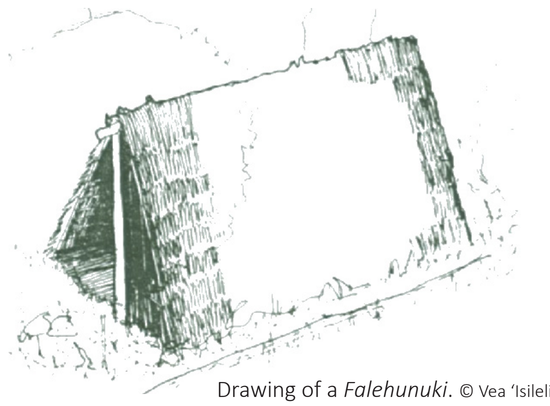
Other shelters

Different kinds of shelters derived from the *fale*:

- *Falefaha'iua*: it has a low wall around the building which helps to handle the wind. It usually has two main vertical posts that supported the whole structure.
- *Fale fata*: it is a lot bigger, with four or more main posts or *pou*. The structures consist of both vertical and horizontal poles and allows for one or more additional space for living and storage, similar to an attic.
- *Falefakamanuka* (originating from Samoa): it has a similar structure to the *fale fata*, but without walls, and is used for weaving and meetings.
- *Falefakafisi* (originating from Fiji) has a higher roof, which enhances ventilation. In Fiji, sugar cane leaves are used for roofs and walls. In Tonga, they are built using the abundant coconut leaves.
- The *falepouono* and *falepouvalu* were typically built using six to eight posts. They were built according to how many nobles were in the area. Each noble would sit in front of a column, as it was symbolic of status. These were very large buildings, and were used for different community activities, functions, and ceremonies.



a. Cross-section of a *fale.*
d. Plan showing the principal posthole arrangement.
S. McNamee, University of Auckland



Drawing of a *Falehunuki*. © Vea 'Isileli

Interior of a *fale fata* at the village of Poa.
Joseph Lemercier (free use)

Thatch roof of a *fale* in Uoleva, Ha'apai group. CC Crys

B. Precarious housing

According to Habitat for Humanity in a study developed by McKey (2009), about 23% of the households in the country (some 5,000 households) lived in "poverty housing" as opposed to "adequate housing". Adequate housing requirements are listed by the UN International Covenant of Economic, Social and Cultural Rights as: tenure security, affordability, adequacy, accessibility, proximity to services, availability of infrastructure, and cultural adequacy.

In fact, in informal settlements, not only the quality of the houses may be considered to be sub-standard, but there are also fewer opportunities for these households to participate in economic activities (McKey, 2009), and they have less access adequate water and sanitation, healthcare and other services.

Precarious housing is often temporary structures built with economical or salvaged materials, particularly in the suburbs of Nuku'alofa. Self-built extensions or houses are erected because of the lack of affordable housing for low-income households and for migrants from other islands as well as because of the lack of land that prevents families from starting large investments that may not be sustainable. Precarious structures are commonly built using reused corrugated iron sheets and timber.

Further consultation in-country is recommended (Shelter Cluster Tonga).

Precarious habitat in Vava'u. CC John Abel

Temporary shelter arrangement just after a disaster.
© Shelter Cluster Tonga

C. Globalised housing

Before 1958, European architecture spread because of a desire to have a more durable dwelling and because of campaigns emphasising better health conditions afforded by these structures (Kennedy, 1958). Many Tongans had the ambition to own a European-style house during their lifetime.

More and more, houses are built with cement-sand blocks or timber.

The *fale papa* or square wooden house

The *fale papa* (Benardo, 2001) is the square wooden house where many Tongans live nowadays. In 2011 61% of Tongans lived in houses with walls made of timber (Secretariat of the Pacific Community and Tonga Department of Statistics, 2014).

The rectangular *fale afa*

International aid after cyclones has historically included shelters, which has shaped to an extent the architecture on the islands. Relief programmes used to build easy, cheap and rapid solutions. As cyclones are frequent, a house typology known as the *fale afa* has emerged (Nonu, 2016).

The *fale afa* was first introduced in 1982 after the cyclone Isaac. According to Vrolijks (1998), some parts of the construction were prefabricated in Nuku'alofa and assembled on site by the people. In the construction process, the need for bracing and strapping was explained to those who received these houses. The cost per house was around T$2900, of which T$700 was paid by the families. The size of these houses is 7.2 by 4.8 meters and they contain one or two rooms and a living room.

The *fale afa* is usually a raised structure with concrete posts or short timber poles approximately half a metre in height. he wall is built with timber panels (T1-11 type or similar). The wall panels and roof trusses of the house are prefabricated. It has a pitched, corrugated iron roof with a slope of 22.5%. Trusses incorporated 300 mm overhang. The house has galvanised iron braces in all corners and in the roof. Kitchen and sanitary facilities are not included in the house, as these are normally separate in Tongan houses.

The houses have stood up well to consecutive cyclones (Vrolijks, 1998).

Fale afa with a raised structure and an extension to the left.
© Care International

Fale afa with the oval shape of a *fale* built with concrete, timber and CGI sheet roof. © Douce Cahute maison-monde.com

The oval *fale afa*

There are also *fale afa* with the oval shape of the *fale*. These houses are usually not raised off the ground. Charmaine (2014b) describes an example of this kind of house in the village of Fangale'ounga, Foa Island, Ha'apai group. This house (usually delivered through aid programs) has a rounded roof and two external doors centred along its two long ends. The family had to provide the costs of cutting down coconut trees, and milling them at a government mill for the exterior surface of the house. The Ecumenical Centre of Tonga provided all other materials: roof tiles, corrugated metal roofing, timber framing for the roof, nails and bolts, a plywood plate, cement, sand and aggregates for the concrete slab floor.

Other spaces like the kitchen were later added by the families to the basic house.

Concrete-block houses

Concrete-block is the material of choice for many Tongans building their *fale* today (31% of households in 2011). According to some studies (Charmaine, 2014) as a structural system it is currently more cost effective than timber or steel.

This author states that concrete-block construction has emerged in recent Tongan building history as a more durable way to build houses and other buildings. In fact, more than any earlier building material, concrete block developers emphasised the notion of permanence.

The use of concrete block for house construction emerged in Tonga during the twentieth century out of several clear influences (Charmaine, 2014):

- foreign trade through agents like Burns Philp, which established a department store there in 1899;
- the Australian Trade Commission also advertised imported Australian-made building products through the local newspaper, the Tonga Chronicle;
- the promotion of concrete block through its use in large-scale religious and commercial structures;
- school buildings erected using foreign-aid donations employing concrete block module systems.

Such applications certainly would have impressed new ideas about building technology on Tongans, and the new spaces that were achievable.

Interviews during recent fieldwork reveal how concrete-block houses have allowed Tongan families to enlarge their houses enabling them to alter earlier traditions of spatial layout, and it has influenced how families organise space to create separate spaces for boys and girls.

Concrete-block construction has also allowed some families to build two storey houses (Charmaine, 2014).

Further consultation in-country is recommended (Shelter Cluster Tonga).

Very simple *fale papa* (square timber house) with a raised structure and an extension to the right. © Care International

Two-storey building built with concrete structure and timber walls. CC Jen Crothers-

House with veranda built with wood and metal structure in Tongatapu. CC- Leo Gaggl

House with a veranda built with concrete blocks and CGI sheets roof in 'Eua. © Bill Flinn- Care

4.5. Organisation of settlements and conditions of use of habitat

LOCATION PATTERNS

According to Kennedy (1958), dwellings were quite dispersed until the beginning of the 19th century. Afterwards, civil war and insecurity pushed the inhabitants to gather in villages. This has been maintained ever since, meaning that lands used for cultivation can be several miles away from the houses. In 1958, villages were almost exclusively located close to the seaside for ease of access for fishing.

Up to now, as winds from the south east are strong and persistent, villages on the southern and eastern sides of islands are located far enough inland to be sheltered by the bush (Nonu, 2016). There are few villages on the high cliffs of the islands. Typically, there are around 300 persons per village (about 50 houses).

Most villages have a community concrete water tank. There are many churches as well as communal workplaces for village women (Nonu, 2016).

In urban informal settlements, the standard of housing is poor, and water and sanitation systems inadequate. Informal settlements in Nuku'alofa are situated in low areas subject to flooding. For example, an informal settlement located in the Popua dump (Tongatapu) between the sea and a lagoon encountered major health hazard as wastewater flowed into the lagoon and back into the village (McKay, 2009).

TRADITIONAL CONDITIONS OF USE OF HOUSING

In the past, the different structures had very specific functions and conditions of access. Usually, there existed gender-based or job-based restrictions.

For example, the *katupa* was a term that was used for the sides of the *fale*: parents slept on one side and girls on the other. These spaces were called *leke*. The main space in the middle of the *fale* was the *lotofale*. The boys and young men slept in a separate *fale*.

Some spaces where used for daily activities:

- *Falehanga*: women-only weaving house.
- *Falevai*: bathroom.
- *Alafolau*: fishermen-only storage place.
- *Feleoko*: farmers-only storage house.

Some other spaces were specifically used for rituals:

- *Faletolia*: used for funerals.
- *Falesiu*: fishermen-only ritual and meeting place.
- *Falehufanga*: sacred refugee place.

RURAL AND URBAN HABITATS

Most Tongans live in rural areas, 76.9% compared to 23.1% living in urban areas.

Today, the further a community is from Nuku'alofa, the lower its access to services such as water, power and markets (Asian Development Bank). As a result, the concentration of hardship is greatest in rural areas, on outer islands, and on the periphery of the urban areas in the case of the informal settlements where disadvantage is great and living conditions are poor (McKey, 2009).

The physical form of Tongan housing has been dominated by single-storey construction, even if some buildings reach two or even more levels, particularly in Nuku'alofa and other cities.

Aerial view in the Vava'u group. CC John Abel

Cultivated land in Tongatapu. © Shelter Cluster Tonga

Houses in Tongatapu. © IFRC

Some uses (kitchen and toilets) are generally separated from the buildings used for sleeping and for living room. Kitchen in 'Eua. © Shelter Cluster Tonga

Usually, the houses of the nobles and the churches were built on top of a hill (Nonu, 2016). The higher the hill, the more protection they had from the ancestors underground and the closer they were to the gods. They would sometimes build artificial hills known as *tanusia*.

SPACES IN HOUSES

In traditional houses, there were two kind of spaces inside the main structure: the *leke* and the *loto fale.* The *leke* is the private sleeping area and the *loto fale* is a multi-purpose space for resting, meeting and working (Charmaine, 2014b). Apart from the main building, some other sleeping houses could form part of the household, for example, the toilets and the kitchen are usually in separate structures. Cooking is usually done outdoors, particularly in rural areas. Sometimes, sheds for pigs or other animals make part of the ensemble. In the past, household sites were not fenced in, but over time fencing is becoming more and more common.

Regarding the entrances to traditional *fale*, usually several door openings provided the ventilation and light necessary for the interior with no window openings around the house. For example, according to Benardo, in 2001 there were still four traditional *fale* in the village of Houma, and they had each four entrances. One of these entrances was almost always kept closed because that side of the house was a place for sleeping and was occupied by a bed. All of the other houses in that village were either *fale papa* (square wooden houses) or more complex houses, which typically had three different entrances on three different sides. Nowadays, many houses still have more than one entrance.

ENTRANCE TO HOUSES AND THE CONCEPT OF FRONT OF A HOUSE OR *MU'A*

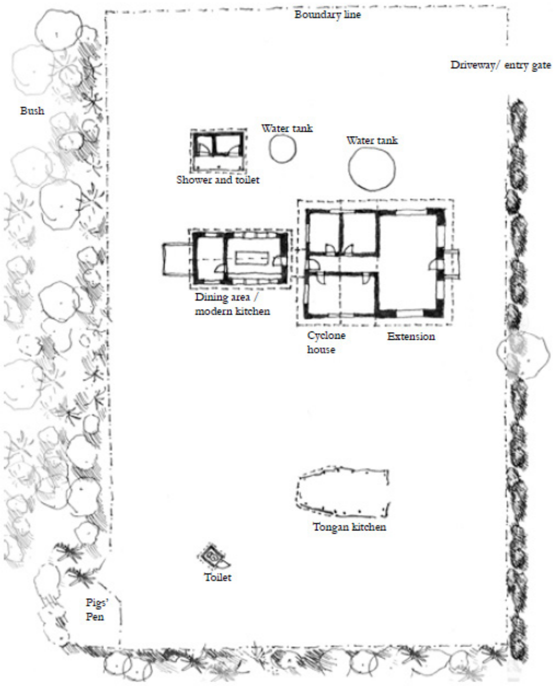
In Tongan culture it is important to know where the front or *mu'a* of a house, church or village is situated, and it is good to ask people about it. The position of the front dictates the place where the chief will sit when visiting a particular house (Benardo, 2001). The chief knows where to sit even when he enters an unfamiliar house and can determine the front of a house without being told, as are usually all villagers, particularly if they have already seen a chief entering the house. The place where a chief sits fixes the seating places of the rest of participants. General spatial parameters exist that chiefs and commoners apply to houses (and villages) in establishing their fronts.

Houses usually have several entrances (Benardo, 2001). One of the entrances is used by the chiefs in special or official occasions. This entrance is not always the one used daily by the inhabitants. The domestic entrance is usually left open.

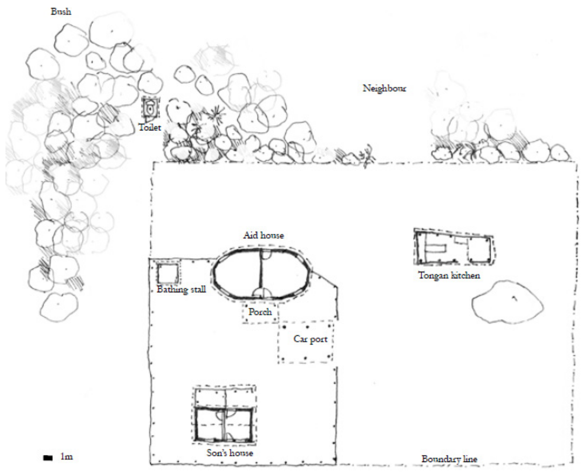
Once the official entrance is determined, the part opposite becomes the *mu'a* or front of the house. This notion of front is very particular to Tongan culture. The *mu'a* or front of a Tongan house is the part opposite the official entrance, and it is where the chief sits if he visits a house.

Apart from that, a low gate in the doorway of the house prevents animals from entering.

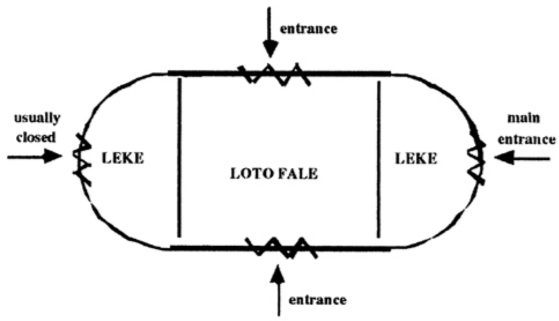
Further consultation in-country is recommended (Shelter Cluster Tonga).



Plan of a rural household in Fangale'ounga village Ha'apai.
© 'I. T. Charmaine



Plan of a second rural household in Fangale'ounga village Ha'apai. © 'I. T. Charmaine



Entrances and spaces of a traditional *fale*.
© G. Benardo

5. Learning from local habitat

5.1. Hazard-resistant practices

Sources: Several documents cited when pertinent.
See bibliography at the end of the profile

A. Cyclones, storms and strong winds

- Winds from the south east are strong and persistent, so villages on the southern and eastern sides of islands are situated far enough inland to be sheltered by the bush. There are few villages on the high sides of non-flat islands (Nonu, 2016).
- Settlement patterns with scattered buildings and vegetation belts contribute to breaking the wind flow thus reducing its impact on the built structures.
- In many constructions (either *fale* or globalised houses), eaves are only a few inches wide thus reducing uplift and risk of damage to the roof under strong winds.
- Low houses are common as they have better resistance to strong winds.
- Hipped roofs are also common as they are far less impacted by high winds.
- Houses with rounded walls on the ends of the building, and with a rounded roof form better resist winds as they are more aerodynamic. This is the case of the traditional *fale* and of the modern *fale afa*.
- Trees planted around the house reduce the wind velocity and impact on the structure, as do all other kinds of vegetation. However, high and rigid trees must be located far enough from the buildings to avoid danger in case of fall. It is therefore common to favour lower vegetation close to the house and to keep high trees at a sufficient distance. Other advantages brought by vegetation are the regulation of temperature and humidity around the house as well as the provision of fruits, vegetables and livelihood for families.
- Stones and other heavy materials are sometimes placed on top of CGI roofing sheets in order to reduce the risk of them being blown or sucked off the roof structure when subjected to strong wind pressure.
- In traditional *fale*, the main timber structure would hold together; only the thatch would need repairs (Nonu, 2016). Also, on some occasions when the winds threatened to shred the walls and overturn the roof, the inhabitants could chop down the pillars, so that the roof fell directly onto the ground. As the roof was curved, the wind tended to flow over it smoothly.
- The main features of the traditional traditional Tongan *fale* concur with some main principles of cyclone resistant houses: strong posts, connections with ropes, a hipped roof and simple building plan (Vrolijks, 1998).
- The roof of the veranda disconnected from the main roof is a good practice allowing for the lift up of the veranda roof only, without damaging the main roof and with less risk of losing the veranda roof when it is has a firm but loose connection.

Further consultation in-country is recommended (Shelter Cluster Tonga).

People's preparedness strategies

According to Magee (2016), Tongans know how to make their property ready for, and more resistant to tropical cyclones. Before cyclones, several actions to secure houses and gardens are developed by inhabitants:

- Gardens and small areas of vegetation are cleared to ensure no loose objects are picked up by high winds.
- Sometimes, roofs are fastened and tied down with ropes so that they are not blown away by tropical cyclones. The structure of the house is secured.
- Depending on the conditions of the roof, heavy objects (such as tyres or sandbags) are often placed on top to protect the roof from strong winds.
- Shutters are placed on the windows to protect them from high winds and flying objects.

Windows are shuttered before cyclones. © Red Cross

The roofs of these verandas are detached from the main roofs, reducing the risk of domino effect starting from them during storms. House in 'Eua. © Bill Flinn- Care

Fale afa in 'Isileli with rounded end walls and roof. © thegirlthatsailsinthealia.blogspot.com

Heavy objects are often placed on the roofs to reduce the risk of wrenching of the CGI roofing sheets.© Caritas

Tying down is important to resist cyclones. *Fale afa* house in Tongatapu. © Shelter Cluster Tonga

B. Earthquakes and tsunamis

- Square shapes in plan present good seismic behavior (the simpler and more compact the shape of the plan is, the better). An ideal construction would have the same rigidity in all horizontal directions.
- The form of traditional *fale* provides some resistance to earthquakes as it presents symmetry along the two axes in plan. In such forms the overall deformations are predominant and the differential movements limited. A *fale* is more resistant when it is not very long.
- Wooden structures as those used in *fale* and in timber houses display a certain level of flexibility which increases their seismic resistance. As a result, they rarely collapse in the event of an earthquake as long as they are properly braced. Therefore, they are also less likely to cause the loss of life of the inhabitants.
- In the earthquake of June 1977 which measured 7.7 on the Richter scale, the whole of the estimated cost of damages caused by the earthquake was related to damage to buildings and infrastructure. Structures built with reinforced concrete and/or blockwork were those more severely affected while traditional *fale* were not damaged (Lewis, 1982). Buildings raised on masonry stilts with timber walls were not badly damaged either, except in some cases where raised foundations had failed. This earthquake showed very low standards of construction where unregulated modern materials and methods had been used.
- After the earthquake of June 1977, many people that had lived in concrete and cement block houses rebuilt their houses using timber as this material had better withstood the shaking (Lewis, 1982).
- After this earthquake, the inclusion of some aspects of the *fale* in contemporary buildings also started to emerge. For example, the Tourist Bureau/Information Centre was rebuilt at the request of the King, but in the style of a *fale*. The Tonga Museum/Cultural Centre was also built in the form of a *fale* (McKay, 2017).

Try to find information on the connections used between the poles and the body of the house, on the one hand, and between the poles and the ground on the other, and analyse to what extent they are relevant to cyclones and against earthquakes. Information on possible bracing of these poles and on their sizes.

Further consultation in-country is recommended (Shelter Cluster Tonga).

C. Floods and heavy rain

- Some houses are built on stilts or mounds, which is a good strategy to avoid both penetration of humidity from the ground to the inside of the house, as well as the intrusion of flood waters in to the living space.
- The houses of the nobles and the churches were often built on natural or artificial hills (Nonu, 2016) for religious and cultural reasons related to protection from the ancestors underground and proximity to gods, but this also protected these particular buildings from flooding. Also, as many Polynesian Royal building structures and homes, the *fale fakatu'i* was built on a platform. Its elevation above ground level symbolised rank in society, but also helped protect the structure from flooding (Nonu, 2016).
- Vegetation cover around the houses can protect them from strong winds. The root system of the vegetation around houses also helps to avoid the ground from being washed away with heavy rains and to slowly absorb flood waters.

Clarification on the materials used to build the stilts?

Progressive floods or very fast flash floods (where the water itself has a strong mechanical action on the walls / piles)?

Further consultation in-country is recommended (Shelter Cluster Tonga).

Hipped roof with better resistance to strong winds. Square shape with better resistance to earthquakes. House in 'Eua. © Bill Flinn- Care

After a disaster, the raised floors of houses on stilts can help to safeguard the goods from the waterlogged soil. © Tonga Red Cross

House built on stilts with shutters in the windows in 'Eua. © Bill Flinn- Care

Floods in Tongatapu. © IFRC

D. Erosion, landslides and coastal erosion

- Vegetation on slopes helps to hold the soil together, mitigating against landslides.
- Surface drainage systems exist. They are usually constructed with simple means and contribute to the reduction of landslides by ensuring that water flows are managed and directed away from unstable areas, and away from building foundations, reducing the likelihood that the flood waters will undermine them.

Further consultation in-country is recommended (Shelter Cluster Tonga).

Vegetation helps prevent landslides. House in ‘Eua.

E. Droughts

- Corrugated galvanised iron (CGI) roofing is desirable as rain is the only source of safe drinking water and washing water. Iron roofs provide a catchment for tanks (Kennedy, 1958) but also increase the force of cyclonic wind forces on buildings compared to thatch.

Further consultation in-country is recommended (Shelter Cluster Tonga).

Fale afa with rectangular plan and concrete water tank.

F. Asbestos

- Asbestos is a rock-based fibrous mineral still used as construction material in many countries. The World Health Organisation (WHO) has assessed the effect of exposure to asbestos on human health. Inhalation of asbestos fibres has been shown to cause different diseases as abestosis, lung cancer or mesothelioma. It is found in asbestos-cement roofing sheets, in asbestos-cement water pipes, in ceilings, floors, thermal, fire and sound insulation, among other uses. Asbestos is now banned in over 40 countries worldwide (Shelter Centre & ProAct Network, n.d.).
- According to a report prepared in 2015 by Contract Environmental Ltd and Geoscience Consulting for SPREP (Secretariat of the Pacific Regional Environment Programme), Tonga had 2,550 m² of asbestos containing materials (WWF, 2018).
- Tonga is at high risk for significant potential to release asbestos fibres when disturbed by disasters. Health risk to occupants of affected buildings and for people working in waste removal is likely to occur.
- Even in an emergency context, with little or no existing asbestos control, legislation or local awareness, a few key steps can be taken to minimise health risks due to asbestos (Shelter Centre & ProAct Network, n.d.):
    1. Identify the locations of asbestos-containing materials and assess the risks.
    2. Ensure that people are adequately informed of the risks and methods of best practice.
    3. Minimise the disturbance of asbestos containing materials.
    4. Minimise the extent to which people have contact with asbestos.
    5. Ensure that waste is securely stored and adequately labelled.

It is important to tie every part of the building right through to the ground, but also to protect from humidity the wood used at the base of the constructions. Here the cement slab should act as a capillary barrier. House in ‘Eua.

5.2. Prevailing dangerous construction practices and recommendations

LOCATION, SOIL, FOUNDATIONS AND SURROUNDINGS OF A BUILDING

- Flood, tsunami and landslide prone areas are to be avoided where possible, as well as proximity to tall trees.
- If there is no superficial drainage at the base of the walls moisture and stagnant water can become a problem, especially if the rain falling from the roof has created a natural dip in the ground.
- Lack of drainage creates breeding ground for mosquitoes and other insects. This should be monitored and remedied on a regular basis.
- If the wooden poles of the housing structure are in direct contact with the ground, (without a barrier such as a stone or concrete posts), they are vulnerable to rising damp and decomposition and the building may be more likely to fail at the foundations in the event of an earthquake or cyclone.
- If the house is not built on stilts and does not have a sufficiently strong concrete slab, the possible movements of grounds linked to concentrated water infiltration / stagnant water can cause serious cracks in the structure.

Houses settled precariously in a flood prone area in the Popua Village, Nuku'alofa. CC- Luis Enrique Ascui- Asian Development Bank

BUILDING PRACTICES

- Cracks and damage should be remedied quickly, as they can allow water penetration and rapid degradation of the core structure if left unrepaired.
- Roofs can be lifted or sucked off as a result of open verandas that permit wind to penetrate the roof. Verandas are better oriented in the opposite direction to that of the dominant wind, and in order to mitigate damage to the main roof of the house, should be constructed as a separate, detached roof structure.
- When a roof is not firmly connected to the walls, it may be lifted or sucked off, due to the strong vertical upward pressures of the wind. It is therefore necessary to firmly attach the roof to the walls in order to avoid the uplift effect. It is also necessary to firmly attach all the different element of the roof to each other in order to avoid this effect (Shelter Cluster Tonga, 2018).
- When roof and walls are too weak, they do not resist the wind pressure. When this happens, roof and wall panels may literally explode to all sides. It is therefore necessary to firmly connect all elements, and reinforce through bracing (Shelter Cluster Tonga, 2018).
- It is necessary to identify what type of timber is to be used in each part of the house (hard wood / coconut wood / soft wood with quick growth for the wall panels...). Further consultation in-country recommended.
- When the walls of a house are not braced, under the strong lateral pressure of the wind, the wooden structure may lean. When the pressure is too strong, the walls might collapse. It is necessary to brace the walls to avoid this tilting effect (Shelter Cluster Tonga, 2018), or to have a solid but loose connection (allowing some movement to happen) between the main roof / structure and the more exposed parts.
- It is important to brace between roof trusses to prevent racking, and between stilts at the sub-floor level to prevent leaning as with the walls.
- Untreated wood infested by termites reduce the strength of the members. It is necessary to reinforce elements through treatment, and to maintain buildings regularly (Shelter Cluster Tonga, 2018). Further consultation recommended.
- If improperly built and reinforced, concrete structures are the most dangerous in case of earthquakes or heavy winds. Damage caused by the wind pushing against an unreinforced or poorly reinforced wall can cause collapse due to excessive wind pressure on the outer surface of the wall. Total or partial collapse can cause serious and fatal injuries due to the weight of cement blocks.
- Using concrete for structural elements is challenging due to scarcity of good quality aggregates and clean water.

Further consultation in-country is recommended (Shelter Cluster Tonga).

A veranda without ceiling and sharing the roof with the whole house may cause the entire roof to lift off in case of strong winds. House in 'Eua. © Bill Flinn- Care

Church in Tongatapu affected by lateral wind probably because of a lack of bracing. © Bill Flinn- Care

This roof, not having been firmly connected to the walls, was lifted off, due to the strong, vertical pressure (suction) of the wind. © Bill Flinn- Care

5.3. Lifespan and maintenance

- Wooden elements should not come in to contact with the soil. They should be elevated above the ground, and separated preferably with an air gap between them and the connecting element underneath. In local architecture, they sometimes stand on waterproof elements (e.g. stones or more recently concrete). They must be protected from the natural elements such as repeated rain. This increases the structural durability by preventing posts from rotting and creating a weak point in the building's structure.
- Coconut trees are never used for the *pou* (timber posts in traditional *fale*) because they rot quickly when they touch the ground (Nonu, 2016).
- All the trees used in the *fale* had to have the skin peeled off to prevent bugs from hiding under the bark (Nonu, 2016).
- When used to construct the floor, timber should be adequately elevated above ground level to allow adequate space under the house for routine inspection of the floor structure for termite or insect infestation. This usually happens in local habitat.
- After cyclones, when the roof has been damaged, many households cover the roof timbers with a waterproof plastic sheet such as a tarpaulin to protect them from the natural elements, preventing further damage. It is advisable to avoid nailing the plastic sheets without intermediate pieces of wood or to fix them by panels as illustrated on the first picture on the right.
- Materials can be salvaged and reused after cyclones and the impact of other hazards. For instance, metal roofing sheets that have been blown away by the wind and have been too damaged to be re-used for roofing can be reused for less sensitive parts of the house (for example walls or veranda roofing).
- The thatch walls of the *fale* were all temporary, as well as the roof (Nonu, 2016). Every seven to ten years, the walls and thatching would be replaced, while the main structure of the *fale* remained. The *pou* (main post or posts) would be replaced as well, but not as often as the other parts of the *fale*. According to various authors (Nonu, 2016; Kennedy, 1958), timber and iron houses are more durable than traditional *fale*, the thatched roof and walls of which needed ordinary repair or replacement.
- The finest homes used dried sugarcane leaves for roofing that could last up to eight years (Nonu, 2016).
- Extensions are very usual, and they permit people to adapt houses to needs and to means available. Extensions are either built as separate constructions (traditionally this was the only way) or connected to the main house (more common nowadays).
- The best treatment of timber against moisture is to avoid the timber elements to get into contact with the humidity and especially to avoid that these elements are affected by regular cycles of humidification and drying.
- Any other methods for treatment of wood or bamboo against moisture or termites?

Further consultation in-country is recommended (Shelter Cluster Tonga).

Plastic sheets on top of a damaged roof after cyclone Gita in 'Eua. © Bill Flinn- Care

Reuse of metal roofing sheets for walls. House in 'Eua. © Bill Flinn- Care

A *fale afa* house with several extensions. © Care International

This damaged *fale afa* house can be repaired by reinstalling the lost roofing sheets/tiles. © IFRC

Houses are quickly repaired after a disaster to provide a temporary space to live before the rest of the house is repaired or reconstruction starts. © Habitat for Humanity

- Once the house has been built, the wood and iron are rarely painted nor properly maintained particularly in modest households, as it represents a significant cost.
- Thatch roofs require frequent maintenance especially if they are not well designed and installed. Thatched roofs also have the disadvantage of being flammable and they may be a nesting place for insects. This type of roof can be reserved for rooms with less risk of fire (avoid on kitchens). Regarding insects, this can become less problematic if the roof is isolated from the interior space by a ceiling.
- Thatch roofs are a traditional craft whereas CGI sheeting is imported and expensive to replace when needed.

What are the techniques of replacement of thatch? Is it usually done as localised replacement (not the entire roof)?

Further consultation in-country is recommended (Shelter Cluster Tonga).

5.4. Green design, comfort and health features, and aesthetics

Cooking is sometimes made outdoors. © Caritas

The roof tiles delay the sun's heat transfer through the metal. CC- Leo Gaggl

- Some houses have verandas and other exterior covered spaces. These spaces are very important as a place of activity in hot and humid climates, where the interior spaces of the shelters are often unlivable on hot days.
- Timber houses without soffit linings have good air circulation because timber finishing allows the cool air to flow in and circulate.
- Roof tiles sit on top of corrugated metal roofing in some *fale afa* delaying and minimising the sun's heat transfer through the metal (Charmaine, 2014b). Does this practice exist with thatch or other fibers placed on the CGI?
- Thatch is a good material for roofing even if almost not anymore used today. Apart from protecting from rain it offers great insulation and good ventilation. Its permeability also renders it more resistant to cyclones than CGI sheeting for roofs.
- The open weave screens of wood or fibre mats allow adequate ventilation in the interior of the buildings in this hot humid country. The high roof structure of the *fale* allowed the hot air to rise while the cool air dropped and ventilated the space (Nonu, 2016). Crossed ventilation is also an asset in terms of thermal comfort.
- Some houses are built on stilts (usually concrete ones), which restricts moisture from the ground entering the house.
- In all the groups of islands apart from Tongatapu where gas dominates, the main fuel for cooking is collected firewood (SPC & Tonga SA, 2014). Kitchens are sometimes placed outdoors, which helps to avoid smoke inside the houses. Most daily cooking is done by women, who usually cook in battered pots over open fires in villages, in wood-burning stoves in some households, and on gas or electric ranges in some of the larger towns. Some meals are prepared mostly by men in earth ovens or *umu* caved in the ground.
- During cold weather, the sun would heat the stone foundation and would help warm the *fale* during cool nights (Nonu, 2016). Additionally, the *fale* was large enough inside to build a fireplace, good practice against fires. Is this a living practice?
- Vernacular habitats as well as contemporary timber houses involve the use of large amounts of wood, a renewable material provided that programmes to manage forestry resources are in place.
- CGI sheets have the advantage of not being heavy, and thus, to require lighter supporting structures, reducing the amount of timber required.

Are false ceilings a common practice?

Further consultation in-country is recommended (Shelter Cluster Tonga).

- The use of CGI sheets causes discomfort for inhabitants and may induce health issues. When a shiny CGI sheet is installed, it reflects some solar radiation, but heats up and radiates the heat inside the house. When CGI sheets rust, they become darker in colour and consequently reflect less radiation. Thus, the interior of buildings become hotter as the CGI sheets rust. Installing a ceiling can create a thermal buffer zone and help to reduce the internal temperature of buildings.
- Apart from their thermal disadvantage, CGI sheet roofs are noisy during rainy periods. Ceilings can help to reduce this noise.
- The floor may suffer from rising damp when it is not elevated from the ground and separated with a damp proof membrane.

Further consultation in-country is recommended (Shelter Cluster Tonga).

5.5. Sociocultural practices fostering resilience

- Tongan people value their relationships with one another and are extremely family oriented. Because of how people are raised and taught, it is harder to feel, act, and think as an individual in Tonga. Even today, extended families live in the same homes together, and people typically live in the same place all their lives (Nonu, 2016).
- Respondents to an interview were very much focused on helping others prepare, particularly those with a disability or those of age who may be less able to prepare (Magee, 2016).
- In traditional Tongan society, working together is of great value (Nonu, 2016). During the building of a *fale*, there were celebrations and rituals throughout the process: the *tanupou* (laying of foundation), *hikisa* (raising of the rafters) and *huufi fale* (open house, completed). They had a big feast and everybody was invited to come and help lift the roof structure and place it on the *pou*. This part of the construction always required a lot of people because everything was done by human labor, without any machines or technology. During these celebrations they would perform certain rituals and celebrations to bring luck during the construction and also to bless the *fale*. These rituals also had *tapu*, which were sacred rules they had to abide by for a period of time. After the construction had been completed, they would have another feast and bless the *fale* to be a safe place and a shelter for whatever purpose the *fale* was built for, as well as to release the *tapu*.
- The whole community participated in the process of building the *fale* (Nonu, 2016). The little children would braid the rope, the men would lash the structure together, and the women did the weaving and preparing of the *tapa* cloth. These were part of the daily activities of the community as they built the *fale*.
- There is a significant awareness amongst the population of what to do in the face of a Tropical Cyclone (TC), the steps that must be followed to become disaster ready and how to prioritise each task. The preparation of properties to make them ready to better resist tropical cyclones is very important for Tongans (Magee, 2016).
- The preparation of food, water and other consumables is also taken into account. Dry food provisions including biscuits, flour and sugar and long-date goods, such as tinned foods, are collected. (Magee, 2016).
- Before cyclones, any crops that may be of use are harvested, consumed or sold (Magee, 2016).
- A working radio, first aid kit, torch and a cyclone tracking map are identified by people as important necessities when waiting out a storm, defined as a 72h kit in Tonga (Magee, 2016).
- Safe public buildings on higher ground, such as churches, schools and community centres, are generally open to residents if they feel their home cannot withstand the impact of the cyclone (Magee, 2016).

Helping others in preparedness and post-disaster situations is very important in Tongan culture.
© Habitat for Humanity

Community hall in a village in Ha'apai. © Caritas

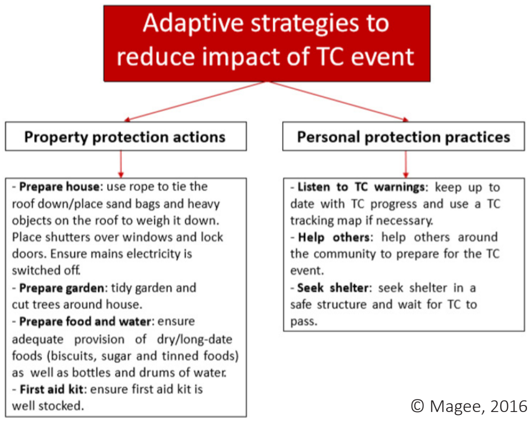
- In post hurricane or drought situation water shortage, the liquid from young coconuts provides the only source of thirst prevention. Even if some consumption of coconuts for drinking and eating purposes is normal throughout the Pacific, in times of water shortage, the consumption of coconuts increases by up to four times, with consequent and corresponding decrease in coco-nuts available for copra production (Lewis, 1982). Copra is an important financial resource for export.
- Traditional spaces of conviviality are important for establishing and maintaining community links. *Fale Fakataha*, or meetinghouses exist in every village in Tonga (Nonu, 2016). In these places, community matters were discussed, often by the elderly people. Meetings and different activities take place in these spaces.
- Staple root crops of taro, cassava, yams and sweet potato remain edible for up to three months after their foliage has been destroyed.
- Weather related traditional knowledge is important for many Tongan people. The following aspects specially related to weather, animals and plants were described by people participating in a recent study (Magee, 2016):
    - Unrelenting hot and humid conditions throughout the day and night are a tell-tale sign of a future Tropical Cyclone (TC) event, coupled with unsettled ocean/atmospheric conditions.
    - There may be a relationship between increased fruit yields and tropical cyclone activity. In particular, early and more abundant flowering of mango and breadfruit in the harvest season preceding a tropical cyclone.
    - The shape of tomatoes was mentioned as a sign of potential tropical cylcone activity (they are often smaller in size and can fall from the vine earlier than usual).
    - Birds native to smaller island groups flying overhead to the main land.
    - Cattle and dogs being very vocal in the days leading to a TC event.
    - The quantity and variety of fish preceding a TC event was also noted as being significantly lower than normal; for example barracuda, a popular catch, is particularly reduced and crabs are reportedly washed ashore.
    - Bee activity and the movement of hives are also perceived as a positive indicator of TC activity. Generally, and under normal weather conditions, bees build their hives on branches close to the ground. However, before a TC, it is reported that bees can often relocate their hive to higher ground or branches much higher above ground level (away from flooding).

Further consultation in-country is recommended (Shelter Cluster Tonga).

- Food crops are usually damaged by cyclones. Absence of food crops in favour of cash crops, of vanilla for instance, reduces capacity for self-reliance and survival (Lewis, 1982).
- The current traditional safety net such as sharing, for example, is proving to be less effective in addressing shocks which affect the entire community or the whole country. Shocks include a low economic growth coupled with high food and oil prices. This situation has led to a growing burden on dependency, leaving less wealth to share (UNICEF, 2011).
- The increasing urbanisation and monetisation of the society is perceived as leading to a deterioration of traditional support systems. Widening development gaps between urban and rural areas and rising urban poverty have also emphasized the need to address disparities. Moreover, the geographic constraints (financial and institutional) of delivering social services to remote areas are an ongoing challenge (UNICEF, 2011).

Further consultation in-country is recommended (Shelter Cluster Tonga).

Reconstruction starts in community the day after a disaster. Houses in 'Eua. © Bill Flinn- Care UK



© Magee, 2016

Information for inhabitants about actions to be taken after an earthquake. © Caritas

6. Projects based on the evolution of local building cultures

ANY RECENT PROJECTS BASED ON THE EVOLUTION OF LBC?

Further consultation in-country is recommended (Shelter Cluster Tonga).

Sources:

PROJECT NAME

Project by:

Contextual Information:

Location:

-

Geographic information:

- Topography:
- Altitude:

Project principles and scope:

Design Considerations:

7. Additional resources and bibliography

7.1. For further information

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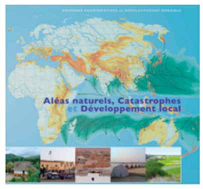

B

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C

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7. Additional resources and bibliography

7.3. Series of detailed shelter response profiles

Country/territory	Language	First edition	Available online
Fiji	English	March 2016 (after Cyclone Winston)	https://www.sheltercluster.org/fr/node/9782
Ecuador (Coastal area)	Spanish	May 2016 (after April 16 earthquake in Coastal area)	https://www.sheltercluster.org/sites/default/files/docs/ecuador_costa_habitat_local_y_estrategias_de_respuesta_craterre310516_1.pdf
Haiti	French	October 2016 (after Cyclone Matthew)	https://craterre.hypotheses.org/1803
Bangladesh	English	September 2018 (between disasters)	https://www.sheltercluster.org/bangladesh/documents/detailed-shelter-response-profile-bangladesh
Ethiopia	English	December 2018	https://www.sheltercluster.org/ethiopia/documents/ethiopia-country-profile
Democratic Republic of the Congo (South and East)	French	December 2018	https://www.sheltercluster.org/democratic-republic-congo/documents/rd-congo-cultures-constructives-locales-pour-des-habitats
Tonga	English	November 2019 (between disasters)	-

↓ Downtown Nuku'alofa, Tongatapu. CC- lirneasia

↓ Thatched roof in a resort in Vava'u. CC- Alessandro

Key issues for initial diagnosis and project implementation

PROJECT MANAGEMENT

- Identify regulatory and social requirements.
- Identify and meet the different authorities.
- Involve representatives of the community (stakeholder groups) and local professionals as much as possible in the decision-making process for the project.
- Coordinate the project with other ones to develop yours in a comprehensive and integrated approach.
- Carry out a field survey as soon as possible to identify the strengths and weaknesses of local building practices and the local market, as well as actual capacities and training needs.

SOCIOCULTURAL PRACTICES FOSTERING RESILIENCE

- Analyse local practices regarding community cooperation in the building sector and other sectors (e.g. agricultural activities).
- Identify local practices regarding risk preparedness and recovery.

SITING

- Carefully select the construction site to avoid risky areas, comply with business activity area requirements and grant access to basic services.
- Plan for an unrestricted access to safe water and sanitation services.
- Take into account land tenure issues.

LOCAL HABITAT ASSESSMENT

- Identify local building practices and know-how and promote the ones fostering the inhabitants' resilience. Appreciate and adapt to local practices, including in the informal sector.
- Identify local practices that contribute to an ecological and comfortable habitat.
- Identify weaknesses so as to give focus to the technical reflection (reverse-engineering process).
- Include building maintenance and repair related issues in the reflection.
- Collect feedback from previous projects.
- Consider different scales: materials, elements, construction systems, building, neighbourhood, environment, territory.

ARCHITECTURAL DESIGN AND CONDITIONS OF USE

- Make sure that the solutions and practices you promote are financially and technically accessible for most people so as to ensure the long term impact of the project.
- Identify the composition of the household and local practices in terms of cohabitation and uses of indoor and outdoor areas.
- Query the concepts of durability, dismantling and reuse related to local customs.
- Allow for a flexibility of the building system so that inhabitants can develop appropriation processes and make it evolve all along its lifespan according to their needs and abilities.
- Carefully define the orientation and position of buildings and public/private outdoor spaces into the compound, and the landscaping of the latter.
- Ensure that the building design provides a sense of pride among the affected population.

CONSTRUCTION AND BUILDING LIFESPAN

- Select materials according to their availability and accessibility and check their quality. Select materials in order to facilitate their reuse or recycling.
- Carefully design and build the crucial elements related to risk reduction: the anchorage of the roof and the walls to the foundations, the structure bracing devices, the water-resistant plinth and/or the post ends protection systems, the protection of walls (plastering, grouting), the seismic bands, etc.
- Sensitise people about the importance of regular maintenance in DRR.
- Assess material sourcing and reuse options to ensure environmental sustainability.

BUILDING PROCESS

- Develop and insist on the potential pedagogical value of the project and on the importance of its replicability.
- When possible, build a prototype that will allow to make any necessary adjustments.
- Beware of climate and seasonal constraints affecting the availability of people and materials.
- Analyse the social aspects of the building processes and their impacts on the community cohesion and the efficiency of works. Ensure that traditional mutual help systems are valorised.
- Give priority to local populations and artisans in the building process to ensure a positive impact for the community.
- Pay attention to supervision, training and communication needs.

THE FIELD SURVEY

CAÏMI (2015)

Assessment contents & main information sources

● main source
○ complementary source

Assessment contents	Community members	Inhabitants / tenants / house and land owners	Self builders / construction artisans	Materials producers / suppliers / carriers / contractors	Technicians / experts construction specialists	Local authorities / governmental departments	Formal & informal community leaders	GOs & NGOs / coordination bodies	Vocational / academic / research / training centres	Observation in the field	Document review
SITE											
Natural environment	●									●	●
Socio-economic profile	●					●	●	○			●
Infrastructures	●					●	●	○		○	●
HABITAT											
Settlements	●					●	●			●	○
Housing/building typologies	●	●	●		○				○	●	○
Building construction	●	●	●		○	○			○	●	○
CONSTRUCTION PROCESS											
Activities & roles	●	●	●			●	●			○	○
Maintenance	●	●	●							○	
Training		○	●	●	●			○	●		
RESOURCES											
Materials	●	●	●	●	○				●	○	○
Skills & know-how	○		●	●	●			○	○		
Costs	●	●	●	●	○	○					
RISK REDUCTION											
Natural hazards & risks	●	●	●			●	●	○		○	○
Adaptation & coping strategies	●	●	●			●	●	○	○	●	
CAPACITIES											
Organizations & networks	●		○		○	●	●	○			
Cooperation systems	●	●	●	○	○	○	●	○	●		
Key persons & groups	●	●	●		●	●	●	○			

TO FIND OUT MORE

ON PROJECT MANAGEMENT AND FIELD SURVEYS:

- Assessing local building cultures, a practical guide for community-based assessment (Caïmi, 2015)

  https://hal.archives-ouvertes.fr/hal-01493386/file/16059_Caimi_Assessing_local_building.pdf

SELF-ASSESSMENT SUSTAINABILITY TOOL FOCUSED ON SHELTER AND SETTLEMENT RECONSTRUCTION IN THE AFTERMATH OF NATURAL DISASTERS:

- QSAND Tool

  http://www.qsand.org/

SUSTAINABLE HOUSING DESIGN TOOL TO ASSIST HOUSING PRACTITIONERS IN DESIGNING SUSTAINABLE HOUSING PROJECTS:

- Sherpa Tool

  https://unhabitat.org/sherpa/

ONLINE REFERENCE GUIDE WITH TOPICS (POLICY, PROGRAM AND OPERATIONAL FRAMEWORK) TO BE MANAGED IN EMERGENCY SITUATIONS:

- Care Emergency Toolkit

  https://www.careemergencytoolkit.org/

Acknowledgements

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With contributions by:

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Institutions

Ministry of Infrastructure. Government of Tonga
Website: http://infrastructure.gov.to/

Global Shelter Cluster
Website: https://www.sheltercluster.org/

Pacific Shelter Cluster
Website: https://www.sheltercluster.org/pacific

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FINAL DRAFT

To be circulated in-country for consultation with key shelter institutions and partners for validation, and to support filling information gaps as noted throughout the document