



1<sup>ST</sup> EDITION / DECEMBER 2023

BUILDING MATERIALS  
IN THE HUMANITARIAN SECTOR

# SOMALIA

GUIDELINES FOR  
SUSTAINABLE RESOURCE MANAGEMENT  
OF BUILDING MATERIALS



#### HOW TO USE

The recommendations presented here for Somalia are not intended to replace local analyses in specific contexts. It remains essential to supplement the information gathered in this document with field surveys that will enable discussions with local stakeholders and residents on the constraints and potential of their territories in terms of land tenure, lifestyles, material and human resources, practices, knowledge and capacities for implementing construction work.

The practices presented in the document are not exhaustive, represent only a sample of those that exist, and some deserve to be better documented. They are constantly evolving and need to be analyzed at the local site level.

## Foreword

Following the production of a Shelter Response Profile for Somalia in 2022 and the beginning of 2023, this document presents reflections and recommendations for the sustainable management of construction materials in habitat, housing and shelter projects in Somalia.

The term sustainable can be understood in different ways in the construction sector. In this document, we propose to provide an integral perspective that considers social, cultural, environmental, and economic aspects.

The construction of shelters, housing and other infrastructure is essential to the quality of life and dignity of communities. Beyond that, construction is a driver of recovery and development, through the activity it will generate locally. But it can also have an impact on the land, its resources, and the wider environment.

In order to encourage building practices that have the greatest possible positive impact on the local area and communities, and also to consider contributing to the overall effort that needs to be made to reduce greenhouse gas emissions, it is necessary to be able to assess these different aspects. To what extent will the local economy benefit from the project? What will the project's environmental footprint be?

Questions relating to the appropriateness of the use of construction materials in different contexts, recycling, reuse, and reduction in the use of materials are at the origin of this guidance document, produced by CRAterre and the Shelter Cluster in Somalia, with the support of UNHCR, ECHO and the Global Shelter Cluster.

This document is not exhaustive but suggests avenues to be explored in greater depth, particularly in the light of local conditions, for more sustainable construction projects.

### ➤ CONTEXTUALIZATION OF SHELTER PROJECTS AND SUSTAINABILITY

This document intends to help improve shelter projects' contextualization and sustainability. Contextualization can help to limit the management of industrial or toxic waste and the recycling or reuse of materials that are difficult for local people to use.

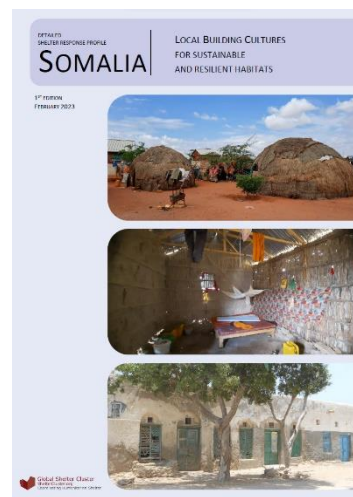
These guidelines are also a way of improving the cultural appropriation of dwellings or shelters, respect for the local and global environment, and promoting the climatic adaptation of buildings and maintenance by their inhabitants, who will have the knowledge, know-how, and means to undertake these tasks.

### ➤ FOR MORE INFORMATION

ENGLISH VERSION:

[Detailed Shelter Response Profile for Somalia: Local Building Cultures for sustainable and resilient habitats](#)

Published in February 2023 with contributions from CRAterre, Somalia Shelter Cluster, Global Shelter Cluster, UNHCR, Unité de Recherche AE&CC - ENSAG - Université Grenoble-Alpes, IFRC, ECHO, BHA-USAID, IOM, and the following partners of the Shelter Cluster in Somalia: AJJRO, AMARD, APPED, AVORD, AYUUB, DRC, HAPEN, HINNA, IRDO, Juba Foundation, LRDO, Mercy Corps, NRC, SASDO, SEA, SHO, SOYVA, WARDO



Cover photos:

Different construction materials in Somalia CC – Enrique Sevillano Gutiérrez - CRAterre



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## Glossary

**Adobe houses:** Adobes (sun-dried raw earth bricks) are traditionally used in two kinds of buildings in Somalia, particularly in the north (Puntland and Somaliland)<sup>1</sup>: in coastal towns, they are present together with stone, usually in the same buildings; in rural areas, adobes appear alone as closing walls of constructions called *dargad*<sup>2</sup>, which usually have a timber structure supporting a nearly flat roof.

**Aqal:** Pastoral nomads live in demountable and transportable round dome-shaped huts called *aqal* constructed of collapsible wood frames covered in panels woven from palm fronds, acacia bark, cotton fabrics recycled from old dresses<sup>3</sup>, as well as sometimes leather. It is carried on camels' backs and set up by women once a new camp is made. *Aqal* are about 1.50 to 2.13 meters in height; the size depends on availability of materials, and they are bigger in areas where materials are more easily accessible<sup>4</sup>. In pastoral zones, a house is the woman's territory and possession<sup>5</sup>, and they are the builders of *aqal*.

**Baraako (or caarish):** These constructions built with wattle and daub walls have a rectangular plan and a two or four slopes roof (made of metallic sheets) and are one of the permanent vernacular houses of Somalia. These houses are found in the agricultural areas of the country<sup>6</sup>, but also in the coastal areas to host fishermen<sup>7</sup>, and in the district and provincial capitals of the interior<sup>8</sup>. Their size varies from short (3 m) to medium span buildings (6 m)<sup>9</sup>, with diverse lengths.

**Biobased construction materials:** Biobased construction materials are materials that are partially or wholly derived from biomass, such as wood (timber and related products), hemp, rapeseed, rice husk, straw, flax shives, cork, corncob, reed, sheep's wool, etc.<sup>10</sup>

**Buul:** Many IDPs and urban poor live in dome-shaped makeshift housing called buul, built with materials sourced in nature, in local markets, through recycling or through humanitarian assistance. Buul are self-built, which is a solution for IDPs and urban poor due to rising housing prices<sup>11</sup>. Buul exist in vernacular architecture as the smaller huts where live

single young women or widows within a nomadic compound<sup>12</sup>. In this case, materials used come from nature and recycling and shelters are more comfortable.

**Circular economy:** The circular economy is a production and consumption model that involves sharing, renting, reusing, repairing, refurbishing, and recycling existing materials and products for as long as possible. In this way, the life cycle of products is extended. In practice, this means reducing waste to a minimum. When a product reaches the end of its life, its materials are retained in the economy, as far as possible, through recycling. These materials can be reused productively, creating additional value<sup>13</sup>.

**Daar:** Towns and villages in the north of Somalia, as well as in the coast have historically used local stones (especially coral limestone, and sometimes with parts made of raw earth adobe bricks) to construct houses and other buildings: mosques, stores, administrative buildings, courtyards, perimeter walls<sup>14</sup>... These houses have generally white facades.

**Geologic construction materials:** Geologic construction materials are materials derived from mineral resources, such as raw earth or dry stone<sup>15</sup>.

**Habitat:** Habitat is the place, in a general sense, where people and communities live<sup>16</sup>.

**Infrastructures<sup>17</sup>:** There are two types of infrastructure: networked and non-networked. Networked infrastructure includes energy, transport, water, waste treatment, and digital communications. Non-networked infrastructures include housing and shelters, health centers, schools, markets, industrial facilities, community centers, courts and prisons, public buildings, etc.

**Local and minimally processed materials:** When they are local and minimally processed, biobased and geologic construction materials generally have a low environmental footprint<sup>18</sup>.

<sup>1</sup> Diriye Abdullahi (2001)

<sup>2</sup> Diriye Abdullahi (2001)

<sup>3</sup> Janzen & Lewis (2022)

<sup>4</sup> Fullerton & Adan (1995)

<sup>5</sup> Mambo (2014), as cited in Said (2019)

<sup>6</sup> Mambo (2014), as cited in Said (2019)

<sup>7</sup> Marco (1994)

<sup>8</sup> Countries and their cultures (n.d)

<sup>9</sup> Joffroy et al (1992)

<sup>10</sup> République française (n.d.)

<sup>11</sup> Bonnet et al (2020)

<sup>12</sup> Fullerton & Adan (1995)

<sup>13</sup> European Parliament (2023)

<sup>14</sup> Maisons du Monde (n.d)

<sup>15</sup> République française (n.d.)

<sup>16</sup> Association Sphère (2018)

<sup>17</sup> Thacker et al (2018)

<sup>18</sup> République française (n.d.)

**Local building cultures (LBC):** A building culture is an intangible dimension of what is produced by humans to live, work, thrive, etc. It includes assets related to each phase of the building life cycle: design, construction, use(s), maintenance, replacement, extension, adaptation, etc., that are linked to social, economic, environmental, and cultural aspects. The genesis and evolution of building cultures are closely linked to their environment and the specific history of each territory. This is why they are so diverse worldwide and why several building cultures can co-exist within a single territory.

**Mundul:** These constructions are mainly found in the interior of central and southern zones, where lives a sedentary population of farmers. They have a circular plan with cylindrical walls made of wattle and daub and conical thatched roofs<sup>19</sup> and their plan has a diameter of 3 to 4 m<sup>20</sup>.

**Recycling:** The recovery of waste materials for conversion into new products, materials, or substances, whether at origin or for other purposes. This includes the reconditioning of organic materials but does not include energy recovery or reconditioning into materials for use as fuel or for landfill operations<sup>21</sup>.

**Reduction:** Increasing the efficiency of the manufacture or use of products by consuming fewer natural resources and materials<sup>21</sup>.

**Reuse** of a product that is still in good condition and fulfills its original function (and is not waste) for the same purpose for which it was designed<sup>21</sup>.

**Revalorization:** Some materials are derived from the reuse of waste, by-products, and co-products, such as cellulose wadding, recycled textiles, pallet wood, cardboard, etc. These materials are part of a circular economy<sup>22</sup>.

**Shelter:** The term shelter is used to refer to both the basic definition of shelter— a ‘habitable covered space providing a secure and healthy environment with privacy and dignity for those residing in the dwelling’— and the process through which this habitable space evolves from emergency shelter to durable solutions, which may take years<sup>23</sup>.

**Sustainable construction:** The term sustainable can be understood in different ways in the construction sector. In this document, we propose to bring a perspective of integral sustainability in the sense of sustainable development, which considers social and cultural aspects as well as environmental, economic, and governance aspects. The VerSus project (Lessons from vernacular heritage to sustainable architecture) integrates these aspects into three main areas of sustainability<sup>24</sup>:

- **Environmental:** the capacity of human intervention to reduce and even avoid the adverse impacts of construction on the environment, which is very sensitive to changes. Human intervention integrates nature and bioclimatic features, controls the production of pollution and waste, preserves health, and prevents natural hazards impacts.
- **Socio-cultural:** the sense of belonging, identity, and personal and community development. This scope tries to gather all social and cultural positive impacts observed on vernacular heritage. It concerns the protection of cultural landscapes, the transmission of construction cultures, the capacity to stimulate creativity, the recognition of cultural values (tangible and intangible), and the reinforcement of social cohesion.

**Socio-economic:** the capacity to reduce the efforts invested during the construction process, the building performance, the maintenance of buildings, and all the impacts that contribute to improving living conditions. Here, the concept of effort and work replaces the idea of cost, especially in contexts where no capital-intensive systems were implemented. Vernacular solutions encourage autonomy and local activity, optimize construction efforts, extend the lifetime of the building and save resources.

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<sup>19</sup> Janzen & Lewis (2022)

<sup>20</sup> Joffroy et al. (1992)

<sup>21</sup> EIB (2020)

<sup>22</sup> République française (n.d.)

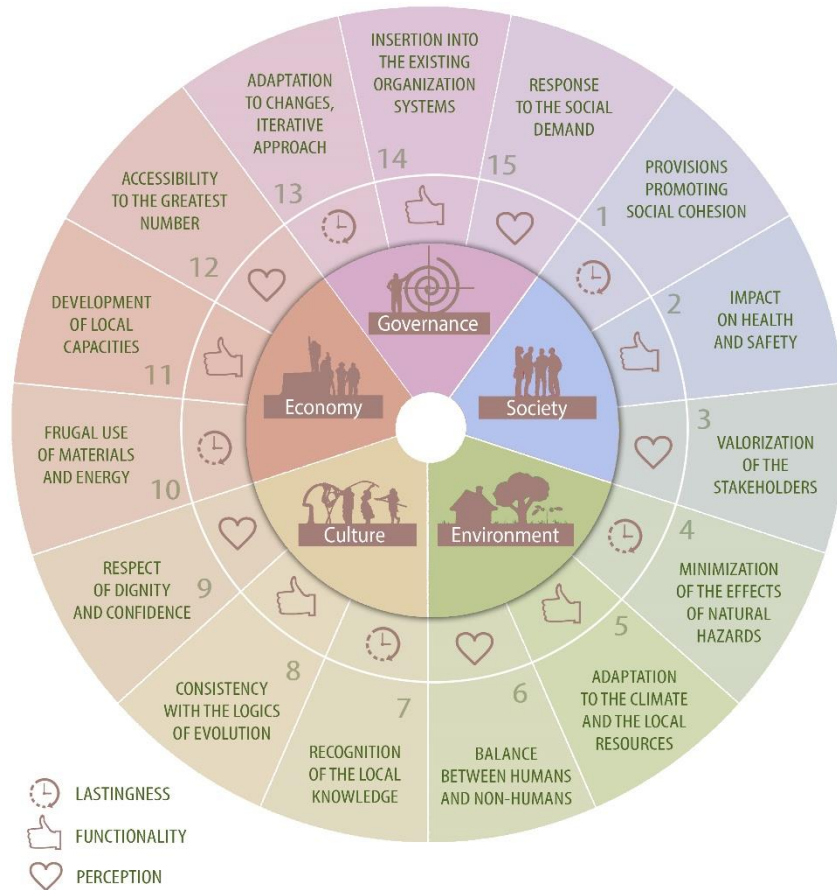
<sup>23</sup> Inter-Agency Standing Committee (2015)

<sup>24</sup> Guillaud et al. (2014)



# [1] Introduction: sustainability in a broad sense

## [1.1] TOWARDS CONTEXTUAL APPROACHES IN SEARCH OF GLOBAL SUSTAINABILITY



Wheel for criteria for a sustainable architecture<sup>25</sup> ©CRAterre, Joffroy T. & Sánchez Muñoz N.

Organizations such as CRAterre have been working for several years to identify construction dynamics in different contexts, including local building cultures (LBCs), to propose appropriate responses to today's major environmental, social, and economic challenges. The aim is to make it easier to identify the strengths and weaknesses of construction dynamics and LBCs and the opportunities they offer to promote them (in an adapted version if necessary) in projects to build, rebuild, rehabilitate, or improve housing or shelters.

It is important to consider that households and communities live in transforming environments due to factors such as climate change, urbanization processes, globalization, changing social attitudes where local practices are being challenged, and the security and humanitarian context.

**SUSTAINABLE MANAGEMENT OF CONSTRUCTION MATERIALS IN THE HUMANITARIAN SECTOR IN SOMALIA**

Sustainability cannot be understood in a partial way by looking only at one of the aspects of the wheel of sustainability principles.

**PEOPLE AT THE CENTER**

Over the years, the people of Somalia have developed numerous strategies for preserving the environment, their living environment, and their livelihoods and for minimizing the impact of natural hazards in the places where they live.

Some of these practices are parallel to housing or shelter and are not necessarily linked to producing materials or housing but are essential to its existence.

All these practices show that people must be at the heart of the analysis of the situation and the decision-making process, as they are at the origin of solutions adapted to their context.

<sup>25</sup> This wheel is an adaptation of the VerSus project "Lessons from vernacular heritage for sustainable architecture" [https://www.esg.pt/versus/pdf/versus\\_booklet.pdf](https://www.esg.pt/versus/pdf/versus_booklet.pdf) widely used in the TCL+ project in Haiti [https://www.youtube.com/channel/UCjNV3BOfxauJDag7m\\_hfepg](https://www.youtube.com/channel/UCjNV3BOfxauJDag7m_hfepg)

## [1.2] STRATEGIES TO MINIMISE THE EFFECTS OF NATURAL HAZARDS AND REDUCE THE ENVIRONMENTAL IMPACT OF CONSTRUCTION

### ► LOCAL BEST PRACTICES TO PROTECT THE ENVIRONMENT/MINIMISE THE EFFECTS OF NATURAL HAZARDS<sup>26</sup>

#### → Frugal and sustainable use of local tangible and intangible resources and adaptation of buildings and lifestyles to climatic and cultural conditions.

Historically, the people of Somalia have been able to make the most of their immediate environment without endangering it. For example, communities in several zones of the country have managed to collect rainwater in public scale infrastructure such as *wars*, but also at the private scale by harvesting rainwater from roofs. Also, regarding the sustainable use of resources, for the construction of *aqal*, women do not touch the main foundation root of acacias, as it is far too deep and its removal would destroy the tree, they use the lesser roots<sup>27</sup>. This avoids deforestation.

#### → Rainwater channeling. Many inhabitants have understood the importance of draining away rainwater to prevent damage to homes and the proliferation of disease-carrying insects, and to do this they dig channels, for example, in the private and public areas of human settlements.

#### → Avoiding fire risk. Families are aware of the fire risk and take measures to avoid it such as cooking in places protected from wind. One solution once fire has started in IDP camps is that people rapidly demount all the buul surrounding the place where fire started so it cannot spread. This is more difficult with other types of houses.

#### → Minimizing flood risk. When possible, communities settle in elevated places to avoid the risk of flood. Also, in several parts of the country, communities build sandbag dams in periods of flood risk, both at infrastructure and domestic levels.

#### ↳ DON'T FORGET STRATEGIES THAT COME WITH LOW IMPACT TECHNIQUES

There is a renewed interest in local, low-processed materials, short supply chains, local economic development, environmental impact, and sustainable development. These approaches are putting the spotlight back on construction techniques. But beyond construction, local populations in Somalia have developed strategies for the sustainable management of their environment.

#### ↳ FOR MORE INFORMATION

Several documents, standards and publications deal with reducing the environmental impact of construction.

[See bibliography](#)

### ► STRATEGIC RECOMMENDATIONS: ENVIRONMENTAL LEVEL

#### → Understand local environmental management systems to contribute to the sustainability of projects.

#### → Use local and minimally processed materials to avoid fuel costs and emissions due to transport, as well as over-consumption of energy during production and processing. What's more, in remote areas that are difficult to access (due to insecurity or the poor state of the road network) local materials represent an undeniable competitive advantage over transport and site supply issues.

#### → Use local, minimally-processed materials, which often offer good thermal comfort, compared with concrete and sheet metal solutions, which offer poorer hygrothermal comfort. Local biobased and geologic materials are usually the source of energy savings during the construction phase, as they are better adapted to local climates.

#### → Design for efficient use of materials<sup>28</sup>; refuse to build if not essential; reduce use of resources; reuse materials; recycle materials; repair existing infrastructure, think about waste treatment, etc.

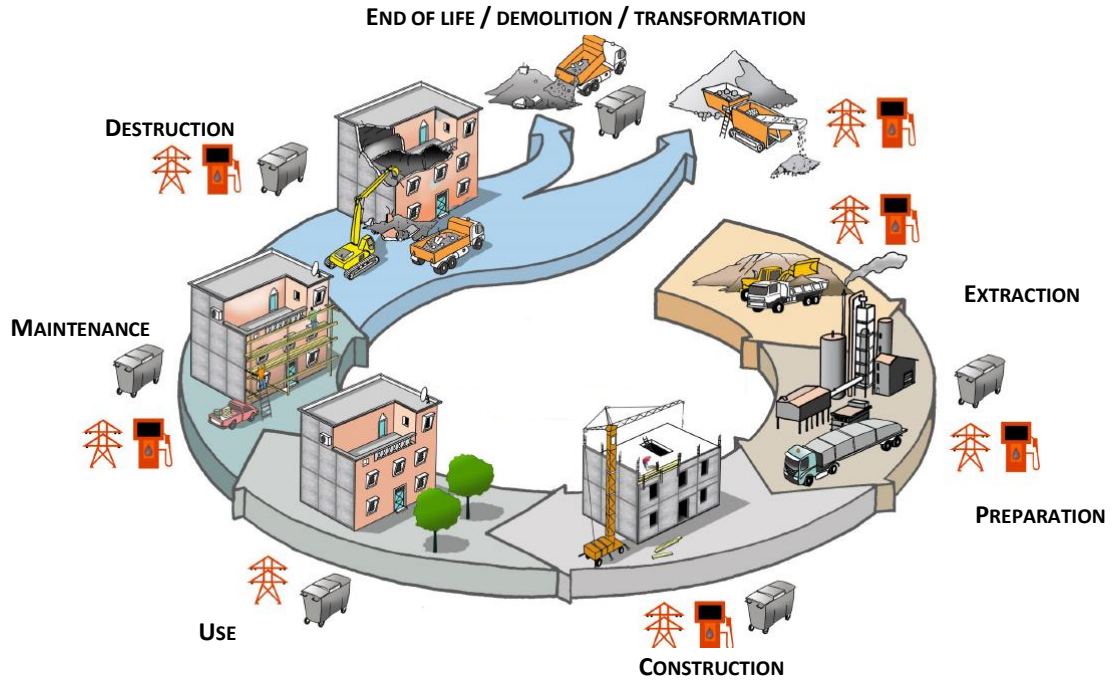
<sup>26</sup> These practices are a small representation of the existing ones

<sup>27</sup> Fullerton & Adan (1995)

<sup>28</sup> The "[Green recovery and reconstruction Training Toolkit](#)" (World Wildlife Fund, Inc. & American Red Cross, 2010) contains recommendations, some of which are in line with sustainable use of material resources.

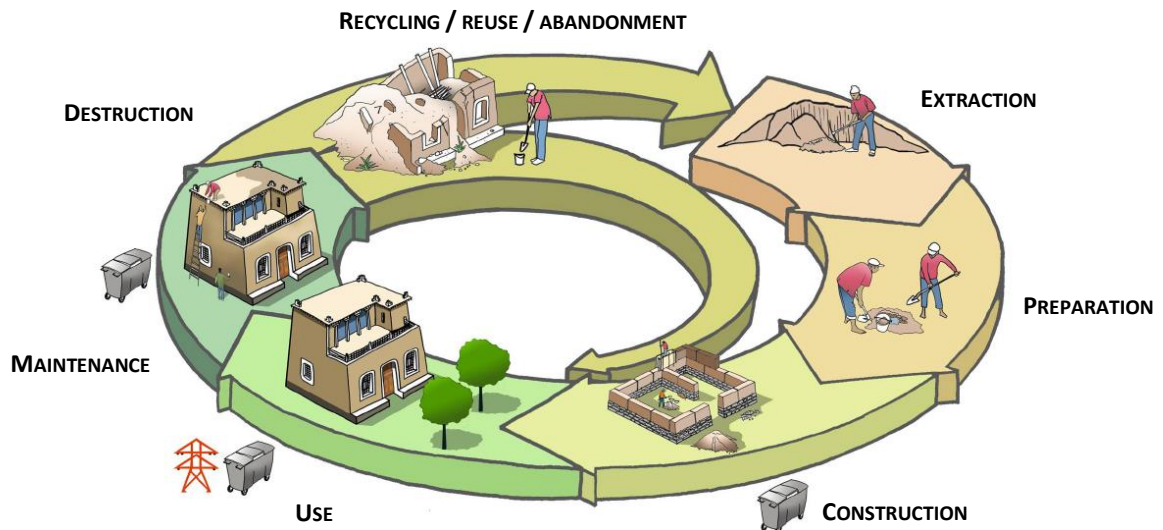
- Design for the climate with a bioclimatic approach that takes into account orientation, site, insulation, thermal mass, ventilation, shading, various issues related to the local climate<sup>29</sup>.
- Design for energy efficiency<sup>30</sup>.

► ACCUMULATION OF WASTE AND OVER-CONSUMPTION OF ENERGY



Vicious circle of building with industrial and processed materials ©CRATERre - Sébastien Moriset & Arnaud Misse

► ENERGY AND WASTE REDUCED TO THE MINIMUM



Virtuous circle of building with local, minimally processed materials ©CRATERre - Sébastien Moriset & Arnaud Misse

<sup>29</sup> World Wildlife Fund, Inc. & American Red Cross, 2010

<sup>30</sup> World Wildlife Fund, Inc. & American Red Cross, 2010

## [1.3] SOCIO-CULTURAL STRATEGIES THAT PROMOTE RESILIENCE

### ► SOCIO-CULTURAL STRATEGIES OF SOMALI POPULATIONS THAT PROMOTE RESILIENCE

#### Neighborhoods and houses to promote social interaction and sense of community

- Some neighborhoods of Mogadishu such as Shingani and Xamar Weyne still have a total absence of boundary walls, common in new constructions. The proximity of buildings and close contact between neighbors has sustained the **social interaction and strong sense of community**<sup>31</sup>.

#### Solidarity mechanisms

- **Giving shelter and food to the traveling visitor** is a cultural institution among Somalis<sup>32</sup>.
- **Savings groups called *Ayuuto*** (Somali for “help”) are very common **interest-free** rotating savings schemes based on mutual trust and primarily run by women in the same neighborhood who know one another and share common experiences. Groups of up to 15 members pool money in a common pot where each member pays a fixed amount. The money is handed over to one person and the next collection goes to another in a similar process until every member receives their pot. *Ayuuto* is an alternative for poor women who live in the displacement camps who do not have access to formal financial services. Beside money, it is a safe space to connect, share their challenges and support each other<sup>33</sup>.

#### Mutual support in construction / access to housing

- ***Goob* is a system of mutual assistance** which exists in construction (and in agriculture), particularly in vernacular models such as *baraako* or *mundul*.
- There is also support for example through **groups of elders who organize the collection of help for vulnerable people** such as new IDPs. Elders ask households to share contributions for the newly arrived: mats, jerrycan, plastic sheets...
- Most IDPs build their own shelters, mainly *buul* which do not have cost for materials or for labor. The only cost is associated with the rental of the plot where the *buul* will be installed<sup>34</sup>. **Many IDPs receive initial help from informal settlement managers, or from friends and relatives.**

#### Mutual support in the construction of *aqal*

- Making the *aqal* is a **collective effort by women**, who sing and recite poems during construction<sup>35</sup>.
- The types of mats *caws* or *harrar* are finished by braiding the top fringe of grass and it is an **occasion for celebration** (the ceremony is called *tidic*) where

#### ↳ MUTUAL AID SYSTEMS

Mutual aid systems are known and practiced historically by the people of Somalia, including in construction, where help from mutuals and neighbors also exists. Building goes beyond the technical and becomes a social and cultural act.

<sup>31</sup> Adbulkadir Ahmed et al (2021)

<sup>32</sup> Diriye Abdullahi (2001)

<sup>33</sup> Hujale (2022)

<sup>34</sup> Bonnet et al (2020)

<sup>35</sup> Mire (2015)

young, unmarried women are invited in the evening to finish the mat while singing songs, which is not a difficult task, but a social event<sup>36</sup>.

- The finalization of the mats called *kebed* is a **communal effort**, and it is a festive ceremony in which the owner will start and invite others (eight to ten women) to join after she has completed a first part<sup>37</sup>. All materials must be ready, and enough food and drink for all. The work takes several days, and once women commit to do it, their families will not migrate until it is finished.

#### **Coping strategies regarding livelihoods**

- In order to cope with changes in weather patterns and other hazards, households have **coping strategies** such as adjusting the timing of mating and birthing, migrating, selling first quality goats in pastoral areas, or adjusting the sowing season and the types of crops at the first rains in areas with crop production<sup>38</sup>.

### ► STRATEGIC RECOMMENDATIONS: SOCIO-CULTURAL LEVEL

- **Facilitate local community involvement.**
- **Take cultural acceptance into consideration** (local acceptance; community participation and analysis of existing practices; construction techniques and knowledge sharing).
- **Promote approaches that encourage the maintenance of mutual solidarity systems**, where they exist, given that they contribute to the weaving of strong social ties. However, we must take into account the fact that today's monetarization of society often favors the paid exchange of services over solidarity.

## [1.4] SUPPORTING THE LOCAL ECONOMY

### ↳ LOW-IMPACT CONSTRUCTION SKILLS

In Somalia, building industries with biobased (timber, thatch...) and geologic materials (earth, stone...) have existed for some time. Similarly, communities are often able to construct quality buildings using local techniques: in general, skills exist to guarantee a proper execution of works, providing good supervision and design of construction, as well as anticipated maintenance plans for low impact building.

### ► STRATEGIC RECOMMENDATIONS: ECONOMIC LEVEL

- **Spend as much of the funds as possible at local level** to promote better living conditions for the target populations.

<sup>36</sup> Fullerton & Adan (1995)

<sup>37</sup> Fullerton & Adan (1995)

<sup>38</sup> FSNAU & FEWS NET (2016)

- Inject resources into the local economy so that the **impact is felt not only by households whose housing has been improved but also by the entire population** through the local construction sector.
- To address the issue of **creating and sustaining a market** capable of providing work for trained technicians and workers and retaining them in construction companies. It is, therefore, important to find mechanisms for sustaining this skilled workforce after their employment in the projects.
- **Promote owner-drive approaches** by providing IDPs with cash and/or materials in kind to build their houses. They may undertake the construction work by themselves, by employing family labor, local laborers, or by using a combination of these options. This approach is more empowering and dignified for households, and it is also often faster and cheaper<sup>39</sup>.
- **Increase self-reliance**, dignity, and well-being by incorporating flexibility into the shelter design for livelihood **opportunities and the potential for IDPs to adapt the shelter**<sup>40</sup>.

#### ↳ CIRCULAR ECONOMY

Technical solutions favoring the circular economy and short circuits enable the bulk of project funds to be injected into local economies, thus promoting the recovery of populations, and constituting an important step towards situations of material stability and improved living conditions in the medium and long term.

## [1.5] TECHNICAL ASPECTS: SITE, DESIGN, IMPLEMENTATION, AND MAINTENANCE

### ↳ AFFORDABLE AND REPLICABLE TECHNIQUES

Technical aspects are essential for the durability of structures. Regardless of the materials used, the quality of design, construction and maintenance ensure that buildings last and reduce their ecological footprint, notably by extending their lifespan.

It is important to note that the techniques used in shelter and housing projects developed by humanitarian organizations have a major influence on the habitat built around them by households. Techniques that are difficult for communities to appropriate should therefore take a back seat to those that draw on local knowledge and know-how and help them evolve.

### ► STRATEGIC RECOMMENDATIONS: TECHNICAL LEVEL

#### Choice of building site

- **Choose sites that do not involve particular risks** (flooding, strong winds, landslides, etc.) for safety reasons and also to reduce the environmental impact of construction, as limiting damage to housing limits the number of materials needed for shelter.
- Building in areas where communities will be able to establish themselves in the long term thanks to the **security of land tenure** is an important strategy for the sustainability of construction.
- Locate new buildings as close as possible to existing **basic services**. Be careful not to saturate them (health, education, water, etc.) or create these basic services.
- Locate camps **close to economic activity opportunities** to enable displaced people to access income.

#### ↳ BUILDING SITE

The location of a building is essential to its sustainability. In the context of population displacement, the right choice of site also makes it possible to use buildings over the long term when conditions do not allow displaced people to return to their places of origin.

<sup>39</sup> Koclejda et al (2022)

<sup>40</sup> Koclejda et al (2022)

## Urban planning and site design

- Check the **general master plan** for the region, town or village, if one exists, to ensure compliance with its requirements.
- Take into consideration the **density of houses / shelters**, the orientation of houses / shelters on plots, and the layout of outdoor and indoor spaces in relation to socio-cultural requirements.
- Plan the location of **infrastructure** (pipes and other services), roads, and access to infrastructure.
- Plan the planting of suitable **vegetation**.

### ↳ SITE PLANNING

Once the construction site has been selected, site planning issues are essential to consider, especially for camps or sites created ex-novo by urban planners or architects.

UNEP & SKAT, 2007  
[After the tsunami. Sustainable building guidelines for South-East Asia](#)

## Design

- Use **simple, hazard-resistant house designs**.
- Emphasize the importance of the **replicability of shelter/housing projects**, bringing construction costs down to levels affordable to low-income households and making technical and spatial choices that take into account local know-how and construction knowledge and needs to make it possible to build projects on a larger digital scale within the limits of existing budgetary resources, but also through self-build strategies.
- Choose **construction models that residents can maintain** thanks to their know-how and the availability of the necessary materials and tools.
- **Consider the entire life cycle**: construction, maintenance, reuse, demolition, and recycling.
- **Consider flexible designs**, easy to adapt to families' changing needs (evolution, extension, etc.).
- Use designs and materials that enable easy **recycling and/or reuse**.
- Integrate **users' needs and aspirations** and take cultural factors into account.

### ↳ DESIGN AND TECHNIQUES

Techniques used in shelter and housing projects developed by humanitarian organizations have a major influence on the habitat built around them by households.

Techniques that are difficult for communities to appropriate should take a back seat to those that draw on local knowledge and know-how.

## Construction

- **Identify needs in terms of supervision, training, and communication**.
- Develop and insist on the **pedagogical dimensions** of projects. **Proceed iteratively**, particularly when building with innovative techniques or those not commonly used in the humanitarian response to shelters or housing. Carry out **pilot and school constructions** to promote best practices and train the companies and workers in charge of the sites.
- **Upgrade the skills of local craftsmen and craftswomen** as part of the projects to achieve better results and also create the foundations for better overall building quality in a given area over the long term.
- **Supervise the construction phase** to avoid unpleasant surprises once the buildings have been completed.
- Ensure that the materials and tools required for the chosen technique are **available**.

### ↳ QUALITY OF CONSTRUCTION

The quality of the workmanship ensures that buildings last longer and are safer in the event of a disaster.

In Somalia, construction is sometimes an activity developed by households, but it is generally carried out by masons from the informal sector who have learned on-the-job. These craftsmen and craftwomen sometimes have the knowledge and know-how to produce quality constructions, but this is not always the case.

- **Take seasonal constraints into account** to assess the availability of inhabitants and materials.
- Analyze the **social organization of the act of building**, its short- and long-term efficiency, and its impact on community cohesion, and value traditional mutual aid systems.
- Promote **local employment** for a better impact on the community.

## Maintenance<sup>41</sup>

- **Raise residents' awareness of the importance of regular maintenance** for longer building life and reduced risk during a disaster.
- Ensure **regular inspection** to know the condition of the building, and to identify or anticipate possible deterioration.
- **Adapt uses to perpetuate the building** (for example, find new families for buildings no longer used by their **original occupants**).
- In the event of structural insecurity, **secure buildings** (temporary reinforcement of structures, prevention of damage, or limitation of access) for the well-being of users pending rehabilitation operations.
- **Care and maintenance of sensitive building elements: effective drainage around the building, foundation-wall-roof anchoring, bracing of the entire structure, underpinning to limit water damage, protection of wooden post bases, protection of walls (plastering, pointing), waterproof roof and operational roof drainage system, etc.**

### ↳ MAINTENANCE IS ESSENTIAL

Maintenance is essential to the life of a building. Good maintenance guarantees a longer useful life and reduces environmental impact.

## [1.6] GOVERNANCE ASPECTS

### ► STRATEGIC RECOMMENDATIONS: GOVERNANCE LEVEL

- **Work in concert with the various stakeholders** present in a territory;
- Adapt to **local organizational systems**;
- Respect the **culture of dialogue and facilitate the expression and decision-making of the different groups of people** living in a community (women, children, men, minorities, the elderly, disabled people, displaced people, etc.);
- **Act iteratively**. Whenever possible, build a prototype first, whose participative evaluation will enable us to propose the necessary corrections and adjustments.

### ↳ GOOD GOVERNANCE

The *Labo de l'Economie Sociale et Solidaire* defines governance as "the set of rules and methods organizing reflection, decision-making and control of the application of decisions within a social body. Governance often evokes "good government" and therefore participatory and inclusive practices. Governance refers to the economic, social, and political spheres, etc".

<https://www.lelabo-ess.org/gouvernance#:~:text=La%20gouvernance%20est%20l'ensemble,des%20pratiques%20participatives%20et%20inclusives>

<sup>41</sup> Main source: programme Africap2016. <http://www.aimf.asso.fr/africap2016/>

## [2] Questions to ask when choosing building materials

### [2.1] THE MAIN BUILDING MATERIALS IN SOMALIA

In this document, the building materials studied are those more broadly used in Somalia: water, raw earth, stone and other materials of mineral origin, gravel, sand, cement-based materials (excluding reinforced concrete), reinforced concrete, local lumber, imported timber, bamboo, other plant-based materials, local materials of animal origin, metallic materials, and plastic materials.




Solution of shelters where each material finds its place in the right part of the building (stone and cement in the foundation and base, wattle and daub in the walls, CGI sheets in the roof), adding value and durability to it. CC – Enrique Sevillano Gutiérrez – CRAterre



#### MATERIAL CARD

The description of materials is presented in the tables called "Material card", which provide practical information: material, extraction, use/techniques, transport, lifespan, cost, know-how, informal/formal economy, urban/rural, large-scale potential, seasonality.

 MATERIAL CARD	
Material	
Extraction	
Application/techniques	
Transport	
Service life	
Cost	
Know-how	
Informal/formal economy	
Urban/rural	
Large-scale potential	
Seasonality	


## [2.2] SELF-QUESTIONNAIRE TO HELP IN THE CHOICE OF BUILDING MATERIALS

A table has been created to help self-ask the right questions when choosing building materials. The below table, "Self-questionnaire for material selection" covers issues relating to the extraction, production, transport, construction, use, and end-of-life of a material.

A critical analysis of the material resources needed for construction in a humanitarian operation, whether in terms of extraction, production, import, etc., is essential to understanding the impact of construction on the environment and society. Similarly, it is essential to analyze materials and techniques in terms of their constructive qualities, cost, lifespan, maintenance requirements, availability on the market, aesthetics, economic impact on communities, and the ecological footprint of a building with a given material.

### ↳ CASE-BY-CASE TABLE

Rather than a material-by-material basis, the proposal is to fill out the table on a **case-by-case** basis when setting up a shelter or housing project, so it can best decide on the appropriateness of using a specific material in a particular context. To complete this table, an analysis of impacts and advantages is carried out by building material in the following chapter.

 <b>SELF-QUESTIONNAIRE FOR MATERIAL SELECTION</b> <sup>42</sup>			
<i>Questions</i>	<i>Yes</i>	<i>No</i>	<i>Depends on context</i>
<b>Selection</b>			
Has the community been involved in the choice of the material?			
<b>Extraction / production / transport</b>			
Does the material extraction, production and/or transport have an impact at the settlement level?			
Is the material produced locally?			
Are all or part of the materials imported?			
Is it economical, abundantly available and/or easily renewable?			
Is it produced in a remote factory?			
Does production require special machinery and equipment?			
Can the material be produced on-site at low cost?			
Does production require much energy?			
Does production generate waste/pollution or other environmental problems?			
Is there an acceptable alternative material that eliminates any production problems? If yes, which one?			
Was production carried out under an environmental management plan?			

<sup>42</sup> Some questions are suggested by Wyss (2005). This table is to be adapted to each context and answered by organizations in the design phase of construction programs.

Was production carried out in compliance with decent working conditions?			
Are transport costs high?			
<b>Construction/use</b>			
Are the material and architectural design adapted to the climatic context?			
Are the material and architectural design sufficiently safe in the event of natural hazards in the area?			
Does the use require a lot of energy?			
Is there an acceptable alternative material that eliminates any problems during use? If yes, which one?			
Can the local population use and understand the material and technique without the need for specialized skill and experience?			
Can the material and architectural design be easily appropriated by a population that did not have access to assistance from the humanitarian sector?			
Is the material socially acceptable / is it associated with dignified housing?			
Can repair and maintenance be resolved locally?			
<b>End of life</b>			
Does end-of-life generate waste and pollution?			
Is the material recyclable?			
Is the material reusable?			



### [3] Sustainable management of building materials in Somalia<sup>43</sup>

This chapter focuses on the impacts, advantages, and recommendations for the sustainable management of building materials most used in Somalia at different levels, environmental, socio-economic, cultural, etc., and for improving the management of materials from the environment point of view.

Recommendations are given for improving materials management regarding extraction, good socio-economic practices, design, construction, service life extension, reuse, and recycling.



#### **DON'T REDUCE A CONSTRUCTION TO A SINGLE MATERIAL**

It is not relevant to carry out only partial analyses that reduce the complexity of a construction to a given material, as constructions are always made with a combination of materials.



#### **▾ BUILDING MATERIAL SELECTION**

Intelligent, frugal combinations of low-processed local materials and industrial materials should be considered. To achieve this, materials need to be selected based on their availability, their contribution to the durability of structures, their technical and financial accessibility, their potential for reuse or recycling, and the environmental impact of their use for housing the greatest number of people.

Construction of a pilot house built by IOM using adobe bricks for the wall's elevations and stone masonry for the foundation and base in Baidoa © Héctor Esteban - CRAterre

<sup>43</sup> Main sources:

[Detailed Shelter Response Profile for Somalia: Local Building Cultures for sustainable and resilient habitats](#) (Sevillano Gutiérrez et al, 2023)

[Building Material Selection and Use An Environmental Guide 2nd Edition](#) (Hettiarachchi, M., & al., 2021)

[Green recovery and reconstruction Training Toolkit](#) (World Wildlife Fund, Inc. & American Red Cross, 2010)

[After the tsunami. Sustainable building guidelines for South-East Asia](#) (UNEP & SKAT, 2007)

### [3.1] WATER



Surface water collection and storage systems are very common in parts of the country. Wars (open air water reservoirs) close to Baidoa  
CC – Enrique Sevillano Gutiérrez – CRAterre



Water fetching in Qoryooley (CC – UN Photo – Tobin Jones)



Water on the back of carts in Merca (CC – UN Photo – Tobin Jones)

#### IMPACTS AND DISADVANTAGES

##### Water scarcity

- The scarcity of water in the period preceding the rainy seasons makes it difficult to build in certain areas of the country with techniques that require a lot of water for their production or implementation (for example use of cement blocks and mortar, concrete, or adobe masonry).
- Water is not always readily available, even during the rainy seasons or immediately afterwards.
- Environmental degradation in Somalia is particularly associated with the problems of drought and water scarcity, and coping with these hazards has become a vicious cycle as these problems lead to solutions that have negative consequences and create additional hazards : the spread of private berkads (sort of water pits) has helped create all-season grazing in some areas, but has also contributed to long-term environmental degradation; water trucking in arid soils has had consequences on the land such as gully erosion.

##### Humanitarian dependence

- Many water systems are reliant on humanitarian assistance, and many primary water sources have stopped functioning, which means longer distances to travel and additional threats to safety and dignity, including GBV, as women and children are responsible for collecting water<sup>44</sup>.

## ADVANTAGES

- N/A.

## GOOD PRACTICES

### Water collection

- Interview the local population to find out what practices are used to access water and what possibilities exist locally, sometimes simpler than those introduced by humanitarian actors. For example: There are different traditional methods for rainwater collection within houses, from gutters to superficial drainage and [berkad](#) (see annex). Also, communities in several zones of the country have managed to collect rainwater in public scale infrastructure such as [wars](#) (see annex).

### Management

- To access water (for construction, but also for life in human settlements), it is recommended to choose different solutions depending on the context: connection to the public water network, drilling, traditional well, boreholes, spring development with gravity system, rainwater harvesting, water transport by tanker truck... These systems should be chosen to supply the quantities of water required for construction and should be as close as possible to the construction site, ideally serving as a source of drinking water for the local population. The options are therefore diverse: connect to the running water network if it exists, make a traditional well with a pump system where the water is closer to the surface, drill a borehole where the water table would be deeper...
- There is a need to consider the frequency and maintenance costs generated by each of the water access systems, in addition to the cost of purchasing the equipment, the human context, the hardness of the soil, the depth to reach the water table and the availability of water throughout the year or not, as some of these systems may be difficult to implement.
- If water is scarce, when building it's best to use water not fit for human consumption to preserve drinking water.
- If possible, build during the period when water is widely available.
- Minimize the use of water in areas where it is scarce, by choosing construction techniques such as those used by the country's nomadic populations based on lightweight materials of plant origin.
- Informal quarries (earth or stone) help to provide water during the dry season that can be used for building.

### Construction

- Water containing salt should never be used to mix concrete or cement mortar, neither to produce adobes or plasters, as salt reduces the strength of concrete and adobes and corrodes steel reinforcement in concrete.

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<sup>44</sup> UN-OCHA (2022)

### [3.2] RAW EARTH



Woman smoothing a *baraako* house in Janaale , South West State (© Thierry Joffroy – CRAterre)



*Mundul* near Janaale, South West State (© Thierry Joffroy – CRAterre)



*Barako* house in Baidoa (South West State) (CC – Enrique Sevillano Gutiérrez - CRAterre)



Adobe house (transitional shelter) under construction in Baidoa (© Héctor Esteban – CRAterre)



Compressed Earth Blocks production in Doolow (Jubaland) (CC – Enrique Sevillano Gutiérrez - CRAterre)



Adobe blocks production (raw earth + water + sand) in Doolow (© IOM)

## IMPACTS AND DISADVANTAGES

### Environmental degradation

- The extraction of materials from informal quarries remains an environmental problem, as they are often operated without authorization, without a management plan, with little control over extraction sites, with uncovered quarries, etc.
- The most used earth technique in Somalia is wattle and daub, which requires important amounts of timber and vegetal fibers. This can cause deforestation if not well managed and particularly when the scale of projects is too important.

### Management issues

- Possible lack of availability nearby for a large number of constructions: quarrying problems.

### Socio-economic disadvantages

- Use of agricultural land is a concern (the land to be built on has to be taken from the non-arable layer).
- Extraction can leave large pits that can present health risks (falls, mosquito proliferation with stagnant water...).

## ADVANTAGES

### Environmental advantages

- Earth is a material that can be recycled for life (provided it is not stabilized with cement or lime).
- Earth is available in abundance in practically all parts of the country, and it is manually processed to build with wattle and daub, or as a mortar or plaster. It can help build sustainable housing both quantitative and qualitatively.
- Earth promotes independence from heavy, polluting industries.
- Local material that does not require transportation.
- Earth creates no pollution or waste.
- Extraction and processing of local raw materials do not require expensive tools.
- The carbon footprint of raw-earth buildings is virtually zero, as the processing of the materials uses little or no fossil energy.

### Health and comfort benefits

- Earth (soil) is a healthy material with no toxic elements (unless contaminated by waste).

- Soil extraction can be carried out in such a way as to favor the development of channels, retention basins, dikes, embankments (access to water).
- A wide variety of solutions enabling a high level of comfort if the bioclimatic conditions of each site are considered.
- Effective moisture regulator in interior spaces, increasing comfort.

### **Community autonomy**

- Used for millennia in Somalia (wattle and daub, adobe, mortar, floors, plasters...). These building cultures are the result of knowledge, know-how and collective intelligence improved over the centuries, through trials, failures and successes.
- Local raw earth building cultures have several advantages: they prevent family impoverishment by benefiting the local economy and the independence of local residents from costly industrial materials that they cannot produce. What's more, they promote the sharing and equitable distribution of wealth, avoiding the enrichment of a minority to the detriment of the majority.
- Soil is an abundant material, often free or at lower cost, and available close to most construction sites, saving on transportation.
- The wattle and daub and adobe techniques are suitable for building affordable housing that promote comfortable conditions in homes, as well as cultural adaptation and ease of construction and maintenance for households.
- The material can encourage local autonomy as it makes self-building possible and reduces economic dependence on the building materials market, thus avoiding debt.
- Stimulates local activity by encouraging local production, processing, and trade. The production of certain materials is labor-intensive.
- Quarries (formal or informal) provide employment for many households and are a source of lower-cost materials. What's more, water is scarce in some areas during the dry season, and the water ponds formed in the quarries provide troughs for domestic animals.

## **GOOD PRACTICES**

### **Extraction and management**

- When projects have a large scale, it is necessary to properly manage quarries for extracting earth, sand or stone to avoid damaging the environment.
- Extract soil in areas where it cannot cause any danger or impact on the environment and manage the useful life of quarries as well as their end-of-life.
- Extracted soil can be used to create canals, retention basins, dykes, etc.

### **Socio-economic good practices**

- Support local livelihoods / industries through the use of these minimally processed local materials.

### **Design and construction**

- Design, build and maintain correctly to ensure long-term sustainability.
- Use local knowledge and building cultures (for wattle and daub, this has to be considered very linked to timber resource availability in order to avoid deforestation).
- Many *baraako* houses have four sloped roofs with overhangs, which protect facades from sun radiation and from rain.
- Doorsteps to prevent water from entering houses are a common practice.
- Drainage is an important strategy to keep wall bases free of moisture and direct contact with water.

### **Lifespan extension**

- To improve the lifespan of earthen constructions, water must be kept away from the base of the walls. This can be done in two main ways: by building a foundation of non-water-sensitive materials, if possible, with a barrier against rising water; or by building houses on earthen platforms with slopes that help drain rainwater away from the base of the walls. The sides of buildings exposed to driving rain should be protected with plasters compatible with the walls (avoid cement as much as possible).
- Improve the resistance of walls with bases made of inert materials (stone, cement blocks, and with anti-dump plastic membranes or similar between base and wall...).

- In many cases, earthen walls have no inert base and sometimes inhabitants add wild stone or earth masses creating a sort of masonry bench or at least a slope to protect the base of walls exposed to rainwater. This sacrificial mass must be maintained to prevent the base of the wall from eroding.
- Avoid building earth walls in flood-prone areas.
- Improve the strength of the surface by applying an earth plaster every year with stabilizers commonly used by communities.
- Adobe masonry walls can have buttresses in the weakest points and are often covered with earth-based plaster. These houses may have stone or adobe (thicker) bases.

**Reuse and recycling**

- Earth is a lifelong recyclable material without losing its cohesive characteristics (provided it's not stabilized with cement or lime).

### [3.3] STONE AND OTHER MATERIALS OF MINERAL ORIGIN



Use of coral stone in buildings of Mogadishu old town (CC - Franck Keillor)



Limestone in Somaliland (CC - Abdirisak)



Stone used in foundation and plinths in Baidoa (CC - Enrique Sevillano Gutiérrez - CRAterre)



Kiln for lime production using coral limestone in Merca (South West State) (1980s) (© Thierry Joffroy - CRAterre)



Construction in Baidoa (South West State): reinforced concrete as bearing structure and stone as infill for walls (CC - AMISOM)



Whitewashed (with lime) adobe houses in Doolow (Jubaland) (© IOM)

## IMPACTS AND DISADVANTAGES

### Environmental degradation

- Unplanned rock extraction can cause landslides and hydrogeological impacts.
- Extraction of materials from informal quarries remains an environmental problem, as they are often operated without authorization, without a management plan, with little control over extraction sites, with unplugged quarries, etc.
- Increased coastal mining (including coral stone mining), affects coastal ecosystems and coral reefs near population centers.
- Both live coral rock in shallow waters and onshore fossil coral limestone occur along some areas of the coastline and are seen as a useful source of building material where the larger boulders sizes are used as building bricks / stones and when broken, can be mixed into concrete as stones and sand<sup>45</sup>.
- Regarding the impact of the current scale of coral rock and limestone quarrying, mention is made of some community-based activities in Somalia resulting in an environmental impact rating of direct and uncontrolled<sup>46</sup>.
- Lime production requires firing. The firing process (especially on a small scale) leads to air pollution and deforestation phenomena.

### Socio-economic disadvantages

- Rock extraction from quarries sometimes involves blasting. Without planning or protection, blasting leads to occupational hazards.
- Quarries cause noise, dust, pollution, habitat destruction and vibration if not properly managed.
- Transporting material can affect rural roads.
- Extraction can leave pits that can present health risks (falls, presence of mosquitoes with stagnant water...).

## ADVANTAGES

### Environmental advantages

- Stone is endlessly recyclable and can be sourced from many parts of the country in sufficient quantity and quality to build sustainable housing.
- Local stone requires no transportation and creates no pollution or waste.
- The carbon footprint of buildings constructed with local materials is virtually zero, as the processing of the materials uses little or no fossil energy in the country. Stone and laterite rock are available in different areas of the country, their processing is manual, and they are reusable mineral resources.
- Water is scarce in some areas during the dry season, and water ponds formed in quarries provide troughs for domestic animals.
- Stone (where it exists) is an abundant material, often free or at lower cost and available close to most building sites, saving on transport.

<sup>45</sup> Barwell (2016)

<sup>46</sup> Barwell (2016)

### **Socio-economic advantages**

- Quarries (formal or informal) provide employment for many households and are a source of low-cost materials. The production of certain mineral materials is labor-intensive.
- Local stone building cultures have several advantages: they prevent family impoverishment by benefiting the local economy and the dependence of inhabitants from costly industrial materials that they cannot produce. What's more, they promote the sharing and equitable distribution of wealth by preventing the enrichment of a minority.
- Local materials promote independence from heavy, polluting industries.
- Wide variety of possible solutions that give rise to a high level of comfort if bioclimatic conditions are taken into account.
- Effective temperature regulator (thermal inertia) in interior spaces, increasing comfort.
- Use of the material can encourage local self-sufficiency as it reduces economic dependence on the materials market, thus avoiding indebtedness, promotes local production, processing, and trade.

## **GOOD PRACTICES**

### **Extraction and management**

- When projects are on a large scale, it is necessary to properly manage quarries for extracting earth, sand or stone to avoid damaging the environment.
- Use only in areas where stone can be extracted without causing danger or environmental impact.
- Minimize the use of lime from small-scale producers using wood-fired kilns in deforested areas.

### **Design and construction**

- Use local knowledge and building cultures. Stone is particularly used in foundations and plinths in areas where it is available. This material used in the right place helps to protect earthen wall elevations.
- Use good storage and loading practices when transporting.
- Design, build and maintain correctly to ensure long-term durability.
- Use local earth mortars or lime mortars wherever possible when earth is not suitable.

### **Potential alternatives to cement**

- As for lime, its overall environmental impact is much lower than that of cement. Moreover, lime production can be improved by using specific kilns and controlling the amount of water used after burning. However, an increase in the use of local lime would have a direct impact on local wood resources, which are already heavily used, and would have to be accompanied by specific programs for the management of lime production and forest preservation.

### [3.4] GRAVEL



Production of gravel in Mogadishu (CC AMISOM - Tobin Jones)



Gravel quarry in Mogadishu (CC AMISOM - Tobin Jones)

#### IMPACTS AND DISADVANTAGES

##### Environmental degradation

- Infrastructural development and building construction using concrete results in heavy dependence on natural resources, including the basic components of building material, including coarse aggregate (stones) for concrete<sup>47</sup>.
- Gravel is often extracted illegally from rivers or quarries, contributing to bank erosion and displacement, increasing bank slopes, leading to changes in river morphology, can cause riverbank collapse, loss of land and/or adjacent structures, downstream changes in deposition patterns and destruction of riparian habitats.
- Unplanned extraction of gravel and sand can cause landslides and hydrogeological impacts.
- Extraction of materials from informal quarries remains an environmental problem, as they are often operated without authorization, without a management plan, with little control over extraction sites, with unplugged quarries, etc.

##### Socio-economic disadvantages

- As with stone, extracting gravel from quarries can involve blasting. Without planning or protection, blasting leads to occupational hazards. Quarries cause noise, dust, pollution, habitat destruction and vibration if not properly managed.
- Although gravel production (crushing) is a source of income for many families, it is associated with fairly arduous working conditions.
- Gravel production is often controlled by influential local residents.

#### ADVANTAGES

##### Lifespan

- Cement-based materials have good constructive characteristics when used in the right places in constructions (foundations, underpinnings) and are appreciated by most users.

##### Socio-economic aspects

- The production of certain materials (gravel) is labor-intensive.

#### GOOD PRACTICES

##### Alternatives

- Use alternatives to concrete and cement-based products, if possible local, non-polluting solutions.

<sup>47</sup> Barwell (2016)

**Design and construction**

→ Mix concrete in small quantities to minimize waste. Do not mix more than is used in two hours.

**Recycling**

→ Use crushed debris as an alternative to gravel. If 30% recycled coarse aggregate is used, the modulus of elasticity is 17% lower, making the concrete still usable for the desired strength requirements<sup>48</sup>.

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<sup>48</sup> Hettiarachchi, M., & al (2021)

### [3.5] SAND



Use of sand for cement mortar production  
CC – Cospe

#### IMPACTS AND DISADVANTAGES

##### Environmental degradation

- Infrastructural development and building construction using concrete results in heavy dependence on natural resources, including the basic components of building material, including sand<sup>49</sup>.
- Catchment degradation due to poor land-use practices including agriculture and uncontrolled mining activities such as sand excavation from rivers and the destruction of riverine habitat are practices that have a negative impact on coastal communities and causes coastal erosion<sup>50</sup>. Coastal erosion occurs in places due to the coastal system being starved of its sources of sand particularly due to aggregate mining in rivers and from foredunes, beaches and the shoreface<sup>51</sup>.
- Regarding the impact of the current scale of beach sand mining, mention is made of activities in Somalia resulting in an environmental impact rating of direct and uncontrolled<sup>52</sup>.
- Sand is often extracted illegally from rivers or quarries, contributing to bank erosion and displacement, increasing bank slopes, leading to changes in river morphology and even the coastline. In addition, it can cause riverbank collapse, loss of adjacent land and/or structures, downstream changes in deposition patterns and destruction of riparian habitats.
- Unplanned extraction of gravel and sand can cause landslides and hydrogeological impacts.
- Extraction of materials from informal quarries remains an environmental problem, as they are often operated without authorization, without a management plan, with little control over extraction sites, with unplugged quarries, etc.

##### Socio-economic disadvantages

- Although sand production is a source of income for many families, it is sometimes associated with fairly harsh working conditions.
- River sand extraction is often controlled by influential local residents.

<sup>49</sup> Barwell (2016)

<sup>50</sup> Barwell (2016)

<sup>51</sup> Barwell (2016)

<sup>52</sup> Barwell (2016)

## ADVANTAGES

### Lifespan

- Cement-based materials have good constructive characteristics when used in the right places in constructions (foundations, underpinnings) and are appreciated by most users.

## GOOD PRACTICES

### Alternatives

- Use alternatives to concrete and cement-based products, if possible local, non-polluting solutions.

### Design and construction

- Use standardized block sizes to minimize the use of setting mortar (sand) and plaster (sand).
- Mix in small quantities to minimize waste. Do not mix more cement mortar than is used in two hours.

### [3.6] CEMENT-BASED MATERIALS (EXCLUDING REINFORCED CONCRETE)



Production of cement hollow blocks in Puntland (CC – Heimo Liendl)



Shelter built with cement blocks with possibility of extension in Garowe, Puntland (CC – Malini Morzaria / EU ECHO)



Production of CSEB (Compressed Stabilized Earth Blocks) in Kismaayo (Jubaland) (© IOM)

#### IMPACTS AND DISADVANTAGES

##### Environmental degradation

- Infrastructural development and building construction using cement-based materials results in heavy dependence on natural resources, including cement, and sand for blocks and mortar<sup>53</sup>.
- The cement industry is one of the most polluting. The use of these construction solutions (cement and reinforced concrete) contributes to climate change. Cement production is energy-intensive, polluting and a source of greenhouse gases that have an impact on climate change. It accounts for 8% of the world's annual production of CO<sub>2</sub>.

##### Humanitarian dependence

- Many water systems are reliant on humanitarian assistance, and many primary water sources have stopped functioning, which means longer distances to travel and additional threats to safety and dignity, including GBV, as women and children are responsible for collecting water<sup>54</sup>.

#### ADVANTAGES

##### Lifespan

<sup>53</sup> Barwell (2016)

<sup>54</sup> UN-OCHA (2022)

- Cement-based materials have constructive characteristics that are good when used in the right places in constructions (foundations, plinths...).
- If well built, properly designed and implemented, it's resistant to extreme conditions, especially flooding.

#### **Possible reduction in the use of wood**

- No need for lumber in load-bearing structures.

#### **Social aspects**

- The construction of cement block houses is not limited to a specific season, so masons can work at any time.
- These types of materials are often appreciated by the local population.

### **GOOD PRACTICES**

#### **Alternatives**

- Use alternatives to concrete and cement-based products, if possible local, non-polluting solutions.

#### **Design and construction**

- Use standardized block sizes to minimize the use of setting mortar and plaster.
- Store cement in a dry, waterproof building with as little humidity as possible.
- Optimize mixing: do not overdose (waste) or underdose (lack of strength) cement.
- Mix in small, sufficient quantities to minimize waste. Do not mix more fresh concrete or cement mortar than will be used in two hours.

#### **Reuse**

- Never dispose of cement-based products in the environment. These can be either reused on-site / off-site for construction purposes (e.g. filling) or transported to a building materials recycling area, or controlled landfill.

### [3.7] REINFORCED CONCRETE



Because of its high cost, reinforced concrete is not widely used by the majority of the Somali population. Nevertheless, reinforced concrete structures are used in construction, particularly in towns. Construction in Mogadishu (CC – UN Photo – Stuart Price)

#### IMPACTS AND DISADVANTAGES

##### Environmental degradation

- Infrastructural development and building construction using concrete results in heavy dependence on natural resources, including the basic components of building material, namely cement, sand and coarse aggregate (stones) for concrete and mortar<sup>55</sup>.
- The cement industry is one of the most polluting. Cement production is energy-intensive, polluting and a source of greenhouse gases that have an impact on climate change. It accounts for 8% of the world's annual production of CO<sub>2</sub>. The use of these construction solutions (reinforced concrete) contributes to climate change.
- The manufacturing process for concrete reinforcing bars requires large quantities of metal, which can contribute to the negative impacts of mining, CO<sub>2</sub> production, impacts on climate change.

##### Socio-economic disadvantages

- Revenues are concentrated on a few people, whether for cement or concrete reinforcing steel. Also, gravel or river sand is often controlled by influential local residents.
- The execution of concrete constructions is not always of very good quality; this is due to a lack of know-how and adherence to standards. At present, and for areas where transport networks are not in good condition, this type of architectural solution is extremely costly and, due to the difficulties of controlling the realizations (landlock, cost of control), it is very difficult to have guarantees on the quality of the realizations.
- In rural areas and for less affluent urban populations, industrial materials are expensive and difficult to obtain.
- Transporting the materials needed to build with reinforced concrete can damage rural roads.

<sup>55</sup> Barwell (2016)

## ADVANTAGES

### Lifespan

- Concrete realizations have constructive characteristics that are good when used in the right places in constructions (foundations, plinths...).
- If well built, properly designed and implemented, it's resistant to extreme conditions, especially flooding.

### Possible reduction in the use of wood

- No need for lumber in load-bearing structures (but need of timber for formworks and need of lumber props for slabs).

### Social aspects

- The construction of cement block houses is not limited to a specific season, so masons can work at any time.
- These types of materials are often appreciated by the local population.

## GOOD PRACTICES

### Alternatives

- Use optimal design calculations to minimize waste.
- Use alternatives to concrete, if possible local, non-polluting solutions.

### Design and construction

- Store cement in a dry, waterproof building with as little humidity as possible.
- Optimize mixing: do not overdose (waste) or underdose (lack of strength) cement.
- Mix in small, sufficient quantities to minimize waste. Do not mix more fresh concrete or cement mortar than will be used in two hours.

### Reuse

- Never reuse rebar to build again in reinforced concrete, as this is structurally unsafe.
- Never dispose of cement-based products in the environment. These can be either reused on-site / off-site for construction purposes (e.g. filling) or transported to a building materials recycling area, or controlled landfill.

### [3.8] LOCAL LUMBER



Use of local lumber and branches of small sections for the structure of a *baraako* house without plaster (CC - Enrique Sevillano Gutiérrez - CRAterre)



Construction of the structure of a buul with small section lumber (Doolow) (CC - Enrique Sevillano Gutiérrez - CRAterre)



Use of lumber in the framework of a vegetal roof (Merca, Jubaland) (© Thierry Joffroy)



Lumber sold in Doolow (Jubaland) (CC - Enrique Sevillano Gutiérrez - CRAterre)

## IMPACTS AND DISADVANTAGES

### Environmental degradation

- Wood is the main construction material for many Somalis. It is used as framework *baraako* or *mundul* and as framework of all inclined roofs.
- Local timber has been widely used in construction and continues to be so despite increasing deforestation. Wood is becoming scarcer due to the climate crisis, increasingly frequent floods washing out the soil, prolonged periods of drought and high demand due to population growth, and in particular wood does not have time to renew itself to meet demand.
- Timber extraction can lead to forest destruction, landslides, soil degradation and habitat destruction, as well as flood risks, droughts and a growing spiral of hardship.
- Today, cutting trees for timber production is proving an unviable alternative in the quest for local materials as building materials.

### Management problems

- Timber production (forestry) is not being established in most of the areas hosting displaced people, with timber coming from natural areas. This means increased pressure on forests.
- In times of famine or financial hardship, households often harvest wood to sell as charcoal. This has a major impact on the environment.
- Attempts to control illegal logging cause conflict with communities.
- The relations between charcoal producers and local communities are complex. In many cases, producers are actual members of the community, but in some cases outsiders have taken control of forest resources, production and sale of charcoal. Many conflicts have arisen, and casualties recorded over this business. Although producers may be aware of traditional rules and regulations governing harvesting of whole trees, branches or dead wood, violations of such rules are now widespread – many people having no alternative option as a source of livelihood<sup>56</sup>.

### Socio-economic disadvantages

- The population uses wood as firewood, most often in three-stone fireplaces, which are very inefficient in terms of firewood consumption.
- The use of toxic chemicals for treatment purposes entails environmental and health risks.

## ADVANTAGES

### Environmental advantages

- It's a renewable resource, if properly managed. Wood from forestry has minimal impact on natural forests. In this sense, forestry can become a priority, both commercially and environmentally.
- Community forestry projects can reduce environmental problems and provide sustainable livelihoods for communities.
- Mitigating the impacts of climate change through tree plantation is particularly important in areas where heavy rains cause flooding and topsoil erosion, which deforestation can only exacerbate.

### Community self-sufficiency

- Plant-based materials are traditionally used and provide good comfort in homes.
- This material can encourage community autonomy as it makes self-building possible. Wood can reduce economic dependence on the building materials market, thus avoiding indebtedness. This can contribute to the local economy and the livelihoods of local communities.
- Community forestry projects can provide sustainable livelihoods to neighboring communities.

<sup>56</sup> United Nations Environment Programme (2005)

## GOOD PRACTICES

### Extraction and management

- When wood is used in construction, sustainable management must be followed: it is necessary to use wood from reliable and legal sources, and consider reforestation as a contribution to habitat solutions that will use wood responsibly.
- Avoid timber extraction in areas where deforestation worsens the effects of flooding and promotes topsoil erosion, and thus mitigate the effects of climate change.

### Design and construction

- Avoid oversizing timber structures. Carry out appropriate structural design and calculate wood requirements accordingly. Minimize cut-offs.
- Store wood in a covered, dry place, high up but taking care to lift it well to avoid sagging.
- Minimize the use of timber for formwork, prefer reusable modular formwork instead.

### Extending service life

Termites are very frequent in rural and urban areas. Wood needs termite treatment to ensure its long-term durability. In this sense, local people have developed a range of strategies over time, which can vary locally. Some examples are shown here:

- Selecting materials: Some local woods are termite-proof, and are very durable<sup>57</sup>, even though these trees may be endangered today because of deforestation problems.
- Treatment of materials: There are several local recipes for termite control: the acacia roots used for the aqal structure are warmed with ash and shaped during one week, after what they are treated with a solution of the bark of the acacia tree, called *asal*, which protects them against termites<sup>58</sup>; the holes to embed in the soil the structural *qabax* used as structure of the aqal (semi-circular shaped poles) are dug about 45 cm (mid-arm) and salt or myrrh are put in the holes to keep away the termites<sup>59</sup>.
- Active strategies: The presence of poultry in concessions helps to control the arrival of termites.

Wooden posts can have rotting problems when in contact with the ground. To prevent this from happening, or to avoid having to replace the whole post when it does, it is possible to:

- Build poles in two joined parts, of which the one in contact with the ground would be "sacrificial", once damaged, the short part in the ground -fusible- can be easily replaced without affecting the main structure.
- Build posts insulated from the natural ground with water-resistant bases (stones, fired bricks or cement blocks, small concrete elements).
- Build wooden posts embedded in concrete (in this case, they cannot be easily substituted).

### Reuse

- Chemically untreated wood can be reused for many purposes, depending on the condition of the wood: survey stakes, caissons for concreting, floorboards, beams, door and window frames, structural elements.
- Chemically treated timber cut-offs should be considered hazardous and never be used as firewood.

### Recycling

- Non-chemically treated wood can be recycled for uses such as landscaping, animal bedding or use as fuel.

<sup>57</sup> Joffroy et al (1992)

<sup>58</sup> Fullerton & Adan (1995)

<sup>59</sup> Fullerton & Adan (1995)

### [3.9] IMPORTED TIMBER



Use of imported sawn timber as framework in a shelter in Doolow, Jubaland (CC - Enrique Sevillano Gutiérrez - CRAterre)



Plywood panels and sawn timber sections used in a shelter in Doolow (Jubaland) (CC - Enrique Sevillano Gutiérrez - CRAterre)

## IMPACTS AND DISADVANTAGES

### Environmental degradation

- It is used as framework for many types of walls such as CGI sheets and framework of roof structures. It is mostly imported nowadays, particularly squared timber. There is a real knowledge of minimalist use of imported wood. Natural wooden logs are sometimes taken from nature, despite deforestation problems.
- Manufacturing takes place in factories that can cause air and water pollution if poorly managed.
- CO<sub>2</sub> is produced during manufacturing, with subsequent impacts on climate change. Similarly, cutting down trees reduces their absorption of CO<sub>2</sub>.
- The manufacture of plywood panels uses chemical binders and takes place in large plants using energy-intensive processes. Processing leads to air pollution.
- Timber production (forestry) is not set up in most areas hosting displaced people, with timber coming from natural areas. This means increased pressure on forests.
- Transporting sawn timber from manufacturing countries generates significant CO<sub>2</sub> emissions.

### Socio-economic disadvantages

- Poorly managed factories cause pollution from solid waste, noise and air.
- The use of toxic chemicals for processing leads to environmental and health risks.
- Timber transport can further damage forests and rural roads.
- Income is concentrated on a few people.
- Lifespan
- Imported sawn wood or plywood is frequently attacked. Termites affect joinery, doors, windows, frames, planks, furniture and carpentry<sup>60</sup>.

<sup>60</sup> Joffroy et al (1992)

## ADVANTAGES

### Environmental advantages

- It's a renewable resource, if properly managed. Wood from forestry has minimal impact on natural forests. In this sense, forestry can become a priority, both commercially and environmentally.
- Community forestry projects can reduce environmental problems and provide sustainable livelihoods for communities.
- Plywood panels are manufactured using sawmill by-products, plus they have the ability to be pre-formed into efficient dimensions and thicknesses.

## GOOD PRACTICES

### Extraction and management

- The population is increasingly using non-local sawn timber for construction, reducing the use of local wood. This has an impact on transport emissions, but not on deforestation in the country.
- When wood is used in construction, sustainable management must be followed: it is necessary to use wood from reliable and legal sources, and consider reforestation as a contribution to housing solutions that will use wood responsibly.

### Design and construction

- Wherever possible, avoid oversizing timber structures. Use appropriate structural design and calculate wood requirements accordingly. Minimize cut-offs.
- Schedule timber delivery according to the phase of the project during which it will be needed to avoid unnecessary exposure to the elements.
- Store wood in a covered, dry place, high up but taking care to lift it well to avoid sagging.
- Minimize the use of wood for formwork (where applicable), prefer reusable modular formwork.
- Extending service life
- Wood needs termite treatment. Treat wood correctly to ensure its long-term durability. There are several recipes for treating wood, which may vary locally depending on product availability (see "Extending service life" in section [Local lumber](#)).
- Wooden posts can have rotting problems when in contact with the ground. There are several strategies for avoiding these problems (see "Extending service life" in section [Local lumber](#)).

### Reuse

- Chemically untreated wood can be reused for a number of purposes depending on the condition of the wood: survey stakes, caissons for concreting, floorboards, beams, door and window frames, framing members.
- Cuttings from chemically treated wood should never be used as firewood.

### Recycling

- Chemically untreated wood can be recycled for uses such as landscaping, animal bedding or use as fuel.

### [3.10] BAMBOO



Farms along the river Dawa is prone to raging floods. Bamboo trees planted by farmers along river Dawa and Ganane in Doolow Somalia in a bid to reduce sediments flowing into rivers (© Nomadic Assistance for Peace and Development)

#### IMPACTS AND DISADVANTAGES

##### Environmental degradation

- Given its invasive nature, bamboo can quickly take over nearby forests.

##### Management issues

- Overharvesting means that greener bamboo is being used while it does not meet the standard of dryness required to extend its longevity.

##### Socio-economic disadvantages

- Mostly imported material. Revenues concentrated on a few people.

#### ADVANTAGES

##### Environmental advantages

- Bamboo has the potential to control desertification as it would reduce the impact on natural forests. It can be grown along the riverbanks.
- The high strength, low cost, rapid growth and potentially high availability of bamboo makes this an ideal resource.
- Replenishes rapidly and over-extraction can usually be managed, except for massive pressure.
- The complex root system of bamboo can be used to stabilize unstable embankments and slopes.

#### GOOD PRACTICES

##### Management good practices

- Good crop management practices can increase bamboo crop yields by up to 400%.
- The best seasons for harvesting bamboo are usually the rainy ones, but it is necessary to study the best season in Somalia.
- It is necessary to treat bamboo properly.

##### Reuse and end of life

- Encourage reuse (e.g., door and window frames, roof elements).
- Never dispose of chemically treated bamboo in water courses. Chemically treated cut-offs should be considered hazardous and never be used as firewood.

### [3.11] OTHER PLANT-BASED MATERIALS



Nomadic constructions (*aqal*) made mostly from plant fibers in Doolow (CC - Enrique Sevillano Gutiérrez - CRAterre)



This *caw* (grass) is woven into mats for the construction of *aqal* (CC - Shafi)



Conical thatched roofs of *mundul* (Banta, Jubaland) (© Jorge Acero)



Thatched roof in a *baraako* (© Thierry Joffroy - CRAterre)

## IMPACTS AND DISADVANTAGES

### Environmental degradation

- Straw is becoming scarcer due to the climate crisis, increasingly frequent floods that wash away the soil, prolonged periods of drought and high demand due to population growth. Deforestation and soil degradation are also the responsibility of populations who burn areas to clear them.
- Pressure on the use of these resources increases the risk of erosion, deforestation, landslides and flooding. This can deprive communities of resources essential to their livelihoods and expose people, infrastructure and ecosystems to an increased risk of future disasters.

### Socio-economic disadvantages

- Thatched roofs have a limited lifespan, due to its susceptibility to rot and insect infestation. If the roof is smoked by fire indoors, this lifespan can increase. That said, exposure to smoke inside the house, when cooking with wood (or charcoal), has harmful effects on health.

## ADVANTAGES

### Renewable resource

- Straw is a renewable resource if properly managed.
- Many types of thatch are a by-product of agriculture, which would be wasted if not used for roofing or animal feed.

### Community self-sufficiency

- Material available to households within reach or on a small industrial scale. Can support local people's livelihoods and enhance their knowledge.
- Extraction and processing of local raw materials do not require very expensive tools.

### Environmental benefits

- Avoids the use of metal or concrete materials in roof construction.
- No need for firewood or energy for its production.
- It is biodegradable.
- If well designed and constructed, a thatched roof is lightweight and therefore requires less wood to support it.

## GOOD PRACTICES

### Management

- Appropriate management of natural or cultivated vegetation (reeds, grasses, branches, etc.) is necessary to avoid negative impacts on ecosystems.

### Good socio-economic practices

- Use local knowledge in the management of these resources.
- Support the livelihoods of the local population and local industries.

### Design and construction

- One way to show local possibilities for roofing humanitarian projects without using plastic or metal perhaps to test thatched roofs in places where straw is available.

### Extending service life

- Thatch needs to be protected against insects and for greater durability. This can, however, be solved by regular inspections. Hen farms are also very useful for insect control.
- Consider the risk of fire when planning and designing as the material is combustible.
- If well designed and constructed, a thatched roof is very durable.

### **Recycling**

- Thatch can be composted, spread on the ground or buried in the soil and left to decompose naturally, provided it has not been chemically treated. Avoid disposing of large quantities in watercourses.

### [3.12] LOCAL MATERIALS OF ANIMAL ORIGIN

#### IMPACTS AND DISADVANTAGES

- Cow dung is not usually available in sufficient quantities for large-scale projects, needing to forecast the availability of these materials with sufficient anticipation.

#### ADVANTAGES

- Cow dung provides good resistance to earthen plasters.

#### GOOD PRACTICES

- These materials are resources valued by communities and used in construction.
- Goat twine is used in aqal for protection of structural elements, which extends lifespan.

### [3.13] METAL SHEETS AND OTHER METALLIC MATERIALS



CGI sheets roofs are more and more prevalent in sedentary constructions (Baidoa) (CC – Enrique Sevillano Gutiérrez – CRAterre)



House completely covered with CGI sheets (Doolow, Jubaland) (CC – Enrique Sevillano Gutiérrez – CRAterre)

#### IMPACTS AND DISADVANTAGES

##### Environmental degradation

- The manufacturing process requires large quantities of metal (depending on the material: iron, steel, zinc and other metals), which can contribute to the negative impacts of mining.
- Manufacturing takes place in large, energy-intensive factories. Plants can cause severe air and water pollution if poorly managed. Manufacturing processes can release toxic heavy metals.
- Production generates CO<sub>2</sub> emissions and impacts on climate change.
- Importing raw materials (iron, zinc, aluminum, and others) to production plants (often located in different places than where the minerals are extracted) also generates greenhouse gas emissions.
- The transport of manufactured products (often from coastal countries in the sub-region) also has an impact on greenhouse gas emissions.

##### Socio-economic disadvantages

- Transport can damage rural roads.
- Income is concentrated on a few people.
- In rural areas and for less affluent urban populations, industrial materials are expensive and difficult to obtain.
- There is the financial difficulty of changing an element of a metallic roof when it is damaged (compared with thatched roofs).
- Another problem in areas where conflicts take place is the fact that sheet metal can be looted (low weight and easy to transport) for resale.

##### Disadvantages for health and comfort

- Dangerous in high winds. The main problem is the possible uplift of sheet metal due to high winds and inappropriate fastenings that can cause injury and loss of life.
- Metallic roofs and walls cause discomfort and can lead to health problems. The sheets reflect some of the sun's rays due to its shiny surface, but also heat up and diffuse heat throughout the house. During the day, the interior of the house and the roof itself become very hot. As the sheets rust, they become darker in color and reflect less and less. As a result, building interiors get hotter and hotter.
- In addition to their thermal disadvantage, metal sheet roofs are noisy during rainy periods.
- Sheet edges can be very sharp, so transporting and handling sheet metal can be dangerous, and hands need to be protected.

## ADVANTAGES

### Socio-economic advantages

- Sheets are easy to transport and lightweight. The supporting structure can also be quite simple and light.
- Sheets are valuable and can be sold if households need to raise funds, for example in times of conflict or after a disaster.
- Corrugated sheeting can eventually be assembled and disassembled elsewhere, and is appreciated by the local population.
- The use of corrugated sheets, although more expensive than straw or plant-based coverings for aqal, is becoming more democratic, and they are available from suppliers at reasonably affordable costs.
- Metal tubes for shelter structures are unaffected by termite attack, prolonging their useful life.

## GOOD PRACTICES

### Management

- Use certified products.

### Design and construction

- Use optimal design calculations to minimize waste.
- Avoid contact with the ground or high humidity levels if used in walls.
- To improve comfort under this type of roof, the recommendation would be to provide ventilation systems, as well as false ceilings to limit discomfort due to radiation from the sheets. In fact, false ceilings compensate for certain defects in the roof sheets: they reduce noise and create thermal insulation.
- Avoid using CGI sheets in corrosive environments (e.g. by the sea).
- Avoid using CGI sheets in walls and search for options with local materials.

### Extended service life

- Proper installation and fastening of the cover is important to ensure watertightness and good mechanical strength of the cover.
- Corrosion resistance makes aluminum sheeting more environmentally friendly than steel sheeting in corrosive environments. Aluminum is a light but strong metal that's not prone to corrosion, is non-toxic, durable and can be shaped at will. It is more durable than galvanized sheet steel, but more expensive.

### Reuse

- Encourage the reuse of uncorroded sheet metal from old buildings, unless you think it was stolen during a conflict.
- Never dispose of metal sheets in the environment; it can be sold as scrap metal.

### [3.14] PLASTIC MATERIALS



Tarpaulin plastic sheet reused in a *buul* (Doolow) (CC – Enrique Sevillano Gutiérrez – CRAterre)



Anti-dump membrane between stone base and adobe elevation (Baidoa) (CC- Héctor Esteban - CRAterre)



Shelters covered with plastic sheets (Baidoa) (CC – Enrique Sevillano Gutiérrez – CRAterre)

#### IMPACTS AND DISADVANTAGES

##### Environmental degradation

- These petroleum-derived materials contribute to environmental degradation during their manufacture, which consumes large amounts of energy and pollutes the air during the combustion required for their production. The oil industry is at the root of major environmental problems.
- Production generates CO<sub>2</sub> emissions and impacts on climate change.
- The import of raw materials (petroleum) to production plants (often located in different places from where oil is extracted) also generates greenhouse gas emissions.
- The transport of manufactured products also generates an impact on greenhouse gas emissions.
- The end of life of the material is that it usually becomes waste, generating pollution.

##### Socio-economic disadvantages

- Plastic tarpaulins and sheets (for walls and roofs) present several problems related to their lack of durability and thermal discomfort in buildings.
- No toxicity in use but can emit dangerous fumes when burned.
- These materials are systematically imported and offer no local benefits.

## ADVANTAGES

### Emergency solution

- Can provide an emergency solution to shelter recently displaced or disaster-affected populations.

## GOOD PRACTICES

### Reducing transport emissions

- Give preference to materials from the sub-region, rather than imports from distant areas.

### Design and construction

- Use optimal design calculations to minimize waste.
- Anti-damp films are sometimes used between the basement and earth walls to prevent capillary rise.
- When it comes to housing nomadic populations, certain transportable solutions may be preferable, following the same logic as their original homes. Improved thermal comfort, durability of roofing materials and construction safety seem to be the key points for this type of habitat.

### Extended service life

- Tarpaulin roofs are sometimes present as reinforcement for straw roofs. They are also very common in the projects of humanitarian organizations. Tarpaulins from these projects are often reused in the houses that families subsequently inhabit, either to reinforce roof waterproofing, or to make curtains or interior or exterior finishes.
- Plastic sheeting is usually reused up to a very end of lifecycle by households living in buul to improve their shelters.
- Use certified products and avoid using them in corrosive environments.
- Avoid exposure to direct sunlight wherever possible.

### Reuse

- Encourage the reuse of tarpaulins still in good condition from former shelters.

## [4] Conclusions

↘ This document assumes that communities have developed contextualized responses to concrete problems, which must be taken into account and valorized within the framework of humanitarian assistance programs. In this sense, recommendations for sustainability in a broad sense are presented for each of these topics: environment, sociocultural aspects, economy, technology, and governance).

After a disaster or during humanitarian crises, shelter/housing response efforts increase the extraction of resources needed for construction. Minimizing this impact is a key criterion when selecting materials, as are their constructive qualities, cost, lifespan, maintenance requirements, availability on the market, aesthetics, economic impact on communities, and ecological footprint. By being aware of this impact, the humanitarian sector can play a crucial role in finding the best balance between different, sometimes contradictory, criteria in the shelter and settlement responses.

However, materials must always be considered with the intangible facet of knowledge and know-how, maintenance practices, and lifestyles because not everything is only technical. Consequently, it is essential to be careful with purely technical responses to situations requiring the assistance of the humanitarian shelter and settlement sector.

**Chapter 1** presents good local practices for the management of building materials in Yemen at various levels: strategies for minimizing the effects of natural hazards and reducing the environmental impact of construction; sociocultural strategies that promote resilience; impacts on the local economy; technical aspects: site, design, construction and maintenance; and governance aspects.

**Chapter 2** provides a table of questions that help to make an informed choice of building materials and techniques. The questions are organized into three blocks:

- Extraction/production/transport
- Construction/use
- End of life.

The choice of material (related to technique and construction process) depends on a contextual balance of a more global approach.

**Chapter 3** analyses the building materials most used in Somalia from environmental to social perspectives and proposes recommendations for better materials management in the various stages of their life cycle, from extraction to processing, construction, service life, and end-of-life. These aspects are divided by theme: environment, health benefits for residents, community self-reliance, good socio-economic practices, etc.

Solutions derived from local building practices without major innovations are more likely to be adopted and thus contribute to long-term development and increased local resilience. An excessive imbalance between what already exists and external and innovative proposals, however relevant, is likely to be unsuccessful, as it is necessary to work in stages before changing existing construction dynamics.

In conclusion, some contexts or situations will be more conducive to industrial materials and others more relevant to local solutions based on the use of local materials and resources. In many cases, a combination of these building materials used in the right places will be the best solution and are often already used by the local population (see, for example, houses built with cement blocks or stone as the base, and adobe walls, which are very common in the country). These choices depend on land tenure security, skills availability, the cost of intervention, the acceptability of the proposals, the issues at stake, and the project approach (emergency, transitional or permanent housing).



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## Annex: material cards


 MATERIAL CARD	WATER
<b>Extraction</b>	<p><b>Surface water storage</b><sup>61</sup>: these storages basically collect storm runoff that occurs when rainfall has sufficient intensity, duration and areal extent. There are several types (for domestic use or sold to outsiders):</p> <ul style="list-style-type: none"> <li>• <b>Balli</b>: small surface water harvesting ponds</li> <li>• <b>Berkad</b>: underground reservoir, lined or un-lined, excavated to store surface runoff, used mainly in Hiran (Hirshabelle) and Gedo (Jubaland) regions for domestic storage and constructed in areas where there are no dug wells. Where the water is sold, they are better maintained with fencing to keep off animals, and in some cases covered with shrubs or iron sheets to reduce evaporation.</li> <li>• <b>Mugciid</b>: underground reservoir storage well with an average depth of 7 to 17 m and a diameter of 1 to 1.5 m, mainly present in the Bakool region (South West State). They are usually constructed in clusters, with each family owning two to three units, and water lasts for two to three months.</li> <li>• <b>War</b>: unlined dug-out (dam), usually 2 to 3 m deep, common in the Bakool (South West), Bay (South West) and Hiraan (Hirshabelle) regions. Settlements can have two or three <i>war</i>. <i>War</i> and <i>berkad</i> are commonly used to collect surface water from small catchments of 2 to 3 km<sup>2</sup>. <i>War</i> are more common in southern drainage basins because of the favorable clayey soil for their construction. <i>War</i> sometimes have to be lined up with plastic sheets to prevent water loss through seepage. The sizes of <i>war</i> vary (from 1,500 to 50,000 m<sup>3</sup>) depending on the manpower available in the village for the construction. Water lasts for up to six months.</li> </ul> <p><b>Groundwater</b><sup>62</sup>: it is harnessed by the rural and urban population to meet domestic and livestock water needs as well as for small scale irrigation and there are several types: shallow wells -hand-dug-; boreholes and springs; sub-surface dams; and infiltration galleries.</p> <p><b>Trucked water</b>: trucked water may offer relatively safe water sources, but prices have risen considerably – up to 136 per cent<sup>63</sup>.</p> <p><b>Piped water</b>: it exists in cities such as Mogadishu.</p> <p><b>River water</b>: it is used in areas where rivers have abundant water, particularly areas close to permanent rivers.</p> <p><b>Water harvesting</b>: some families use water harvesting with traditional systems such as collecting rainwater in reservoirs in their houses.</p>
<b>Application/techniques</b>	<ul style="list-style-type: none"> <li>• Production of earth mortar for wattle and daub walls (<i>baraako</i> and <i>mundul</i>).</li> <li>• Production of masonry elements (sand-cement blocks, adobe blocks, CSEB...);</li> <li>• Production of mortar for masonry or for plastering these elements (earth, earth-cement or cement-based mortar);</li> <li>• Production of concrete and reinforced concrete;</li> <li>• Production of earthen flat roof terraces;</li> </ul>
<b>Transport</b>	Sometimes water supplies are far away, and water has to be transported by truck or cart.

<sup>61</sup> Basnyat (2007)


<sup>62</sup> Basnyat (2007)

<sup>63</sup> UN-OCHA (2022)

<b>Service life</b>	N/A
<b>Cost</b>	N/A
<b>Know-how</b>	N/A
<b>Informal/formal economy</b>	Both
<b>Urban/rural</b>	Both
<b>Large-scale potential</b>	Depends on drought situation or not
<b>Seasonality</b>	Easier to obtain in the rainy seasons or immediately afterwards

 <b>MATERIAL CARD</b>	<h2>RAW EARTH</h2>
<b>Materials</b>	<p><b>Raw earth</b> is present below the topsoil and there are several types of soil in the country in terms of granulometric composition: types of clay (more or less active in contact with water), proportion of clay, silt, sand, gravel...</p> <p><b>Termite soil</b> is used for plastering <i>baraako</i> and <i>mundul</i>.</p>
<b>Extraction/production</b>	<ul style="list-style-type: none"> <li>• The choice of soil is empirical (texture, granulometry, water status, etc.) and based on in-depth knowledge of the environment and human settlement.</li> <li>• Extraction sites are generally close to the construction site, and are often tried and tested.</li> <li>• Other important criterion for selecting a soil extraction site is to avoid locations deemed unsuitable after consultation in the village or area.</li> <li>• The soil is extracted from the ground and cleared of organic matter and large stones.</li> <li>• The soil is mixed with water and, very often, additives such as grass, cow dung or donkey dung. If the soil is very clayey, it is mixed with straw and sand.</li> <li>• Termite soil is very much used for wattle and daub. The tight weave of the base trellis (in <i>baraako</i> and <i>mundul</i>) forms an anti-shrinkage armor for the earth plaster, which is prepared using an inert red termite soil (<i>arra gudud</i>) reduced to dust by the women, together with cattle manure and water.</li> </ul>
<b>Application / techniques</b>	<ul style="list-style-type: none"> <li>• Infill of wattle-and-daub walls (timber structure with earth infill and finishing in <i>baraako</i> and <i>mundul</i> models) -&gt; Load-bearing or non-load-bearing walls;</li> <li>• Moulded earth blocks (adobe) -&gt; Load-bearing or non-load-bearing walls;</li> <li>• Mortar in stone and adobe walls -&gt; Load-bearing or non-load-bearing walls;</li> <li>• Wall and floor finishing plasters -&gt; Finishings;</li> <li>• Earth flat roofs -&gt; Roofing;</li> <li>• Compressed Earth Blocks (CEB) or Compressed Stabilized Earth Blocks (CSEB) exist in the country in a very incipient stage -&gt; Load-bearing or non-load-bearing walls;</li> <li>• Other :</li> </ul>
<b>Transport</b>	Normally no transport
<b>Service life</b>	Long if well designed, built and maintained
<b>Cost</b>	Low cost
<b>Know-how</b>	Existing in areas where techniques are used (wattle and daub), and very limited for adobe construction

<b>Informal/formal economy</b>	Both
<b>Urban/rural</b>	Both (more common in rural areas)
<b>Large-scale potential</b>	Yes
<b>Seasonality</b>	Adobe construction is preferred during dry seasons

 <b>MATERIAL CARD</b>	<b>STONE AND OTHER MATERIALS OF MINERAL ORIGIN</b>
<b>Material</b>	<p><b>Coral limestone:</b> Available in the coast.</p> <p><b>Other stones and minerals:</b> In the interior of the country, different types of stone are available and used in construction. Rocks and minerals are known to exist and available for exploitation include tin in the Majiyahan-Dhalan area (south of Boosaaso-Ceelayo coastal strip), sepiolites from Ceel Bur, and quartz, granite, marble, limestone and gypsum in different parts of the country<sup>64</sup>.</p> <p>The country holds deposits of bauxite, copper, iron, kaolin, quartz, granite, silica, sandstone<sup>65</sup>.</p>
<b>Extraction / production</b>	<p><b>Stone:</b> quarry stone is available throughout the country. It is used in foundations of different typologies and as main material of masonry walls as infill or as bearing wall.</p> <p><b>Coral rock and limestone:</b> quarrying of coral rock and limestone for cement manufacturing and coarse aggregates for concrete and road building. Limestone mining exists for instance at Mogadishu<sup>66</sup>.</p> <p><b>Lime:</b> Coral stone is burnt to create lime and mixed with sand for mortar and plastering. Quarrying of lime and kilns to bake it were important local industries<sup>67</sup>.</p>
<b>Application / techniques</b>	<p><b>Several uses:</b> Stone is used in manufacturing cement, walls, roofing materials, floors, and aggregates<sup>68</sup>.</p> <p><b>Stone foundations and plinth:</b> Stone walls usually have stone foundations too. Some earth constructions have stone foundations and plinths.</p> <p><b>Stone walls:</b> They are very common in the coast (where coral stone is more often used) and also in some places inlands where stone is available. There are different patterns of stonework, different colors of stones (from pinkish to white hues), as well as colorings applied to the layers of stones, particularly in the north<sup>69</sup>.</p> <p><b>Lime (from coral stone):</b> Lime is used as a mortar, particularly well-suited to plastering earthen walls. Stone houses are often whitewashed with lime and are covered with lime plasters<sup>70</sup> (or cement).</p>

<sup>64</sup> United Nations Environment Programme (2005)

<sup>65</sup> Atta et al (2021)

<sup>66</sup> Fielding et al (2010)


<sup>67</sup> Scikei (2017)


<sup>68</sup> United Nations Environment Programme (2005)


<sup>69</sup> Diriye Abdullahi (2001)

<sup>70</sup> Scikei (2017)

<b>Transport</b>	Little transport when the material is locally available By road when it comes from an area other than that of the construction site
<b>Service life</b>	Long-term if well designed, built and maintained
<b>Cost</b>	Medium - High
<b>Know-how</b>	Available depending on location
<b>Informal / formal economy</b>	Both
<b>Urban / rural</b>	Both
<b>Large-scale potential</b>	Depends on material availability and cost
<b>Seasonality</b>	Not applicable

 <b>MATERIAL CARD</b>	<b>GRAVEL</b>
<b>Extraction / production</b>	Available where wild rock exists. In the coast it is most often crushed coral stone, not very hard. It is produced from crushed, often artisanal, wild rock, or harvested from the surface.
<b>Application / techniques</b>	Concrete and reinforced concrete.
<b>Transport</b>	Little transport when the material is locally available. By road when it comes from an area other than that of the construction site.
<b>Service life</b>	Not applicable
<b>Cost</b>	Medium - High
<b>Know-how</b>	Available depending on location
<b>Informal / formal economy</b>	Rather formal
<b>Urban / rural</b>	Both
<b>Large-scale potential</b>	Not applicable
<b>Seasonality</b>	Not applicable

 MATERIAL CARD	<b>SAND</b>
<b>Extraction / production</b>	Informal removal of sand from beaches and foredunes. Beach sand mining is practiced (for instance at Berbera) <sup>71</sup> . Artisanal sand mining from the catchment, floodplains, riverbanks <sup>72</sup> , beaches, etc.
<b>Application / techniques</b>	Coatings / Concrete and reinforced concrete / Sand-cement blocks / Compressed earth blocks (CEB) and stabilized compressed earth blocks (CSEB).
<b>Transport</b>	Little transport when the material is locally available. By road when it comes from an area other than that of the construction site.
<b>Service life</b>	Not applicable
<b>Cost</b>	Medium - High
<b>Know-how</b>	Available depending on location
<b>Informal / formal economy</b>	Rather formal
<b>Urban / rural</b>	Both
<b>Large-scale potential</b>	Not applicable
<b>Seasonality</b>	Not applicable


 MATERIAL CARD	<b>CEMENT-BASED MATERIALS</b> (EXCLUDING REINFORCED CONCRETE)
<b>Material</b>	<b>Cement:</b> Cement is available from local traders in most parts of the country. Some areas are difficult to supply because of the security situation.  Sand and gravel have already been introduced in the previous sections.
<b>Extraction / production</b>	There does not seem to be industrial production of cement in Somalia in 2023. Berbera cement plant (Red Sea Cement Company) is not operational since the 1990s, even though there is an ongoing project to restart production in that factory.  Cement is imported primarily from Oman, Iran and the UAE (USD ~30 M) <sup>73</sup> .
<b>Application / techniques</b>	Sand-cement blocks / Laying mortar / Plasters / Floor screed / Compressed stabilized earth blocks (CSEB)...  <b>Cement blocks:</b> they can be hollow or solid and are made from cast concrete, composed of Portland cement and aggregate (usually sand and fine gravel) for high-density blocks, while

<sup>71</sup> Fielding et al (2010)


<sup>72</sup> Barwell (2016)

<sup>73</sup> Atta et al (2021)


	<p>including industrial wastes (such as fly ash or bottom ash) as an aggregate for lower-density blocks. They are produced manually using compressing machines. Typically, cement is mixed with coarse sand and gravel with the ratio of 1:2:3, respectively, for the casting part. Casts are fully filled with the concrete created on site and compressed using the machine. After compression, pieces of flat wood are placed under the concrete blocks as a support, allowing the operators to set them down (preferably under the sun) in order to let the blocks dry out for about 2 days. Afterwards, blocks are kept wet to provide enough compressive strength. Most hollow bricks have these dimensions: 400 mm L x 300 mm H x 200 mm S.</p> <p>Hollow blocks are mainly used in elevation walls, while solid blocks are more used in foundations and plinths.</p> <p><b>Plaster:</b> cement is also used in plasters for finishings, together with sand and water.</p>
<b>Transport</b>	By road
<b>Service life</b>	Long if well designed, built and maintained
<b>Cost</b>	High
<b>Know-how</b>	Available depending on location
<b>Informal / formal economy</b>	Both
<b>Urban / rural</b>	Both
<b>Large-scale potential</b>	No
<b>Seasonality</b>	Year-round


 MATERIAL CARD	<h2>REINFORCED CONCRETE</h2>
<b>Material</b>	<p>Uses <a href="#">cement</a>, aggregates (<a href="#">sand</a> and <a href="#">gravel</a>) rebar.</p> <p>Concrete reinforcing bars are available in various standardized diameters for use in different structural elements (e.g. 6 mm, 10 mm, 12 mm, 16 mm, 20 mm).</p>
<b>Extraction / production</b>	Sand and gravel are available locally. Steel and cement are imported.
<b>Application / techniques</b>	<b>Reinforced concrete structure:</b> foundation, pillars, beams, slabs, lintels in structural concrete (with different diameters steel bars).
<b>Transport</b>	By road
<b>Service life</b>	Long if well designed, built and maintained
<b>Cost</b>	High
<b>Know-how</b>	Available depending on locality

<b>Informal / formal economy</b>	Rather formal
<b>Urban / rural</b>	Rather urban
<b>Large-scale potential</b>	No
<b>Seasonality</b>	Year-round building possible


 MATERIAL CARD	<b>LOCAL LUMBER</b>
<b>Material</b>	<b>Many trees and shrubs are used in various forms for construction.<sup>74</sup></b> <b>Bark / Roots / Branches</b>
<b>Extraction / production</b>	Wood is the main construction material for many Somalis. Wood harvested from the wild is becoming increasingly scarce as a result of deforestation and its use as a building material and fuelwood.
<b>Application / techniques</b>	<b>Lumber:</b> It is used as framework for many types of walls such as CGI sheets, <i>baraako</i> or <i>mundul</i> and as framework of all inclined roofs. Natural wooden logs are sometimes taken from nature, despite deforestation problems. <b>Bark:</b> the red pigment traditionally used for dyeing mats for the <i>aqal</i> came from the bark of acacia ( <i>galool</i> ). <b>Roots:</b> acacia roots are used for <i>qabax</i> and <i>ubud</i> , main structural elements of <i>aqal</i> . <b>Branches:</b> they are used as part of the frameworks of vernacular constructions ( <i>baraako</i> , <i>mundul</i> ). <i>Acacia bussei</i> ( <i>galool</i> ) branches are transformed into fibers to weave <i>kebel</i> mats for <i>aqal</i> .
<b>Transport</b>	No transport if resource available locally
<b>Service life</b>	By road if far away
<b>Cost</b>	Long if well designed, constructed, processed (treatment is needed against termites) and maintained
<b>Know-how</b>	Depends on extraction method
<b>Informal / formal economy</b>	Availability depends on locality
<b>Urban / rural</b>	Rather informal
<b>Large-scale potential</b>	Rather rural
<b>Seasonality</b>	Not applicable

<sup>74</sup> For more information: Mahony, D. (1994). Trees of Somalia: a field guide for development workers  
<https://policy-practice.oxfam.org/resources/trees-of-somalia-a-field-guide-for-development-workers-121179/>


 MATERIAL CARD	<h2 style="text-align: center;">IMPORTED TIMBER</h2>
<b>Material</b>	<p>Sawn timber comes in various sizes and is often imported. Sawn timber is often available from materials dealers.</p>
<b>Extraction / production</b>	<p><b>Sawn timber:</b> Most often imported.</p> <p><b>Plywood panels:</b> Plywood panels are manufactured using sawmill by-products or cultivated softwood and chemical binders. Most often imported.</p>
<b>Application / techniques</b>	<p><b>Timber:</b> It is mostly imported nowadays, particularly squared timber. There is a real knowledge of minimalist use of imported wood. Timber is also used in openings, enclosures, ceilings, slabs, plywood panels, etc.</p> <p><b>Plywood panels:</b> Plywood panels are sometimes used as wall-closing material in shelters where the load-bearing structure of the walls is wood framing.</p>
<b>Transport</b>	<p>By road</p>
<b>Service life</b>	<p>Long if well designed, constructed, treated and maintained</p>
<b>Cost</b>	<p>Depends on quality</p>
<b>Know-how</b>	<p>Availability depends on locality</p>
<b>Informal / formal economy</b>	<p>Both</p>
<b>Urban / rural</b>	<p>Both</p>
<b>Large-scale potential</b>	<p>Yes for sawn timber from certified crops</p>
<b>Seasonality</b>	<p>Not applicable</p>


 MATERIAL CARD	<h2 style="text-align: center;">BAMBOO</h2>
<b>Extraction / production</b>	<p>Bamboo in Somalia needs procurement on regional and international bamboo stocks as it is not sufficiently harvested locally. The area under growth in Somalia is not recorded (it is a local material both in Kenya and Ethiopia).</p>
<b>Application / techniques</b>	<p>Structural elements</p>
<b>Transport</b>	<p>By road</p>
<b>Service life</b>	<p>Long if well designed, constructed, treated and maintained</p>
<b>Cost</b>	<p>Depends on quality</p>
<b>Know-how</b>	<p>Availability depends on locality</p>

<b>Informal / formal economy</b>	Both
<b>Urban / rural</b>	Both
<b>Large-scale potential</b>	Yes for bamboo from certified crops
<b>Seasonality</b>	No data


 MATERIAL CARD	<b>OTHER PLANT-BASED MATERIALS</b>
<b>Material</b> <sup>75</sup>	<b>Reed / Grass / Palm leaves / Sisal fiber / Other plants</b>
<b>Extraction / production</b>	The many varieties of herbs, materials and plant fibers are selected, prepared and used at different levels of construction. The type and quality of material can vary.
<b>Application / techniques</b>	<p><b>Reed:</b> it is used in different forms, for traditional flat roofs or for the production of woven mats for <i>aqal</i>. Three <i>duur</i>, thin reed, are used to make <i>lool</i>, smaller structural elements of <i>aqal</i>.</p> <p><b>Grass:</b> used for thatched roofs, but also for the fabrication of the mats of <i>aqal</i>. <i>Caws</i> is the name given to all grasses, while <i>maadh</i> is the most quality grass for weaving mats.</p> <p><b>Palm leaves:</b> used to weave mats for <i>aqal</i>, as well as for thatched roofs wherever they are available.</p> <p><b>Sisal fiber:</b> used for mat weaving, particularly for decorative mats. The sisal leaves are cut and pounded with the addition of some water and then buried for seven days, after what they are washed. The green part will have rotten and easily washed away, and the white part will be dried before use. The white color is used without dyeing as one of the colors of different decoration motifs.</p> <p><b>Other plants:</b></p> <ul style="list-style-type: none"> <li>- black traditional pigment used for dyeing mats for the <i>aqal</i> came from a poisonous plant called <i>dacar</i>,</li> <li>- fiber ropes are made from different plants and used to tie, anchor different construction elements.</li> </ul>
<b>Transport</b>	No transport
<b>Service life</b>	Long if well designed, built, treated and maintained
<b>Cost</b>	Low
<b>Know-how</b>	Available depending on locality
<b>Informal / formal economy</b>	Rather informal
<b>Urban / rural</b>	Rather rural
<b>Large-scale potential</b>	Yes
<b>Seasonality</b>	Usually linked to rainy seasons (e.g.: grasses available after rainy seasons)

<sup>75</sup> Fullerton & Adan (1995)

 MATERIAL CARD	<b>LOCAL MATERIALS OF ANIMAL ORIGIN</b>
<b>Material</b>	Leather / Cow dung / Goat twine
<b>Extraction / production</b>	Not applicable
<b>Application / techniques</b>	<p><b>Leather:</b> it is used in the form of strings to tie different elements of <i>aqal</i>.</p> <p><b>Cow dung:</b> used in finishings of wattle-and-daub houses mixed with earth.</p> <p><b>Goat twine:</b> used in <i>aqal</i> for protection of structural elements.</p>
<b>Transport</b>	No transport
<b>Service life</b>	No data
<b>Cost</b>	Low
<b>Know-how</b>	Availability depends on location
<b>Informal / formal economy</b>	Informal
<b>Urban / rural</b>	Rather rural
<b>Large-scale potential</b>	Depends on location
<b>Seasonality</b>	Not applicable

 MATERIAL CARD	<b>METAL SHEETS AND OTHER METALLIC MATERIALS</b>
<b>Material</b>	Steel rebars / Metal sheets / Metal openings / Steel sections
<b>Extraction / production</b>	Imported materials
<b>Application / techniques</b>	<p><b>Steel:</b> it is used in reinforced concrete structures, but also steel reinforcement bars (rebar) are used both vertically and horizontally inside cement blocks walls to maximize the structural performance, and grouting cells with rebars are used for enabling their bond to the wall.</p> <p><b>Metal sheets:</b> they are available in different qualities and sizes, and in different materials such as CGI and aluminum. They are used in roofing and walls.</p> <p><b>Metal openings:</b> frames and openings used for doors and windows and made of steel of aluminum.</p> <p><b>Steel sections:</b> used as main structure in some buildings</p>
<b>Transport</b>	By road
<b>Service life</b>	Depends on quality and processing.

<b>Cost</b>	High
<b>Know-how</b>	Rather available
<b>Informal / formal economy</b>	Both
<b>Urban / rural</b>	Both
<b>Large-scale potential</b>	Yes
<b>Seasonality</b>	Not applicable

 <b>MATERIAL CARD</b>	<b>PLASTIC MATERIALS</b>
<b>Material</b>	<b>Plastic tarpaulins (Polyethylene / PVC / Tarpaulin -polyester-) / Anti-damp plastic membranes</b>
<b>Extraction / production</b>	Imported materials
<b>Application / techniques</b>	<b>Plastic tarpaulins:</b> Different plastic materials are used in construction, from plastic sheets for emergency shelters, <b>Anti-damp plastic membranes:</b> Used as anti-damp membranes between foundation or plinth and walls.
<b>Transport</b>	Par route
<b>Service life</b>	<b>Plastic tarpaulins:</b> Short – very short <b>Anti-damp plastic membranes:</b> Good service life
<b>Cost</b>	Low
<b>Know-how</b>	Availability depends on location
<b>Informal / formal economy</b>	Both
<b>Urban / rural</b>	Both
<b>Large-scale potential</b>	Yes, but not relevant for durable / semi-durable shelters
<b>Seasonality</b>	Not applicable

# Acknowledgments

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## LAYOUT

Elsa CAUDERAY



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