

Annex 13: Green building practices and most common building materials

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Background

- The use of local materials and building practices can reduce environmental impacts associated with transportation and distribution, leverages existing extraction, production and supply chain processes.
- If these were previously well regulated then are likely to have lower environmental impacts than importing materials
- Ensure that the provisioning and regeneration capacity of locally sourced natural materials has been considered to avoid over-extraction or exploitation.
- When replicating local building practices ensure supply chains are not overwhelmed in cases of sudden increased demand, potentially leading to unsustainable practices.

Building practices overview

There are three most common types of housing and subsequent materials:

1. RURAL / TRADITIONAL DWELLINGS (43%)¹: generally fully made of natural materials that can be found in the village and surrounding locations and are constructed using traditional construction methods and local materials such as thatch, natangura (woven palm fronds), woven cane, or other naturally available material. Key features include:

¹ Cyclone Pam PDNA:

https://cop23.com.fj/wp-content/uploads/2017/06/vanuatu_pdna_cyclone_pam_2015.pdf

- a concrete or crushed coral gravel floor
 - lightweight timber frame with local material wall cladding
 - roof sheeting made from locally grown material, sometimes with chicken wire covering the thatch (predominantly outer island and peri-urban)
2. RURAL / SEMI PERMANENT DWELLINGS (30%): may be made of a mix of different traditional and modern building materials and techniques which are yet to be well integrated and developed into strong disaster resilient building structures and systems. Semi Permanent housing is incrementally constructed from traditional materials that are replaced or supplemented over time with salvaged or second hand materials. Key features include:
- concrete or crushed coral rock floor, inadequately designed timber-framed walls
 - natangura grass or corrugated galvanized iron (CGI) roof on non engineered roof members (predominantly informal settlements or rural communities).
3. URBAN DWELLINGS THAT MAY BE PERMANENT OR SEMI-PERMANENT: can be built of a combination of different building materials and techniques. May be constructed with modern building materials e.g. steel or concrete (structural elements) concrete block (structural masonry or infill), timber (structural elements for floors, wall and roof and/or floorboards or wall or roof cladding) and corrugated galvanized iron (CGI) roof cladding. The semi-permanent urban dwellings are generally made of a combination of new and/or recycled or scavenged building materials using modern building techniques without necessarily following neither the building codes and regulations nor the traditional building principles, which make them particularly vulnerable to natural hazards. Permanent housing comprises single- and double-story structures that were likely designed to be comparatively durable. Key features include:
- engineered concrete or timber frame floor
 - concrete block or timber-framed walls
 - CGI on trussed roof structure or roof tiles.

Traditional knowledge including natural resource management for resilience should be supported. The Shelter Cluster has produced various IEC materials to support traditional knowledge in safer shelter construction. These can be found on the [Vanuatu Shelter Cluster website](#) and include:

- Community networks and social capital
- Improvement of traditional construction techniques
- Women participation in construction
- Local materials, resources, management and sustainability
- Traditional knowledge and knowledge transfer

See Annex 3 for more info on the housing and construction context.

Building Materials

Project Cycle and Materials >>

Material related decisions in a construction project are not all made at one time. Different issues on material selection, sourcing, procurement, storage, use and disposal emerge at different stages of the project cycle. Figure 1 gives the typical building material related decisions you have to make and sustainability tips at different stages of the project cycle.

For example, materials that can substantially impact the cost of construction and project management have to be selected very early at the inception stage even before the detailed designs are done – e.g. bricks versus rammed earth walls. More detailed issues, such as using water-based paints instead of solvent-based paints, can be addressed later in the design stage or construction stage. Disposal of waste material is an issue that arises in the construction stage, but reuse or disposal methods and disposal sites should be identified well ahead of commencing construction.



Source: WWF Green Building Materials Guide

Social & Environmental Implications Of Commonly Used Materials

The most common materials for the above construction techniques are listed in the table below, with an overview of potential social and environmental impacts, benefits, and best practices/opportunities.

IEC: See Shelter Cluster Poster on “[Local Materials, Resources Management and Sustainability](#)” that lists plant species and how they are used for construction and emphasises the importance of environmental protection.

Some information in the table below is taken from the [Green Buildings Materials Selection and Use Guide](#) by WWF and partners, and contextualised for Vanuatu.

Material	Social and environmental impacts	Social & environmental benefits	Better practices and opportunities

<p>TIMBER: Including KOYU, KAURI, WHITE WOOD, COCONUT TIMBER (Tri blong Kokonas), BANYAN</p> <p>Key facts</p> <p>Main use</p> <p>Structural elements for floors, wall and roof, floorboards, wall or roof cladding</p> <p>Coconut timber: Roofs, walls, mats, rafters</p> <p>Banyan: Rafters, purlin, rope</p> <p>Key Govt. actors</p> <p>Ministry of Agriculture, Livestock, Forestry, Fisheries and Biosecurity</p> <p>Related laws/legal frameworks²</p> <p>Code of Logging Practice (1998)</p> <p>Forestry Rights Registration And Timber Harvest Guarantee Act No. 28 (2000)</p>	<ul style="list-style-type: none"> ● Extraction can cause forest destruction, landslides, land degradation, and habitat destruction and can increase flood risk. ● Disasters have an impact on demand for timber for shelter and fuel and can disrupt forestry programmes. ● Transport of logs can further damage forests and rural roads. ● Where processing takes place in timber mills, poorly managed mills cause solid-waste pollution and noise and air pollution. ● Requires treatment for pest control. Using toxic chemicals for treatment causes environmental and health hazards. When not treated, easily disintegrates. 	<ul style="list-style-type: none"> ● A renewable resource, if well managed ● Community forestry projects can provide sustainable livelihoods for neighbouring communities 	<ul style="list-style-type: none"> ● Do not over design/over specify— where possible, conduct proper structural design for timber buildings and calculate the timber need accordingly ● Minimize cutoffs ● Treat timber properly for long-term durability ● Encourage timber reuse (e.g., door and window frames, roof members). ● Timber fallen as a result of a cyclone should be used as a priority to support rapid shelter construction. NB. The lifetime of this timber may not be as long as properly dried and treated timber. ● Never dispose of timber in streams or coastal areas. ● Chemically treated timber cutoffs should be considered a hazardous material; never use as firewood
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² Annex 3 provides more info on laws and legal frameworks

<p>BAMBOO</p> <p>Main use</p> <p>Women split bamboo used for walls windows, rafters</p> <p>Key Govt. actors</p> <p>Department of Forests</p>	<ul style="list-style-type: none"> Given its invasive nature, bamboo can quickly take over nearby forests There is an aversion to building with bamboo - there is an attempt to move people towards using faster growing materials like bamboo 	<ul style="list-style-type: none"> The high strength, low cost, rapid growth and high availability of bamboo makes this an ideal resource Replenishes rapidly and over-extraction can usually be managed Good crop management practices can increase bamboo crop yields by up to 400% 	<ul style="list-style-type: none"> Ministry of Forestry has a programme in place to grow and use bamboo.
<p>RIVER / BEACH SAND / CORAL</p> <p>Main use</p> <p>Increased demand for concrete in Port Vila</p> <p>Key Govt. actors</p> <p>Department of Geology and Mines</p> <p>Related laws/legal frameworks</p> <p>An <i>environment permit</i> is required for the disturbance of coastal or estuarine areas, including seagrasses, coral and sand. This includes the removal of sand, gravel, rock, coral and rubble.</p> <p><i>Sand Mining Ban (2014)</i> : The Department of Geology and Mines banned commercial</p>	<ul style="list-style-type: none"> Erodes channel bed and banks, increases channel slope, and leads to changes in channel morphology. These impacts may cause: <ul style="list-style-type: none"> undercutting and collapse of river banks loss of adjacent land and/or structures upstream erosion downstream erosion downstream changes in patterns of deposition destruction of riverine habitats 	<p>No environmental or social benefits</p>	<ul style="list-style-type: none"> Use alternatives to concrete - e.g. traditional building materials Use premixed concrete instead of in-situ mixing Use prefabricated concrete items Optimize concrete mix design (don't over-specify) Store in a manner free from contamination by other site materials Protect from rain and other water sources. Adhere to the building specifications mixing mortar and concrete and building. Overuse of the material will not add additional strength, and will cause waste. Mix in small adequate batches to minimize waste. Do not mix more fresh concrete than you will use in a two-hour period. Never dispose of washout cement, sand, cement mortar, or concrete in environment. They can be reused on-site/off-site for construction purposes (e.g.,

<p>sand mining at Teouma Bay and Mele Bay in Port Vila.³</p> <p><i>Quarry Act (2013):</i> requires a permit for most quarries and sand mining.</p>			<p>filling), safely transported to a construction material recycling facility, or safely transported to a sanitary landfill</p>
<p>CEMENT</p> <p>As above</p>	<ul style="list-style-type: none"> • Uses limestone and other minerals extracted from quarries or mines in manufacturing, which can cause severe mining impacts. • Transport using large trucks affects rural roads and may cause noise and air pollution. • Produces greenhouse gases both directly through the production of carbon dioxide when calcium carbonate is heated (producing lime and carbon dioxide), and indirectly through the use of energy, particularly if the energy is sourced from fossil fuels. 	<p>No environmental or social benefits</p>	<ul style="list-style-type: none"> • Use alternatives to concrete/mortar, e.g., stabilized earth walls Use premixed concrete instead of in-situ mixing • Use prefabricated concrete items • Optimize concrete mix design (don't over-specify) • Use standardized bricks to minimize mortar and plaster • Use precast concrete designs for construction; precast concrete can be designed to optimize (lessen) the amount of concrete used in a structure or element • Avoid wastage by calculating adequate hauling times when purchasing premixed concrete and use retarders in case of long hauls. Do not mix more fresh concrete or cement than you will use in a two hour period. • Never dispose of cement slurry or washout in streams or street drains. Never dispose of empty cement bags in the environment. Instead, dispose of them in a sanitary landfill.

³<https://www.sprep.org/attachments/Publications/IOE/pebacc/port-vila-social-mapping-analysis-ecosystem-use.pdf> - See Annex 3

<p>CGI SHEETS (Kapa)</p> <p>Key facts</p> <p>One of the most common roofing materials in Vanuatu</p> <p>Main use Roof cladding</p> <p>Key Govt. actors NDMO</p> <p>Related laws/legal frameworks n/a</p>	<ul style="list-style-type: none"> • Few suppliers in Vanuatu - carbon footprint of importation • One of the most common roofing materials in Vanuatu but has a limited life span in the volcanic regions • CGI sheets are considered valuable items, therefore any distribution needs to be carefully considered and discuss with relevant stakeholders, to ensure equity of distribution and avoid tension within communities • May not be an appropriate material especially when communities have traditionally been using thatch made from natangora leaf, coconut palm, split cane or a combination of these materials. • Can be dangerous in cyclones. 	<ul style="list-style-type: none"> • No environmental benefits • CGI sheeting is a valuable material and can be useful if the householder needs to raise funds, for example during or post-disaster (provided they are not deteriorated due to the way they are used or fixed). 	<ul style="list-style-type: none"> • Use optimum design calculations to minimize cut wastes • Use certified products and avoid using in corrosive environments (e.g. volcanic regions) • Avoid contact with ground or high levels of moisture if using for wall panels • Encourage reuse of uncorroded sheets from old buildings • Store in a dry place in suitable stack heights and use proper packaging and loading/unloading procedures in transport. • Never dispose of CGI in the environment; it can be easily sold as scrap metal.
<p>NATANGURA THATCH, SAGO PALM, VANUATU BANGULU PALM TRI</p> <p>Key facts</p> <p>Various local materials used for wall and roof cladding. Materials used very across the islands. Often woven by women.</p> <p>Main use</p> <p>Rafter, purlin, roof, mat, broom</p> <p>Roof cladding: natangora leaf, coconut palm, split cane, combination.</p>	<ul style="list-style-type: none"> • Natangora may be dipped in chemicals to increase the life span - need for correct disposal. Part of the traditional preservation methods is to smoke the buildings that have thatched roofs. • Without proper management, it may have impacts on forests and natural vegetation. • Material needs seasoning and may cause water pollution if not properly managed. • Natangura / pandanus are sometimes overharvested, not only in amount but also in timing, which can kill off the plant (Erakor Bridge, Erakor Village, Mele, Pango, and Seaside). The supply for natangura for traditional roof thatching is not meeting local demands and as a 	<ul style="list-style-type: none"> • No requirement for quarried material or clay • No firewood or energy requirement • Support Ni-Van livelihoods and knowledge 	<ul style="list-style-type: none"> • Never dispose of chemical treated natangora in streams or coastal areas. • Non-chemical treated materials do not harm the environment since they are biodegradable. However, avoid disposing of large quantities in streams, estuaries and coastal areas. • Support local livelihoods and industries

<p>Key Govt. actors n/a</p> <p>Related laws/legal frameworks n/a</p>	<p>consequence costs are rising (e.g. in Mele).⁴</p> <ul style="list-style-type: none"> Consider fire risk in planning and design since thatch is combustible 		
<p>TARPAULIN SHEETS</p> <p>Key facts</p> <p>SCV distribution item</p> <p>Main use</p> <p>Shelter material and wall panels (in temporary structures), Weather proofing building sites</p> <p>Key Govt. actors</p> <p>NDMO</p> <p>Related laws/legal frameworks</p> <p>Vanuatu Waste Management Act</p> <p>Resources:</p> <p>Recycling, Reuse and Disposal of Plastic Sheeting, Operational Guidance Note, Global Shelter Cluster 2018</p>	<p>Extraction: Tarpaulin sheets are layered sheets that sandwich a polyester woven fabric base between plastic films. Crude oil is the main raw material used for production.</p> <p>Transport: Transport can damage rural roads.</p> <p>Production/Treatment: Emits greenhouse gasses during production. Untreated wastes from factories contain toxic chemicals and cause water pollution.</p> <p>Toxicity: Chemicals contain toxic substances.</p> <p>Vanuatu Waste Management Act Ban on single use plastics (2018) : from 1 July plastic straws, single use plastic shopping bags and polystyrene takeaway boxes are longer allowed for sale or distribution. This resulted from three orders made under the Vanuatu Waste Management Act. This ban potentially impacts forms of emergency shelter assistance (tarpaulins, packaging of household items etc).</p>	<ul style="list-style-type: none"> Encourage reuse of material. 	<ul style="list-style-type: none"> Reuse, Recycling and Disposal of Plastic Sheeting, – Operational Guidance note (Bislama) Encourage the use of natural fibers (e.g., coir) in fiber reinforced plastic sheets . Design to optimum criteria to minimize wastage. Never dispose of in the environment; only dispose of in a sanitary landfill.

Timber species and local tree building construction materials

Source: Department of Forestry

⁴
<https://www.sprep.org/attachments/Publications/IOE/pebacc/port-vila-social-mapping-analysis-ecosystem-use.pdf>

Scientific Name:	Family Name:	Common Name/ Bislama:
<i>Garuga floribunda</i>	Burseraceae	Namalaus
<i>Instia bijuca</i>	Fabaceae	Natora
<i>Pterocarpus indicus</i>	Fabaceae	Bluwota
<i>Dysoxylum aneityensis</i>	Meliaceae	Red sting wud
<i>Myristica fatua</i>	Myristicaceae	Nagaoaga
<i>Mimosop elengi</i>	Sapotaceae	Natariu
<i>Cryptocaria turpinata</i>	Lauraceae	
<i>Veichia winin</i>	Palmae	Palm
<i>Donax canniformis</i>	Marantaceae	Nanene
<i>Terminalia catapa</i>	Compretaceae	Natapoa
<i>Castanospermum australe</i>	Fabaceae	Bintri
<i>Pouteria costata</i>	Sapotaceae	Komtri
<i>Gardenia tannaensis</i>	Rubiaceae	
<i>Gyrocarpus americanus</i>	Hernandiaceae	Kenu tri
<i>Dysoxylum armoroides</i>	Meliaceae	Stingwud
<i>Adenanthera pavonnia</i>	Fabaceae	Red sida(Bisa)
<i>Ficus subcodata</i>	Moraceae	Nabanga
<i>Aglaiia saltatovum</i>	Meliaceae	
<i>Neo nauclea fosteri</i>	Rubiaceae	Naboga
<i>Macaranga tannarius</i>	Euphorbiaceae	Navenue
<i>Micromelum pinnatum</i>	Rutaceae	Nalangu
<i>Acasia simplex</i>	Fabaceae	Namariu(solwota)
<i>Acasia spiropis</i>	Fabaceae	Namariu(Bush)

<i>Bampusa vulgaris</i>	Bampusaceae	Bambu
<i>Elatostagis falcata</i>	Sapindaceae	
<i>Syzygium nomoa</i>	Myrtaceae	Wael nakaviga
<i>Agathis silbae</i>	Araucariaceae	Kauri
<i>Bischofia javanica</i>	Euphorbiaceae	Nakoka
<i>Casuarina equistifolia</i>	Combretaceae	Orktri
<i>Diospyros samoensis</i>	samoensis	
<i>Macaranga dioica</i>	Euphorbiaceae	Navenue-boe
<i>Calophyllum inophyllum</i>	Guttiferae	Nabagura
<i>Calophyllum neo ebudicum</i>	Guttiferae	Tamanu
<i>Hibiscus tiliaceus</i>	Malvaceae	Burao
<i>Dysoxylum gaudichaudianum</i>	Meliaceae	Stingwud
<i>Antiaris toxicaria</i>	Moraceae	Melektri
<i>Syzygium malaccense</i>	Myrtaceae	Nakaviga
<i>Alphitonia zizyphoides</i>	Rubiaceae	Nadovae
<i>Pometia pinnata</i>	Sapotaceae	Nadao
<i>Cyathea lunulata</i>	Cyatheaceae	Blackpalm
<i>Calamus vanuatuensis</i>	Arecaceae	Navolae
<i>Preynia disticta</i>	Euphorbiaceae	Nadame
<i>Aleurites moluccana</i>	Euphorbiaceae	Candel tri
<i>Croton insulare</i>	Euphorbiaceae	Namamahao
<i>Glochidion stepulare</i>	Euphorbiaceae	Namamalau
<i>Pittosporum campeli</i>	Pittosporaceae	
<i>Pongamia pinnata</i>	Fabaceae	

<i>Trema orientalis</i>	Ulmaceae	
<i>Aceratium oppositifolia</i>	Elaeocarpaceae	
<i>Tapnospermum kajewskii</i>	Myrsinaceae	
<i>Metrosideros collina</i>	Myrtaceae	
<i>Pleigynium timorensis</i>	Anacardiaceae	Red nakatabol
<i>Vaavea amicorum</i>	Meliaceae	
<i>Pandanus sp</i>	Pandanaceae	Naveveo
<i>Buckella obovata</i>	Sapotaceae	Naduledule
<i>Syzygium nutans</i>	Myrtaceae	Wael nakaviga
<i>Dracontomelon vitiense</i>	Anacardiaceae	Nakatabol
<i>Cleidon speciflorum</i>	Euphorbiaceae	
<i>Celtis paniculata</i>	Ulmaceae	
<i>Serianthes aneityensis</i>	Fabaceae	Wael krismastri
<i>Palaquium neo-ebudicum</i>	Sapotaceae	
<i>Endospermum medullosum</i>	Euphorbiaceae	Waet wud
<i>Pinus caribaea</i>	Pinaceae	Pine
<i>Elaeocarpus floridanus</i>	Elaeocarpaceae	Tanna waet wud
<i>Samanea saman</i>	Fabaceae	Raintri
<i>Leucaena leucocephala</i>	Fabaceae	Kasis
<i>Santalum album</i>	santalaceae	Sandal wood
<i>Canarium indicum</i>	burseraceae	nangai

Hazardous building materials

Avoid the use of hazardous or harmful substances in all shelter programs.

Asbestos exists in some residential and non-residential buildings in Vanuatu. There is an asbestos pit on Efate.

References:

- [The State of Asbestos in the Pacific](#)
- [Safety and collection guidelines for asbestos](#)
- [Green Guide to Construction](#)

Tools:

- [Flash Environmental Assessment tool - FEAT focuses primarily on immediate and acute impacts arising from released hazardous chemicals.](#)

Recommendations for shelter practitioners when choosing/sourcing building materials

- Reforestation can be a good way to produce sustainable building materials.
 - Reforestation is one of the priority activities of the Forestry Department. The Department can provide technical advice starting from seedling collections, nursery establishment and management and on woodlot/plantation establishment and management.
 - One example of a reforestation project is the Maewo 'Second Homes' project for Ambae displaced includes using (invasive) Cordia timber for recovery and reconstruction and replanting new native tree crops. The project, also on Ambae, will also plant tree nurseries and conduct trainings such as sawmill training in 2020.
- When sourcing natural resources such as water, timber, sand, soil and grasses, and fuel for firing bricks and roof tiles, be aware of the environmental impact.
- In large emergencies, the best for the environment is to promote multiple materials and multiple sources because any material or source will become environmentally damaging when used at huge scale. The challenge is that this approach takes more time.
- Promote socially acceptable reuse of salvaged materials, where the rights to such material and quality can be confirmed
- A rapid market assessment and analysis and an environmental impact assessment should inform the selection of materials.
- Sourcing materials locally may affect the local economy, workforce or the natural environment. In some situations, adequate quality materials may not be available locally. In those situations, use alternative materials or production processes, or

commercial shelter systems, but consider the impact of using materials which are unfamiliar to the local culture.

- Strike a balance between locally used materials and minimising environmental impact.
- Any certified materials available in Vanuatu? System of certification in place for sustainable sourcing, safety of materials, etc?

Cash programs and natural building materials

Consider the impact on natural resources of an influx of cash for shelter materials that might already be under pressure e.g. injection of cash could lead to increased chainsaw / logging operation for production of locally milled timbers for housing reconstruction.

Resource:

- [Cash and environment guidance](#)

Access to technical assistance

Technical assistance is an integral part of shelter and settlement responses. It supports the self-recovery of affected people and improves the quality and safety of their shelter and settlement. It is essential that affected households or communities are actively involved in choosing their accommodation, the design of shelters, determining the site layout in choosing materials, and supervising or building shelters and other construction.