Fiji

Baseline data on local building culture & coping strategies

CRAterre
ENSAG

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Cover (from top to bottom):
Traditional *bure* house (©Vaughn); transitional timber house (©culturevixen.com); formal timber house after 2015 cyclone Winston (©UNICEF)

1. Data gathering

Level of analysis

- [x] General level
- [ ] Local level

Where: _____

Organisation:_____

Information sources

- [x] Document review
- [ ] Field assessment

Situation

- [x] Post-disaster assessment
- [ ] Ordinary situation / Pre-disaster assessment

2. Country profile

Location

Population

Total:	909,389
Urban population:	53.7%
Rural population:	46.3%
Urban population growth:	1.45% annual rate
Population density:	48.2 people/km²

Ethnic groups

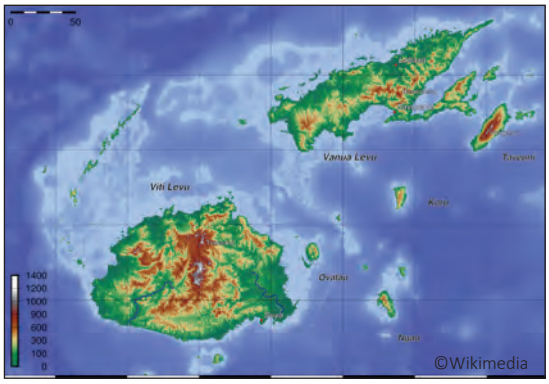
iTaukei (native Fijians):	56.8%
Indian:	37.5%
Rotuman:	1.2%
Others:	4.5%

(data from CIA World Factbook and Preventionweb)

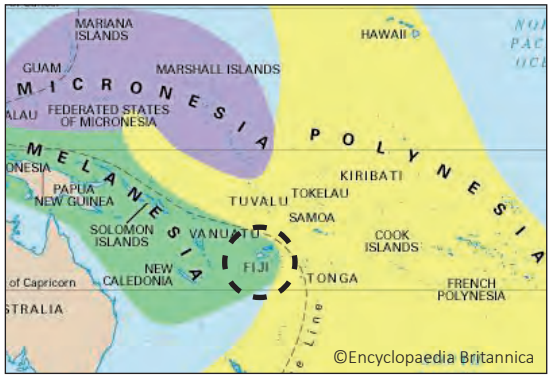
Climate

Tropical marine with slight seasonal temperature variations

Rainy season & South-Pacific cyclone seasons:
November to April



Topography map

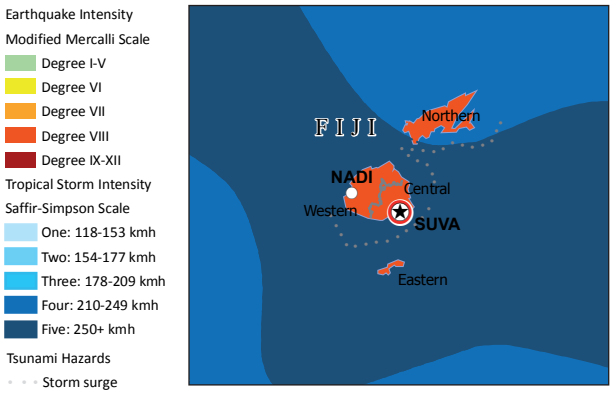


Map of culture areas in the Pacific Islands

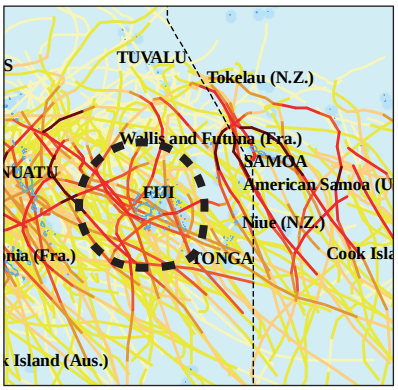
Natural hazards

- [x] Cyclones & strong winds
- [x] Earthquakes
- [x] Floods
- [x] Tsunami & storm surges
- [ ] Landslides
- [ ] Other:

Note:
Cyclones are the most recurrent and devasting hazards



Natural hazard risk map (UN-OCHA)



Storm tracks 1956-2006 (UN-OCHA)

3. Local habitat

3.1. Land tenure

Fiji is divided into provinces which consist of several *tikina* (districts). Each *tikina* is made of several *koro* or villages.
More than 80 percent of the land is registered by the land owning unit (*mataqali* / clan) of Indigenous Fijians while the others include State hold, freehold land and leases.
In the past decades, an important migration from rural to urban areas has been registered, leading to several squatter settlements located in risk-prone areas. Settlement refers to place of residence on lease, owned land, or at will apart from villages.

3.2. Local housing & construction types

Existing housing can be subdivided according to various quality and materials used.
Low-cost and/or owner-built houses can be classified into one of the three categories: traditional, transitional or formal housing.

Traditional housing:
lightweight flexible construction and 4-slope hipped roof for better wind resistance

Transitional wooden housing:
partial damage after 2016 cyclone Winston

Formal low-cost housing:
cement block masonry with anchoring for roof structure

Transitional CI sheet housing:
elevation on stilts for better protection from floods

Remarks on the three construction types:

- According to recent census, only a very limited portion of the population is actually living in traditional housing, so-called *bure*. Most of the families live in “temporary” (lean-to, *vale vkakenani*) and “permanent” (bungalows, *vale tudei*) dwellings.
- Building materials for the transitional and formal types must be imported in significant quantities from outside the country and then shipped from distribution points. This increases the overall cost and can result in long waiting periods before a house can be assembled. This situation is further exacerbated in the aftermath of a disaster increasing recovery time and costs.
- Generally, traditional and transitional houses have external kitchens in a detached small building and pit-toilet located outside.
- Kitchens and additional buildings, which are usually much less sturdily built than the homes, are frequently almost totally wiped out during cyclones and earthquakes. Flying debris from the structures (occasionally even the entire units become airborne) often causes sever damage to houses that might otherwise have weathered the storm.

3.2.1. TRADITIONAL HOUSING

Fijian traditional housing is often referred as *vale vaka-viti* (Fijian's house) or *bure* in present days, although originally *bure* meant men's house.
This type of house is still found in large numbers throughout the country, with a great variety of shapes, architectural styles and materials used. These one-room thatched houses are particularly well adapted to the local climate and environment. They are comfortable, inexpensive to build and maintain, and often display great craftsmanship and woodworking skills in their construction.

Various types of traditional housing across the country (©Intertect)

STRUCTURE

FOUNDATIONS
Platform of large boulders and earth raised from a foot up to 3 or more feet from the ground.
On the inside the floor is covered with coconut leaf mats.

MAIN STRUCTURE
Strong corner posts and wall posts from hardwood round timber set in the ground before the construction of the stone platform.

ROOF
A wooden roof frame erected on top of the posts lashed together by coconut fibre ropes and covered by a thatch made from grass (*pandanus*) or other palm leaves stitched together and laid in sections overlapping one another.
In recent years, many thatched roofs have been replaced by corrugated iron (C.I.) sheets.

Traditional house: woven mat walls are fixed on the outside with additional wood elements to improve resistance to wind pressure; the top of the roof is reinforced with an additional layer of special grass tied to a timber beam protrunding from two sides of the roof

WALLS
Mats made of woven bamboo or reeds are attached on the external side of the posts, often supported by small vertical posts to reinforce the walls in the centre.
In some areas, grass thatch walls are also used.

CONNECTIONS
Traditionally, the house is bound together with ropes made from coconut fibre (*magimagi*) or other natural materials.

A net of woven reeds is applied on the rafters to better fix the thatching

RESILIENT CONSTRUCTION PRACTICES

- Settlement pattern with scattered buildings helping to cut the wind flow reducing the impact on construction.
- Vegetation belt around the settlement help to reduce the speed of strong winds.
- A 45° hipped 4-sided configuration of the roof as protection against strong winds.
- Steep slope of the roof allows rain to shed quickly and away from the house, improving durability of thatching.
- Few inches eaves reducing uplift and risk of damage to the roof under strong winds.
- The house elevation on mounds protects from flooding and storm surges.
- Stones are placed all around the elevated mounds filled with soil to protect from erosion.
- Strong hardwood corner posts buried sufficiently to resist uplift.
- Lightweight and rope tying providing ability of the structure to bend and sway without collapse (ductility) during cyclones and earthquakes.
- Round shapes gables for improved wind resistance.
- Even though extensive structural damage may result from cyclones, a total collapse of the *bure* is rarely lift-threatening as they are lightweight structures and, because they are woven together, components will not fly off to cause major harm to the occupants.

Scattered houses and tree barrier for reduced vulnerability to wind

Elevated stone platform for protection from floods and soil erosion. Small eaves and steep roof for reduced vulnerability and improved durability

CONSTRUCTION WEAKNESSES

- Modifications to *bure* construction, such as the use of nails, iron roofing and the reduced use of some traditional hardwoods because of their limited availability, render many recent built *bure* more vulnerable.
- Possible lack of rigidity and bracing of the structural frame.
- Possible lack of stability of the overall structure if the base of the posts is rotten.
- The primary causes of structural failure are generally:
  - separation of the roof from the walls caused by uplift and failure of the connections between the roof and walls;
  - collapse of the walls resulting from lack of rigidity in the centre portion of the wall;
  - failure of the corner post due to deterioration of the wood in the ground.

Coconut fibre tying for roof trusses (left) and corner post-ring beam (right)

House damaged by a cyclone: a large quantity of materials can be reused for repair the existing house or to built a new one

BIOCLIMATISM & CONFORT

- Improved ventilation thanks to the elevated floor, the reduced width of the house and a high thatched roof.
- The thickness of the walls varies according to climate. In dry areas rows of reeds are lashed together and form a screen which allows ventilation. In wet areas this screen is lined with thatch on the outside.
- Houses were built with open frames with generally no interior subdivision. Control of privacy, security, wind, and wind-blown rain are provided with lightweight moveable screen elements.
- Houses are very dark and dim inside as no windows are provided to reduce the strong outside light and to keep a cool indoor temperature.

LIFESPAN & MAINTENANCE

- The hot and damp climate limits the durability of the buildings to approximately 20 years. However, if well constructed it may last for 30 to 40 years.
- A particular types of reeds are tied together to thicken the topmost part of roof thatching.

CONSTRUCTION PROCESS

- The relatively narrow width decreases structural spans and the need for heavy structural members.
- For a medium size *bure*, it takes about 2 weeks for the material collection and 4 weeks for the construction with 8 men and the master carpenter.
- Traditionally, housing construction was always carried out by the collective work of village people. It began with a person who wished to construct a new one or to re-thatch the roof conveying the request to the chief who was in charge of organizing village meetings to discuss whether the construction was necessary. Once the village people agreed, they decided who involved and what tasks each had.
- Materials used for the traditional housings are obtained in and nearby villages. The carpenters and fellow members have an extensive knowledge on location and availability of resources for construction.
- Traditional construction in villages has been replaced by housing with newly introduced materials and styles in the latter half of the XXth century. It is hardly practiced in most villages in present day, however, there are still elderlies who have knowledge and skills based on their past experience.
- The 200 years old village of Navala, situated in the Nausori Highlands, still maintains today its traditional way of building and living as a result of the decision by the village committee.
- In recent years there has been a general decline in the level and quality of building skills that is evident in the damage levels observed after recent cyclones. For example, the timber posts which form the main structural components of the *bures* are insufficiently imbedded in the ground. Roofs that were traditionally bound together and to the main frame of the building are now nailed, with a dramatic loss in strength.

Housing construction with the involved of the community

Construction with mixed materials: even if heavily affected, its lightweight limits risks of serious injury

CI sheet *bure* after cyclone Winston: even if some have been damaged, they have resisted better than other constructions

Bure built using CI sheets as evolution of the traditional building practices: round shape for improved aerodynamism

3.2.2. TRANSITIONAL HOUSING

Transitional houses are temporary or interim structures erected by families until they can afford more formal houses. In addition to the type of materials used, a usual criteria to determining if a house is formal or transitional is by whether or not it has interior running water and sanitary facilities.
Transitional houses are the most vulnerable type of buildings, frequently adopted by squatters to whom lack of title to land is a disincentive to make improvements, and by people living from subsistence farming in rural areas which the limited cash income does not allow to make many improvements on housing.

Wall types of transitional timber-framed housing (from left to right): with woven mats, CI sheets and timber boards (©Intertect)

STRUCTURE

FOUNDATIONS
None or in some cases short concrete piers.

MAIN STRUCTURE
Saw timber frame with elevated wooden platform

ROOF
1-side sloping or 2-side gabled roof covered with CI sheets and more rarely with *pandanus* thatch.

WALLS
Palm or bamboo woven mats, CI sheets, timber boards

CONNECTIONS
Nails

Timber-framed house: the elevated floor protects from soil humidity

RESILIENT CONSTRUCTION PRACTICES

- Construction on stilts as protection from floods, coastal erosion and sea level rise.
- The platform is generally elevated above the ordinary level of local floods.
- Large corner posts anchored to the ground providing enough strength to hold down the building during strong winds.
- Corner bracing is sometimes used to improve the strength of the structure.
- Flexible materials and lightweight structures that can sway and bend during earthquakes with reduced risk of injury in case of collapse.

CI sheet house: tilting shutters can be easily fixed during cyclones

CONSTRUCTION WEAKNESSES

- Sometimes, there is some provision for anchoring the frame to the concrete pier, but usually the building simply rests on the posts greatly increasing the vulnerability of the whole house that can be lifted off and toppled over during cyclones or slip from the piers during earthquakes.
- Corrugated iron sheets if poorly attached to wooden frames (nails frequently too short) can fly away and cause serious injuries and damages during cyclones.
- Weak connection of walls to the frame, especially in the corners, can cause walls separation and "box explosion" under strong winds.
- Low angled, gabled roofs with large overhanging caves are very vulnerable to strong winds.
- When construction budget is limited, there is a tendency for using less CI sheets resulting in a reduced slope of the roof with an increased vulnerability to wind and higher risk of tearing off.

BIOCLIMATISM & CONFORT

- Woven mat walls allow for improved ventilation as air can pass through while CI sheets considerably increase heat inside.
- Tilting wooden shutters protecting from sunlight while ensuring cross ventilation.
- Increased ventilation and protection from ground moisture thanks to the elevated platform.

LIFESPAN & MAINTENANCE

- Woven mats if properly maintained can will last for many years and can be upgraded by replacing them with boards.
- Elevation of the base of the posts for protection from moisture and increased durability.

CONSTRUCTION PROCESS

- These houses can be built very quickly in a matter of a day or two with extensions made over time.
- In squatter dwellings, materials come generally from former houses and wood is collected from the nearby timber mills or "borrowed" through relatives and friends.
- Thanks to their lightweight they can be easily moved.
- Wood frame houses were in the past affordable to almost all income groups. In the last decades, because of the cost of lumber, this type of house has become almost as expensive to build a cement block and steel house.

4-slope CI sheet roof for reduced vulnerability to wind

Elevation of the house above ordinary flood level

Even if other vulnerabilities have led to serious damages, corner bracing under the platform is an important feature to improve the house stability

"Box explosion" under wind pressure due to weak connection between walls. Lack of anchoring between the corner posts and the concrete foundations

3.2.3. FORMAL LOW-COST HOUSING

Owner-built and government-subsided housing consists of a variety of concrete block and more formal wooden frame structures. In addition, this category also includes government-aided housing often built after a disaster using a variety of prefabricated panel systems transported to the affected areas and erected on site.

STRUCTURE

FOUNDATIONS
Cement block wall, cement foundations

MAIN STRUCTURE
Cement block masonry walls unreinforced or reinforced with steel rods; wooden frame

ROOF
1 sloping, gabled or hipped roof
Timber structure with CI sheet covering

WALLS
Cement blocks; timber boards

CONNECTIONS
Steel rods, nails

RESILIENT CONSTRUCTION PRACTICES

- Connection of the roof structure to the masonry walls:
  - A portion of the steel rods used in the reinforcing columns is left protruding out of the ring beam. A boars plate is laid on the top of the ringbeam with a hole drilled for the rod to pass through. The rod is bent over to hold the plate down. The roof trusses are then attached to the plate.
  - Bolts are imbedded in the cement when the ring beam is poured. The plate is then attached by bolting it down.

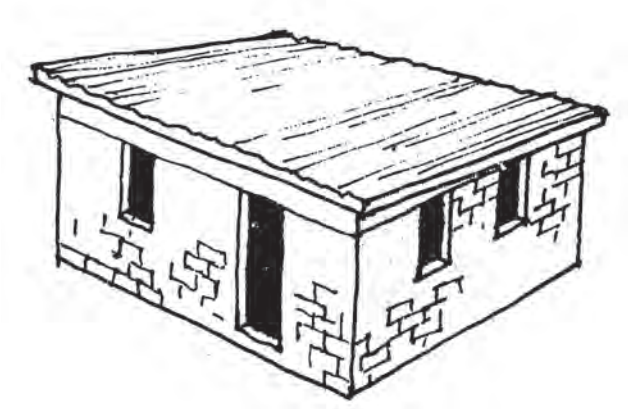
CONSTRUCTION WEAKNESSES

- If properly built, a concrete block house can withstand the forces of both earthquakes and windstorms. If improperly built and reinforced, this type of construction is the most dangerous. 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 deathly injuries due to the weight of cement blocks.

BIOCLIMATISM & CONFORT

LIFESPAN & MAINTENANCE

CONSTRUCTION PROCESS



Ordinary formal low-cost housing with cement block masonry (©Intertect)

Formal timber-framd house on cement block plinth

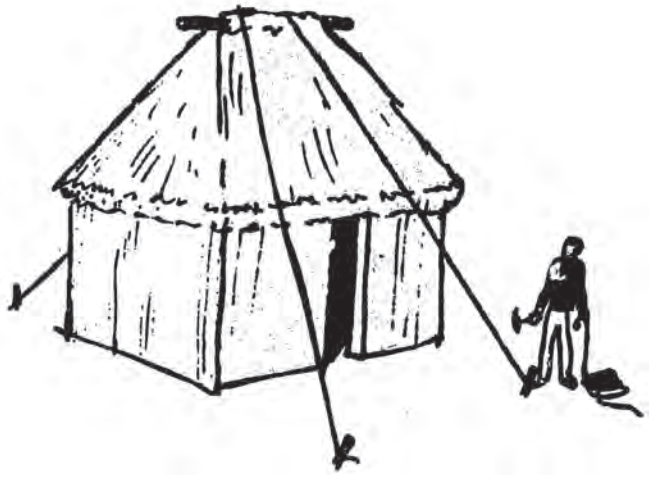
Poor quality cement block masonry house with steel rods

Government-subsided low-cost housing

4. Local coping strategies

4.1. Vulnerability reduction practices for construction

- Lightweight collapsible houses if cyclones or earthquakes are stronger than the capacity of the construction to withstand. By doing so, the occupants will not be injured and a new structure can be quickly and easily rebuilt using materials available from the former house.
- Systems to secure and stabilize the building or some of its parts:
  - Roofs and windows are secured by tying together the ends of two dry coconut leaves and laying then over the roof, with the heavy base hanging downwards.
  - Tying the roof down with ropes and fastening it to large sturdy trees.
  - Banana leave veins woven and tied with green coconut leaves and use them to cover the thatched roofs to keep them intact.
  - Tyres, heavy cement bricks and sacks filled with sand are placed onto CI sheet roof to avoid blown off.
  - Cutting of big trees near the house.
- During cyclones, *bure* roofs were often blown off in one piece and deposited on the ground nearby, where because of their shape they provide a very safe and stable shelter for the people who crawl underneath and sit upon the rafters. In traditional times, this process was frequently hastened and made less hap-hazard by removing the roof before the wind.
- During floods, some communities live on shelves strung on the rafters, diving in and out of the door and cook and move around on rafters of bamboo and banana stems.
- Fijians traditionally prepared for each hurricane season by propping up and tying down houses on the month of October, when the season of storms and cyclones is supposed to start. Nowadays they usually wait for more immediate signs, or radio announcements; however, some practices for vulnerability reduction are still in use (for example, tying to roof structure to nerby sturdy trees).



Using rope to anchor the house and the roof to the ground (©Intertect)

Using woven leaves for improved protection of the walls and for additional closure of the openings (©Intertect)

©Reuters AAP

Tyres placed on CI sheet roof to reduce vulnerability to wind

©AP

Residents boarding up windows as they prepare of the arrival of 2016 cyclone Winston

4.2. Additional coping strategies for disaster preparedness & recovery

Community cooperation & self-help

- The chief's house was traditionally used as the evacuation centre and recent assessments reported that *bures* are still today often used as communal shelters during cyclones.
- From the onset of disasters, most communities display considerable cohesion as members provide mutual assistance: for instance for cleaning up of debris and putting the village back into a liveable condition, sharing of meagre resources.
- Where there was widespread destruction building materials (reeds, *pandanus*, or bamboo) may have become scarce, but access to them through inter-community linkages was undoubtedly a common occurrence. Community cooperation was a key to post-disaster recovery: affected households could stay with other communities while waiting for recovery and non-affected communities could assist affected communities in the recovery process, bringing foods and building materials.
- Following a disaster, many affected households have arranged their own repairs through voluntary involvement of family and local communities, instead of deferring the repair works until the arrival of some form of government or civil society assistance.

Traditional warning systems

In rural willages, people know several natural warning signs foretelling a cyclone. Traditional effective practices- such as blowing the conch shell or beating wooden drums- are still used today to issue disaster warnings to complement modern technical methods.

Season calendar

The names of the months refer to various natural phenomena. For instance, the period from March to May is known as the "rainy season" when heavy rains are expected while the period from December to February is often called "hot season" or also "sail-wrapping season" to indicate that sailling is not normally undertaken because of the danger of cyclones.

Famine crops & disaster-resistant food

After crisis, communities were relatively self-sufficient in food resources thanks to their knowledge about comestible wild plants, the use of a wide range of plants able to resist to various natural hazards and supplementary crops - so-called "famine crops" - that were rarely consumed in time of plenty.
Among traditional means of food preservation, particular cooking and drying processes were also used to prepare long-lasting emergency reserves that can be stored for 15 months without deterioration

Scatered crops & land fragmentation

In rural areas, crops were scattered in different locations with differential vulnerability between species and sites to reduce the risk of a total devastation from extreme events.

5. Further resouces

5.1. Key documents

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5.2. Regional & local stakeholders

National authorities & agencies

- Housing Authority of Fiji: http://www.housing.com.fj
- Housing Assistance and Relief Trust HART, Fiji: http://hartfiji.com/
- Habitat for Humanity Fiji: http://www.habitatfiji.org.fj
- iTaukei Land Trust Board, Fiji: https://www.tltb.com.fj/

Universities & training centres

- School of Building & Civil Engineer, Fiji National University: http://www.fnu.ac.fj/new/colleges/engineering-science-technology/school-of-building-civil-engineering
- University of the South-Pacific, Fiji: https://www.usp.ac.fj/
- School of Architecture, The University of Queensland, Australia: http://www.architecture.uq.edu.au/

Complementary resources

- Kalevu Cultural Centre, Sigatoka Town, Fiji: http://www.fiji.travel/us/activity/kalevu-cultural-centre
- Department of Heritage & Arts, Fiji Ministry of Education: http://www.culture.gov.fj
- Pacific Disaster Net: http://www.pacificdisaster.net

5.3. Recommendations

This document presents baseline data on Fijian local building culture and coping strategies that can be useful to consider in designing and setting up habitat and disaster risk reduction programmes.
It has been prepared on about 1 week on the basis of documents identified through Europe-based online research. Only very limited information has been found and in many case this may be outdated.
It is strongly recommended to involve local stakeholders for more up-to-date data and more specific information coming from local-based assessments.