



# REPORT

## Mali environmental impact study of the emergency shelter models

June 2022

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# 1. Definitions

**Carbon neutral** means that any greenhouse gases (including but not limited to carbon dioxide) that are released into the atmosphere are balanced by an equivalent amount of greenhouse gases being removed.

**Carbon offsetting** a way to reduce emissions and to pursue carbon neutrality is to offset emissions made in one sector by reducing them somewhere else.<sup>1</sup>

**Carbon positive** means that an activity goes beyond achieving zero carbon emissions to create an environmental benefit by removing additional carbon dioxide from the atmosphere<sup>2</sup>

**Carbon footprint** is a term commonly used which refers to the total greenhouse gas emissions caused by an individual, event, organization, service, place or product, expressed as carbon dioxide equivalent (CO<sub>2</sub> equivalent)<sup>3</sup>.

**The Climate Risk Index (CRI)** indicates a level of exposure and vulnerability to extreme events, which countries should understand as warnings in order to be prepared for more frequent and/or more severe events in the future<sup>4</sup>.

**Climate change** is a long-term shift in global or regional weather patterns. Usually, the term climate change refers specifically to the increase in global temperatures from the mid-20th century to the present<sup>5</sup>.

**CO<sub>2</sub> equivalent** A carbon dioxide equivalent or CO<sub>2</sub> equivalent (a.k.a. CO<sub>2</sub> eq..) is a metric measure used to compare the emissions from various greenhouse gases (GHGs) on the basis of their global-warming potential (GWP), by converting amounts of other gases to the equivalent amount of carbon dioxide with the same GWP<sup>6</sup>.

**Decompose** is the process by which dead organic substances are broken down into simpler organic or inorganic matter such as carbon dioxide, water, simple sugars and mineral salts.<sup>7</sup>

**Embodied carbon** comes from the embodied energy consumed to extract, refine, process, transport and fabricate a material or product (including buildings). It is often measured from cradle to (factory) gate, cradle to site (of use), or cradle to grave (end of life). The embodied carbon footprint is therefore the amount of carbon (CO<sub>2</sub> or CO<sub>2</sub> emissions) which is generated in order to produce a material<sup>8</sup>.

**Environment** refers to the physical, chemical, and biological surroundings in which communities live and develop their livelihoods. It provides the natural resources that sustain individuals and determines the quality of the surroundings in which they live<sup>9</sup>.

**Environmental Impact** is defined as any change to the environment, whether adverse or beneficial<sup>10</sup>, caused by a project, a process, an organism(s) and a product(s), from its conception to its end of life.

**Environmental Performance Index (EPI)** is a method of quantifying and numerically marking the environmental performance of a state's policies<sup>11</sup>.

**Environmental sustainability:** A state in which the demands placed on the environment can be met without reducing its capacity to allow all people to live well, now and in the future. While environmental sustainability is broader than climate action, limiting climate and environmental impacts can both contribute to mitigating climate change, for instance by reducing emissions and greening practices, and to strengthening people's resilience to climate change<sup>12</sup>.

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<sup>1</sup> European Parliament

<sup>2</sup> Fast Company

<sup>3</sup> Carbon Trust

<sup>4</sup> Germanwatch

<sup>5</sup> National Geographic

<sup>6</sup> Energy Manager Canada

<sup>7</sup> Lynch, Michael D. J.; Neufeld, Josh D. (2015). "Ecology and exploration of the rare biosphere"

<sup>8</sup> Circular Ecology

<sup>9</sup> NSW Government

<sup>10</sup> University of Calgary

<sup>11</sup> Yale Center for Environmental Law & Policy, and Center for International Earth Science Information Network at Columbia University.

<sup>12</sup> IFRC

**Global warming** is the unusually rapid increase in Earth's average surface temperature over the past century primarily due to the greenhouse gas effect. Global warming is often described as the most recent example of climate change<sup>13</sup>.

**Greenhouse gas effect** a natural phenomenon that causes a rise in the surface temperature of our planet.

**IDP (Internally Displaced person)** is someone who is forced to leave their home but who remains within their country's borders.<sup>14</sup>

**Life cycle** refers to the consecutive and interlinked stages of a product or service, from raw material acquisition or generation from natural resource, to design, production, transportation / delivery, use, end-of-life treatment and final disposal<sup>15</sup>.

**Life cycle assessment (LCA)** is a method of evaluating the environmental impact associated with all stages of a product's life, i.e., from the extraction of raw materials, through materials processing, manufacturing, distribution, use, repair and maintenance, to disposal or recycling.

**Waste** any residue from a production, transformation or use process, any substance, material, product or, more generally, any movable asset disposed of or intended for disposal by its holder<sup>16</sup>.

**Waste management** A set of operations involving the sorting, pre-collection, collection, transport, storage, recycling and disposal of waste, including the monitoring of disposal sites.

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<sup>13</sup> NASA

<sup>14</sup> UNHC

<sup>15</sup> ISO

<sup>16</sup> <https://assembly.coe.int>

## 2. General information

**Project/mission title:** Mali environmental impact study of the emergency shelter models

**Country:** Mali

**Report date:** June 2022

**Type of operation:** Remote consultancy

**Requesting Organization:** International Aid of the Luxembourg Red Cross



## 3. Context

The Aide Internationale de la Croix-Rouge luxembourgeoise (AI-CRL) has been working for several years in the field of emergency shelter and sustainable housing in the Sahel region. AI-CRL collaborates closely with the IFRC Shelter Research Unit (IFRC-SRU)<sup>17</sup> in the development of shelter models adapted to the climatic conditions and cultural contexts of the Sahel.

Numerous research missions have made it possible to develop shelter models that take into account the specificities of the contexts and the availability of materials at the local level. In the particular case of Mali, the AI-CRL and the Malian Red Cross have developed two shelter models. The first model built is the “Case Végétale” (or Cases Peulh), of a total surface of 24m<sup>2</sup>, which can accommodate up to six people. It is made of metal tubes and a dome-shaped geometry covered with plastic sheeting, eucalyptus wood and woven mats made from the palm doum tree. It is representing 89% of the shelters installed in Mali by AI-CRL since 2018. The second shelter model is the “Case en Milieu Humide”, of a total surface of 20m<sup>2</sup> which can accommodate up to five people. It has been adapted from a UNHCR model, it is made of metal tubes, a double-sided roof (basswood timber) and closures with plastic sheeting and fabric (70% Nylon & 30% Cotton).

This experience gained in the field and the feedback collected from targeted populations has helped the evolution of the shelter models designed by AI-CRL and adopted by all humanitarian actors in the different countries of the Sahel. However, one key factor has not been analysed in detail: the environmental impact of the shelter models. This is necessary in order to understand which option is best adapted to the local context, and is in line with the current global trend to improve the environmental sustainability of humanitarian assistance.

The change in weather patterns caused by global warming has happened faster over the past century. Natural disasters, such as floods, droughts, desertification, fires, etc., are increasing due to climate change, and they are contributing to food insecurity, economic losses, population displacements, and are also conflict drivers. People all over the world are facing the reality of climate change, and in many parts of the world this manifest as increased volatility of extreme weather events. Only between 2000 and 2019, over 475 000 people lost their lives worldwide<sup>18</sup> due to them. The 2021 edition of the Climate Risk Index clearly shows that signs of escalating climate change can no longer be ignored, on any continent or in any region. Impacts from extreme-weather events hit the poorest countries hardest as these are particularly vulnerable to the damaging effects of hazards, have a lower coping capacity and may need more time to rebuild and recover<sup>19</sup>. Africa is already one of the continents most affected by climate change, even if is responsible for only 4% of the world's greenhouse gas emissions. The frequency of heavy rainfall and storms has tripled in the Sahel since the 1980s<sup>20</sup>. The area of the Sahel desert has increased by 10% in the last 100 years<sup>21</sup>.

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<sup>17</sup> The IFRC Shelter Research Unit was one of the six global RCRC Movement Reference Centres, dedicated to furthering knowledge and practice in humanitarian sheltering. Hosted by the Luxembourg Red Cross, it was established in 2010 as an initiative of the Benelux Red Cross Societies in collaboration with the IFRC Shelter and Settlement Department to fulfil its mission to improve humanitarian sheltering interventions, and to strengthen technical capacities and resources on sheltering within the RCRC Movement.

<sup>18</sup> Global Climate Risk Index 2021

<sup>19</sup> Global Climate Risk Index 2021

<sup>20</sup> World Meteorological Organization

<sup>21</sup> University of Maryland

Mali is forecast to become hotter with more erratic rainfall, impacting seasonal regularity and increasing the risk of droughts and floods<sup>22</sup>. Like much of the Sahel, it is highly vulnerable to climate change. Moreover, conflict, political instability and weak government institutions undermine effective adaptation to climate change. A high demographic<sup>23</sup> growth (3% in 2020) and climatic constraints have led to overexploitation and degradation of natural resources<sup>24</sup>. Mali's economy is essentially based on the exploitation of these resources, with more than 80 percent<sup>25</sup> of Mali's population found to be dependent on rain-fed agriculture for their livelihood. Two-thirds of the country is arid and semi-arid, dominated by the problems of desertification<sup>26</sup>. These climate-related changes are already being felt and have led to a steady southward relocation of fishing, agricultural, and livestock-keeping activities where the population density is much higher, increasing the conflicts between pastoralists, fishermen, and farmers<sup>27</sup>. The recent history of violent civil conflicts is hampering the development of Mali and threatening food security, livelihoods, and local economies. In the future, severe climate change effects will continue especially in the north of the country where temperatures will further increase and rainfall will decrease. All this makes the country extremely vulnerable to the impacts of climate change<sup>28</sup>.

Good environmental practices from humanitarian agencies can help protect the local environment, contribute to improve the resilience of communities to natural disasters, and reduce their vulnerability, as well as reduce the contribution made to further climate change. However, in the past a lack of consideration for the environment has led to humanitarian responses having a negative impact on the environment. For instance, huge quantities of relief items have been brought into the country, local natural resources have been overused, and large amounts of unmanaged waste generated, without considering the consequences for the environment. Humanitarian agencies should not contribute to the degradation of the natural resources that affected communities rely on, and should take steps to mitigate climate change. The concept of 'do no harm' should also be extended to the environment. This comparative study of the environment impact of the Sahel Shelter models implemented in Mali is a contribution to the growing body of work on the environmental impact of humanitarian assistance.

## 4. Outcome and Outputs<sup>29</sup>

### Outcome

With the support of the IFRC-SRU, AI-CRL seeks to improve the quality of the shelter response in Mali, and minimise the environmental impact of its operations.

### Outputs

- A comparative study of different shelter models in Mali. This individual study is part of a set of studies in four countries in the region (Niger, Chad, Burkina Faso and Mali)
- Recommendations to reduce the environmental impact of AICRL shelter interventions
- Comparative study of the shelter models analysed in the region (Niger, Chad, Burkina Faso and this one in Mali)<sup>30</sup>

The scope of this study is limited to the comparative environmental impact of the two shelter models. It does not include aspects relating to the preparation, construction and maintenance of the sites where the shelters were constructed, nor does it include factors relating to cost, functionality, and satisfaction of targeted populations etc.

## 5. Methodology

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<sup>22</sup> *Climate, Peace and Security Fact Sheet. May 2021*

<sup>23</sup> *World Bank data*

<sup>24</sup> *Climate change profile. Mali, April 2018*

<sup>25</sup> *Climate change and violent conflict in Mali. Kheira Tarif (SIPRI) and Anab Ovidie Grand (NUPI). June 2021*

<sup>26</sup> *Global Security org*

<sup>27</sup> *Climate change profile. Mali, April 2018*

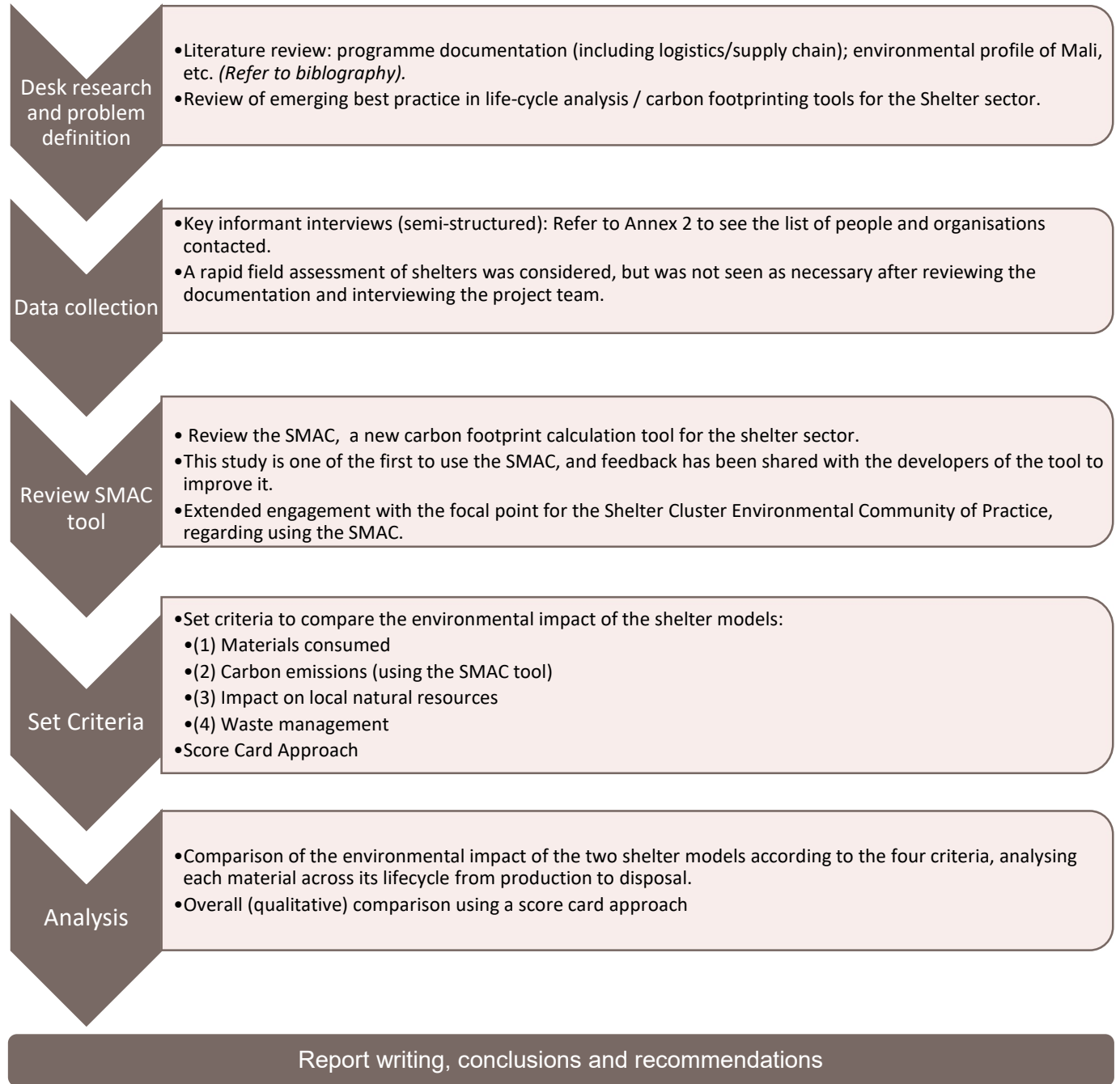
<sup>28</sup> *Climate change profile. Mali, April 2018*

<sup>29</sup> *As included in the Terms of Reference for this study.*

<sup>30</sup> *This comparative study will be carried out on an individual basis.*

This study was conducted remotely, with the support of AI-CRL field staff (shelter, logistics, other); the Shelter and Non-Food Item Working Group in Mali; environmental experts from the shelter sector; and a few “Economic Interest Groups” (groupements d'intérêt économique (GIE), involved in ecological recycling and waste recovery in Mali<sup>31</sup>.

The methodology adopted is summarised by the graphic below.





<sup>31</sup> Refer to Annex 2 to see the list of people and organisations contacted.


## 6. Background information

### 6.1. Country profile


# MALI




**Location**  
Mali is a landlocked country in West Africa with an area of 1,240,000 square kilometres.




**Geography**  
It is bordered by Algeria to the north-northeast, Niger to the east, Burkina Faso to the south-east, Ivory Coast to the south, Guinea to the south-west, and Senegal to the west and Mauritania to the north-west.




**Population**  
Mali has a population of 19.7 million in 2019.<sup>32</sup>




**Income**  
It ranks 184 out of 189 on UNDP's 2019 Human Development Index. 40.1% of the population lives below the poverty line.<sup>33</sup>



**Political situation**  
Mali has been experiencing instability and conflict since the military coup of 2012 and the occupation of the north by armed groups.<sup>34</sup>



**Climate<sup>35</sup>**  
The northern parts of Mali reach into the dry Sahara Desert, while the southern regions experience a wetter, more tropical, climate. The seasonal rainfalls in Mali are controlled by the movement of the tropical rain belt, which oscillates between the northern and southern tropics over the course of a year, and brings rainfall to the southern regions between June and October, peaking in August. In the dry months between November and March, almost no rain falls at all. The northern, desert regions of Mali receive very little rainfall all year round.



**Natural disasters<sup>36</sup>**  
Most of Mali's inhabitants are living with serious natural hazards, including floods, droughts and crop or livestock diseases.

<sup>32</sup> World Bank

<sup>33</sup> World Bank

<sup>34</sup> World Bank

<sup>35</sup> Global Security.org

<sup>36</sup> Afrol news

## 6.2. Environmental Challenges in Mali

# Environmental Challenges

**Climate change**

Mali is highly vulnerable to climate. Already subject to frequent droughts and experiencing significant variability in annual rainfall, climate change is expected to increase local temperatures, the variability of rainfall, and the magnitude of extreme weather events. Mali is the 9th most vulnerable country and the 43rd least ready country – meaning that it is extremely vulnerable to, yet unready to address climate change effects<sup>37</sup>.

**Increasing Temperature**

The mean annual temperature is projected to increase by 1.2 and 3.6 °C by the 2060s, and 1.8 to 5.9 °C by the 2090s, the projected rate of warming being similar in all seasons and regions of Mali<sup>17</sup>. This will result in increased evapotranspiration which will dry land surfaces and soil.<sup>38</sup>

**Floods**

During rainy seasons, many people are exposed to floods along the two great rivers Niger and Senegal and their tributaries.<sup>39</sup>

**Droughts**

Mali is prone to extreme climatic events, especially droughts. Their incidence is increasing due to the temperature and rainfall effects.<sup>40</sup>

**Desertification and land degradation**

The north of the country is threatened by encroaching deserts. Under climate change, this situation is likely to worsen, with accelerated desertification and limited water availability, especially in already water scarce areas<sup>41</sup>

**Deforestation**

Deforestation is an especially serious and growing problem. According to the Ministry of the Environment, Mali's population consumes 6 million tons of wood per year for timber and fuel. To meet this demand, 4,000 square kilometres of tree cover are lost annually, virtually ensuring the destruction of the country's savanna woodlands.<sup>42</sup>

**Wind erosion**

Wind erosion is caused by strong winds and drought. It is most often encountered in the north of the country, where the soil is not covered, and where there are few trees and grass.<sup>43</sup>

**Water pollution**

3.5 million people don't have clean water. Almost 1 in 5 of the population.<sup>44</sup>

<sup>37</sup> USAID (2018). *Climate Risk Profile*. April 2018: Mali. <https://tinyurl.com/smx7f3sc>

<sup>38</sup> USAID (2018). *Climate Risk Profile*. April 2018: Mali. <https://tinyurl.com/smx7f3sc>

<sup>39</sup> USAID (2018). *Climate Risk Profile*. April 2018: Mali. <https://tinyurl.com/smx7f3sc>

<sup>40</sup> USAID (2018). *Climate Risk Profile*. April 2018: Mali. <https://tinyurl.com/smx7f3sc>

<sup>41</sup> USAID (2018). *Climate Risk Profile*. April 2018: Mali. <https://tinyurl.com/smx7f3sc>

<sup>42</sup> Wikipedia

<sup>43</sup> Mali : Agriculture : l'érosion du sol et insécurité alimentaire ([maliactu.net](http://maliactu.net))

<sup>44</sup> [Wateraid.org](http://Wateraid.org)



### **Solid waste**

The system of waste collection, storage, treatment and disposal is not well functioning. The municipal solid waste generated annually is 1,937,354 tons (2012 est.)<sup>45</sup>











### **Air Pollution**

The air quality in Mali is considered unsafe. The data indicates the country's annual average concentration of PM<sub>2.5</sub> is 39µg/m<sup>3</sup><sup>46</sup> which exceeds the recommended maximum of 10 µg/m<sup>3</sup> according to the WHO<sup>47</sup>. Contributors to poor air quality in Mali include dust storms and vehicle emissions. Seasonal variations in pollution exist, with highest levels during Harmattan which runs from November to March.<sup>48</sup>

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<sup>45</sup> CIA  
<sup>46</sup> CIA  
<sup>47</sup> IAMAT  
<sup>48</sup> IAMAT

### 6.3. Mali shelter models

<b>CASE VÉGÉTALEE</b> 		<p>This emergency shelter is designed as a variation adapted to the context of Tombouctou</p> 
	Total area 24m <sup>2</sup>	<b>Dimensions</b> 4 x 6 m.
	Occupancy 6 persons	<b>Depth of excavation</b> The depth of the excavation will be according to the soil context, with a minimum depth of 25 cm for each pillar.
	Construction time 1 day	<b>Structure (wall/roof)</b> 10 steel columns with a minimum section of 40x40mm, e=1.5 mm. The roof geometry is a dome shape created using arches fixed above the column heads. The material used is eucalyptus timber with a cross-section of 3 to 8 cm, e= 1.5 mm.
	Cost 197 euros	<b>Cladding walls</b> The walls are made of 10 doum palm mats of 1x2m directly sewn to the shelter structure.
	Durability 1 to 2 years	<b>Roof covering</b> The inner layer consists of 24 doum palm mats of 4x2m, sewn together, which cover the entire dome structure. The second layer consists of 2 plastic sheets (tarpaulins) of 4x4m.
	Total # Built 1000	

## CASE EN MILIEU HUMIDE



UNHCR designed this emergency shelter in response to the needs of the displaced population in Mauritania. It was later implemented in Mali with some minor adaptations to the local market and Tombouctou context



Total area  
20 m<sup>2</sup>

### Dimensions

5m x 4m



Occupancy  
5 persons

### Depth of excavation

Depending on the soil context, with a minimum of 25cm depth to a maximum of 50cm for each pillar.



Construction  
time  
1 day

### Structure (wall/roof)

11 galvanized steel poles of a diameter of 40 mm. The roof geometry is a gable shape created with lumber rafters attached in a lintel ring over the pole's heads.

The material used is 6 timber wood (basswood) with 80 x 80 mm section and length between 4 and 5 meters.



Cost  
746 euros

### Cladding walls

The walls are made of two layers of fabrics (70% Nylon & 30% Cotton) stitched together.



Durability  
2 to 3 years

### Roof covering

The inner layer consists of two layers of fabric stitched together (fabric is 70% Nylon & 30% Cotton). The second layer consists of 1 plastic sheeting (tarpaulin) of 4x5m.



Total # Built  
163

### Openings

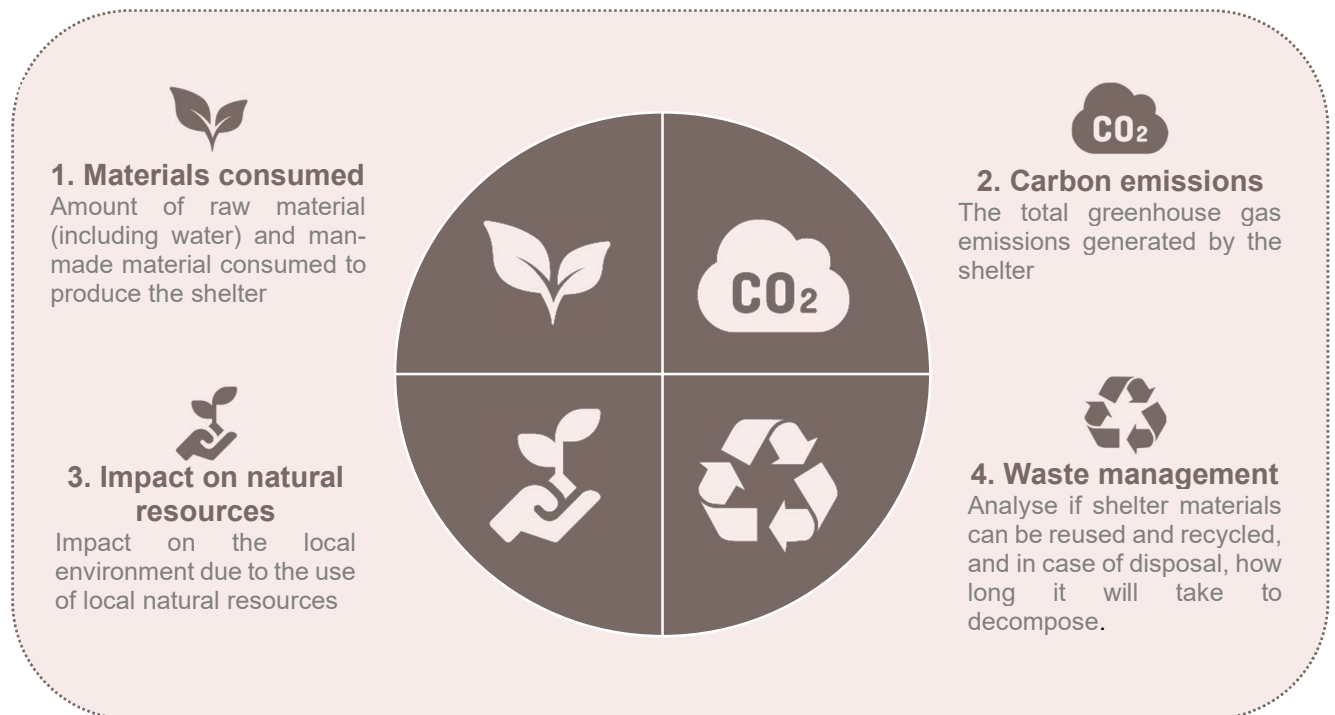
The doors and windows are made of Corrugated Galvanised Iron (CGI) over a wooden framework

## 7. Criteria used to analyse environmental impact

To do a comparative study of the environmental impact of the two shelter models, each material must be analysed across its lifecycle, from production to end of life and finally disposal. The following criteria were selected to structure this analysis:

1. Materials consumed
2. Carbon emissions
3. Impact on local natural resources
4. Waste management

Each of these is explained in detail below.



### 7.1. Criteria 1: Materials consumed

The consumption of materials is calculated by taking into consideration the materials / resources needed to build one shelter. It does not reflect the materials / resources used for the preparation, construction and maintenance of the sites where the shelters were constructed. This includes two main groups of materials:

- Natural materials used (in kilograms or litres): any naturally sourced product or physical matter (water, timber, etc.).
- Man-made materials (in kilograms): any product or physical matter that goes through rigorous processing (steel, plastic, etc.).

Water consumption is calculated as an input for all the man-made materials used to build the shelter. The water consumed by the natural growth of the doum palm trees, the eucalyptus trees and basswood trees, is not considered.

Any other raw materials which go into the production of the man-made materials are not considered – due to the complexity of this analysis and since data is not readily available.

## 7.2. Criteria 2: Carbon emissions

### What is a carbon footprint?

A carbon footprint is the total greenhouse gas emissions caused by an individual, event, organization, service, place or product, expressed as carbon dioxide equivalent (CO<sub>2</sub> equivalent).

### Life cycle analysis (LCA)

LCA is a commonly adopted methodology for quantifying carbon emissions and can be used to help compare shelter options. This 'cradle to grave' assessment evaluates the carbon emissions of the shelter from extraction of raw materials to the end of its life. It is a good starting proxy for a quantitative approach to measuring the environmental footprint of the different shelter options.

Using CO<sub>2</sub> equivalent doesn't cover the entirety of the complex issue of environmental impact, as there can be other more local impacts related to humanitarian shelter and settlement practices, but it provides a useful metric that can inform decision making.



### Carbon calculator tool

The carbon calculator tool used in the study is the new SMAC<sup>49</sup> (Shelter Methodology for the Assessment of Carbon) tool. It calculates the CO<sub>2</sub> equivalent for most shelter designs and allows for the comparison of different shelter solutions in terms of their environmental impact over their entire life cycle.

The SMAC allows for comparison of up to 4 different shelter types, in terms of their embodied CO<sub>2</sub> equivalent emissions from the following factors:

1. Production of the component materials
2. Packaging
3. Transport
4. End of Life



#### 7.2.1. Data required to use SMAC

In order to use the tool and calculate a kg CO<sub>2</sub> equivalent figure for the two shelter options, the following data has been compiled:

- A list of the shelter components and materials
- The amount of each material used (in kg) for each shelter
- The type of packaging used for the materials
- The amount of each packaging material used (in kg) for each shelter
- The transportation distances and modes from point of source of materials to point of use and disposal (there is further guidance in the SMAC tool on this if accurate distances are not known).

##### i) Shelter components and packaging materials

The amount (in kgs) of each raw material used in every shelter component is required.

Refer to Annex 4 to find the information regarding shelter material and quantity in kilograms, packaging components, and origin of the material used in the calculation. All this information was provided by the AI-CRL team in-country.

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<sup>49</sup> SMAC It is a simplified LCA methodology, developed by BRE Trust, the Global Shelter Cluster Environment Community of Practice, and WWF, based on components of shelter options that use CO<sub>2</sub> equivalent emissions as a metric for assessment. Information on SMAC can be found at <https://www.sheltercluster.org/community-of-practice/environment>  
This study is one of the second to use the SMAC tool, and feedback has been shared with the developers to improve it.

This individual study is part of a set of similar studies in four countries in the region (Niger, Chad, Burkina Faso and Mali). In some of the other countries, this packaging data was not available. Therefore, it has also been excluded from this particular study, in order to ensure consistency and to compare of results.

## ii) Transportation

When calculating the CO<sub>2</sub> equivalent, one of the key factors is the origin of the materials, since transportation can make a big contribution to carbon emissions. Whether a material has been purchased locally or imported, transported from a neighbouring country by road, or produced in a distant country and transported by sea or air, will have a material impact on total carbon emissions.

To calculate the transportation distance, the following distances in kilometres for each product are required.

- Country of origin to point of arrival in country
- Point of arrival to warehouse / store
- Warehouse to construction site
- Construction site to disposal site
- Type of transport used for each phase (truck/road, train, sea or air)

## Calculating transport distances

For the purpose of this study, since the exact travel distance and the exact location of each factory are not known, average transport distances have been estimated and can be found in Annex 5. The following assumptions have been made:

- The tool and the analysis here do not include any transportation that may have occurred earlier in the supply chain, for example if part of a product is manufactured in one country and then shipped to another country where production is completed, from where the programme purchases it. The data is not available to include this, and the complexity of such analysis is beyond the scope of the SMAC tool.
- When one material could come from different locations, the average distance is calculated according to a weighting determined by the proportion of material coming from each location.
- When calculating the average distance from the warehouse to the construction site, the distance has been calculated based on the proportion of shelters that have been built in each location.
- The distances in kilometres have been calculated using Google Maps, when they have not been provided by the field team.
- Plastic sheeting, steel poles, screws and the fabric used in the Case en Milieu Humide model were manufactured in China and transported by boat to Dakar (Senegal), and then transported by road to Bamako.
- All the rest of the materials have been transported by road (as per information provided by the field team)
- Since the exact location of the Chinese factory wasn't available, the suggested approximate distance baseline provided by the SMAC guidelines from Asia to West Africa has been used: 19,000 kilometres.

## iii) End of life

SMAC uses assumptions about the level of recycling and CO<sub>2</sub> eq. released at the 'end of life', meaning when the material has reached the end of its useful life, based on standard construction practices for each material. However, the actual portion of each material that is recycled at 'end of life' may be overestimated in the CO<sub>2</sub> eq. calculation, according to the SMAC developers. This means that the carbon emissions calculated from 'end of life' are probably underestimated.

## 7.2.2. Limitations of the SMAC carbon calculator tool

One of the limitations of the SMAC relates to the types of materials included in the database<sup>50</sup> used by the tool. It was not possible to find Environmental Product Declarations (EPD) for all possible shelter materials that are used in humanitarian operations. As a result, the user must choose a similar material when the precise material is not listed in SMAC's drop-down lists (for example, acrylic-based fabric was selected instead of cotton-nylon fabric). Similarly,

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<sup>50</sup> The data from the tool has been taken from the Inventory of Carbon and Energy (ICE database), as well as from various environmental product declarations (EPD, such as those found in Eco Platform and Greenbooklive). The ICE database is a collation of aggregated and EPDs. Where data did not exist in ICE, and one EPD was available, that data point was used. Where several EPDs were available, an average was used. All data sources have been referenced within the tool. Data for packaging, end of life and recycled content have been sourced from BRE.

assumptions are made in the SMAC relating to end of life (recycling options and level of CO<sup>2</sup> released from disposal), where the best data available publicly was used. However, the developers of the SMAC consider both of these limitations to be acceptable, and in line with what they term a “good enough approach”.

### 7.3. Criteria 3: Impact on local natural resources

Going beyond the carbon emissions measured by CO<sup>2</sup> equivalent, which is only one measure of environmental impact, this criteria looks at impacts on the local environment due to the use of local natural resources. It is important to analyse whether the production or harvesting of natural resources could be causing environmental harm.

For instance, while carbon emissions analysis may indicate that importing wood generates greater emissions than procurement of locally available wood, this local procurement could result in excessive local tree cutting and environmental degradation. Another example is where using locally sourced straw or thatch to roof one house is not an environmental issue, however 1,000 houses may pose some stress on the local eco-system, while roofing 10,000 houses every year could create a major issue in the local area.

The following factors are considered: Deforestation and vegetation removal, soil erosion, and degradation of water quality.

A few Regional Authorities<sup>51</sup> from the Government (or Regional Management) who specialise in the protection of forests and ecosystems in Mali were contacted, but without success. Literature review<sup>52</sup>, and feedback from the project team has formed the basis for this analysis.

### 7.4. Criteria 4: Waste Management

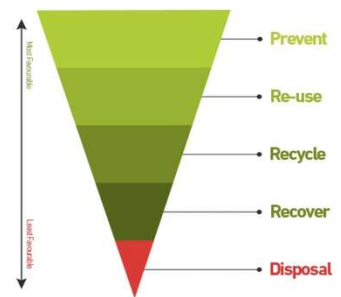
One of the challenges of humanitarian action is that more end-to-end thinking about waste isn't common in the largely 'truck and chuck' humanitarian reality. All throughout the project cycle, any organisation that imports, produces, transports, or generates waste in some way, must think of the waste management implications. The ultimate goal is to generate the minimum amount of waste and extract the maximum benefit from products, keeping them in use for as long as possible.

This section studies if the life cycle of the shelter materials can be prolonged by reusing and recycling, and in case of disposal, how long it will take to decompose.

#### Waste hierarchy

Reduce, Reuse, Recycle: Commonly referred to as the “3 R's” of the waste hierarchy. Reduce means to minimise the amount of waste created. Reuse refers to using items more than once. Recycle means putting a product to a new use instead of throwing it away. The full waste hierarchy is usually characterised as: Reduce/Prevent; Reuse; Recycle; Recover; Disposal<sup>53</sup>. The different options (in order of preference) are in the illustration.

The levels indicate the progressive order of actions to take to reduce waste. More energy should be spent on the more significant layers at the top of the chart, like redesigning, reducing, and reusing. And to minimize the activities at the bottom, like residual management or landfill.



<sup>51</sup> Refer to Annex 2

<sup>52</sup> Refer to biography

<sup>53</sup> EU Commission, 2014

A number of “economic interest groups” (groupements d’intérêt économique (GIE),<sup>54</sup> involved in ecological recycling and waste recovery in the country in Mali were contacted for this study. Literature review<sup>55</sup>, feedback from the “GIEs”, the project team, and environmental experts from the shelter sector<sup>56</sup> have been considered for this analysis.

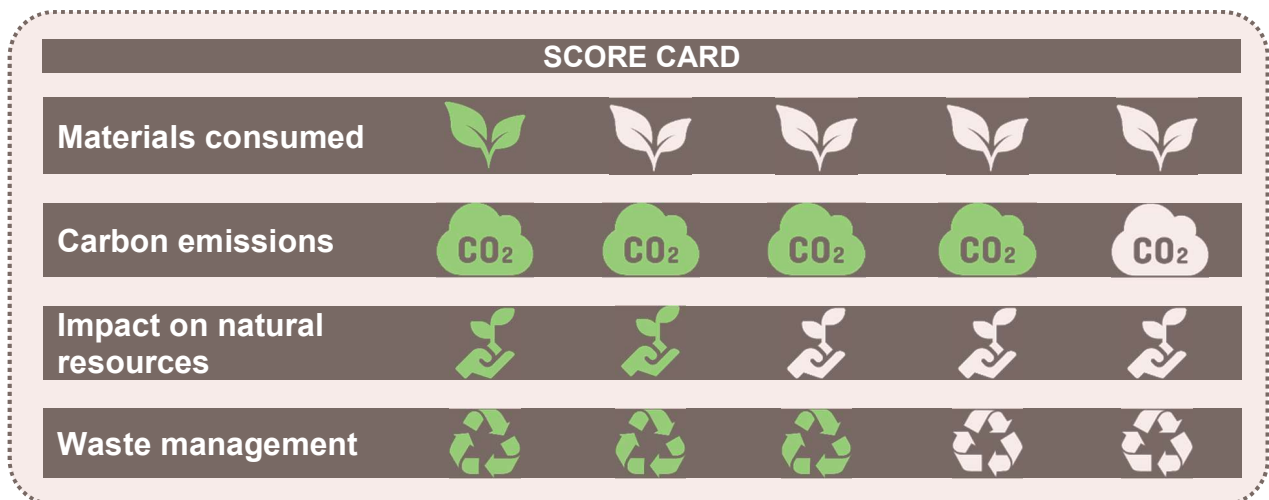
## 7.5. Score card approach

A simple ‘score card’ approach is used to compare the two shelter models across the four criteria. This recognises that carbon emissions, while being critical, are not the only factor in environmental impact. A score card also recognises the challenge in applying any kind of numerical weighting for the four criteria in order to arrive at a calculated score. This would require too many assumptions on the relative weight of each category. Instead, a qualitative conclusion will be made based on the score card.

While acknowledging the methodological limitations of this approach, it is the only feasible option in the limited scope and time allotted to this study. A score card highlights in a simple way what the main environmental issues are for each shelter, thus identifying where mitigating solutions could help to improve the overall environmental impact of the shelter models.

Both shelter models will be scored from 1 to 5 against each of the criteria, to enable comparison.

Example of the score card (noting that a higher score is better, meaning lower environmental impact):



1 poor, 2 average, 3 medium, 4 good, 5 very good

<sup>54</sup> Refer to Annex 2

<sup>55</sup> Refer to biography

<sup>56</sup> Refer to Annex 2 to see the list of people contacted.

## 8. Comparison of environmental impact of the shelter models

### 8.1. Criteria 1: Materials consumed

#### 8.1.1. Overview of the materials used and their general impact on the environment



### Plastic

Is the term commonly used to describe a wide range of synthetic or semi-synthetic materials that are used in a huge and growing range of applications.<sup>57</sup> Half of all plastics ever manufactured have been made in the last 15 years. Only in 2020, 367 million tons were produced and this is expected to double by 2050.

#### Types of plastics used in the shelter model

**Polyethylene;** The poly tarpaulin was invented in 1932. Because polyethylene is such a versatile material, it became the most widely used type of plastic in the market, used to produce everything from shopping bags to plastic containers.

**Nylon;** Is composed of polyamides, it is a silk-like thermoplastic generally made from petroleum, that can be melt-processed into fibres, films, or shapes. It was the first fabric made entirely in a laboratory. It became widely available to the general public around the time of World War II, thanks to its strength and durability.<sup>58</sup>

#### General environmental impacts

**Greenhouse effect;** the use of fossil fuels and other chemicals in the production of these products is a key contributor to the global warming crisis. Plastic production and incineration currently account for 3.8% of carbon emissions and is estimated to be responsible for 13% by 2050. In 2019 alone 850 million metric tons of carbon dioxide equivalent was released into the atmosphere due to plastic.<sup>59</sup>

**Ocean contamination;** 10 percent of this plastic ends up in the ocean, where it breaks down into microplastics.<sup>60</sup> By 2050, the world's oceans will contain more plastic than fish (by weight) if current trends continue.

**Harm to wildlife;** Plastics harm fish, plants, wildlife and the natural environment by leaching toxins into soil, water and air. They poison, injure and kill wildlife.<sup>61</sup>

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<sup>57</sup> [www.aquapakpolymers.com](http://www.aquapakpolymers.com)

<sup>58</sup> [www.greenpeace.org](http://www.greenpeace.org)

<sup>59</sup> <https://goodonyou.eco>

<sup>60</sup> Center for International environmental law.

<sup>61</sup> Green Peace

<sup>62</sup> [Stopplastic.ca](http://Stopplastic.ca)



## Steel

is an alloy (a metal combined with two or more metallic elements) made up of iron and a percent of carbon, to improve its strength and fracture resistance. Other elements may be present or added. Iron is the world's third most produced commodity by volume - after crude oil and coal. Over 2,000 million tons of iron is mined a year - about 95 percent is used by the steel industry.<sup>63</sup>

### General environmental impacts<sup>64</sup>

**Energy consuming;** Production of steel is the most energy-consuming in the world.

**Pollution;** Steel production requires large inputs of coke (a type of coal) which is extremely damaging to the environment. Coke ovens emit air pollution highly toxic and can cause cancer. Wastewater from the coking process is also highly toxic and contains a number of carcinogenic organic compounds.

**Greenhouse effect;** Steel production is responsible for the emission of 3,3 million tons of CO<sub>2</sub> annually<sup>65</sup>



## Cotton

is a natural plant fiber which grows around the seed of the cotton plant. Cotton fibers are the starting point of the production chain for the textile industry.

### General environmental impacts<sup>66</sup>

**Water consumption;** Cotton's most dramatic negative impact is on water availability. It takes 10,000 liters of water to produce one kilogram of cotton. Global cotton production requires over 250 billion tons of water annually.

**Chemical pollution;** Cotton is the crop most heavily sprayed with chemicals in the world. Hazardous pesticides commonly used for cotton production are often found in nearby water resources.

**Soil degradation;** Cotton cultivation also causes soil degradation and erosion as well as loss of forest area and other habitat.

**Greenhouse effect;** Cotton production is responsible for the emission of 220 million tons of CO<sub>2</sub> annually<sup>66</sup>.

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<sup>63</sup> The world counts

<sup>64</sup> The world counts

<sup>65</sup> The world counts

<sup>66</sup> The world counts



## Doum palm tree

*Hyphaene thebaica*, with common name doum palm is a type of palm tree. Individuals can grow to 25 m.<sup>67</sup> It is a native to the Arabian Peninsula and also to the northern half and western part of Africa,<sup>68</sup> where it is widely distributed and tends to grow in places where groundwater is present. Most of its parts are used by local people, but especially the leaves to make woven mats for walls and roofs of housing.

### General environmental impacts<sup>69</sup>

**Soil fertility;** Palm trees promote soil fertility.

**Wind erosion;** Palm trees fight against wind erosion and the desertification

**Tree extinction:** Commercial over-exploitation will lead to the disappearance of the tree



## Eucalyptus

is an ever-green tree native to Australia. It is widely planted in different parts of the world, integrated into various farming systems. It is commonly cultivated as a monocultural crop in short rotations of 3 years for biomass crops and 6 or more for timber use. It is a highly profitable forestry crop.

### General environmental impacts<sup>70</sup>

**Water consumption;** Growing eucalyptus in low rainfall areas may cause adverse environmental impacts due to competition for water with other species.

**Soil erosion;** Short rotations and intensive management practices, result in soil compaction, soil erosion, and other adverse effects.

**Pollution;** Due to the use of fertilizers, weedicides and pesticides, and fire hazards.

**Soil nutrient;** When is grown as a short rotation crop for high biomass production and removal, soil nutrients are exhausted rapidly.

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<sup>67</sup> [www.eol.org](http://www.eol.org)

<sup>68</sup> *World Check List of Selected Plant Families (WCSP)*. Kew Sciences.

<sup>69</sup> *Valoriser les produits du palmier doum pour gérer durablement le système agroforestier d'une vallée sahélienne du Niger et éviter sa désertification*. Régis Peltier, Claudine Serre Duhem et Aboubacar Ichaou

<sup>70</sup> *Silviculture of eucalyptus plantings – Learning in the region*. K.J. WHITE. FAO



## Tilia americana (basswood)

is a species of tree in the family Malvaceae, native to eastern North America but also now found in parts of Africa. The American basswood is a medium-sized to large deciduous tree reaching a height of 18 to 37 m, with a trunk diameter of 1–1.5 m at maturity. It grows faster than many North American hardwoods. Life expectancy is around 200 years, with flowering and seeding generally occurring between 15 and 100 years, though occasionally seed production may start as early as eight years.<sup>71</sup>

Basswood is an important commercial hardwood. Its wood is light, generally straight-grained and fine-textured. Its lumber is used for furniture, millwork, caskets, frames, toys and novelty products.<sup>72</sup>

### General environmental impacts

The basswood provides food and shelter for many species of wildlife. Squirrels, chipmunks, mice, rabbits, upland game birds, songbirds, porcupines and foxes eat the seeds or bark of this tree. Trees become dens for many animals.<sup>73</sup>



## Water

covers 70% of our planet, however, only 3% of the world's water is fresh water.<sup>74</sup> Billions of people worldwide lack access to water. Water is at the core of sustainable development and is critical for socio-economic development, healthy ecosystems and for human survival itself.<sup>75</sup>

### Environmental impacts

**Water shortage;** Water shortages are likely to be the key environmental challenge of this century.<sup>76</sup> More than half the world's wetlands have disappeared. Many of the water systems that keep ecosystems thriving and feed a growing human population have become stressed. Rivers, lakes and aquifers are drying up.

**Agriculture;** consumes more water than any other source, 70% of the world's accessible freshwater, and wastes 60% of it, much of that through inefficiencies due to leaky irrigation systems, inefficient application methods as well as the cultivation of crops that are too thirsty for the environment in which they are grown.<sup>77</sup>

**Water pollution;** comes from many sources including pesticides and fertilizers that wash away from farms, untreated human wastewater, and industrial waste.<sup>78</sup>

**Climate change;** is altering patterns of weather and water around the world, causing shortages and droughts in some areas and floods in others.<sup>79</sup>

<sup>71</sup> Wikipedia

<sup>72</sup> LE TILLEUL D'AMÉRIQUE (lronline.com)

<sup>73</sup> LE TILLEUL D'AMÉRIQUE (lronline.com)

<sup>74</sup> WWF

<sup>75</sup> www.un.org/waterforlifedecade

<sup>76</sup> NASA

<sup>77</sup> University of Dundee

<sup>78</sup> WWF

<sup>79</sup> WWF

### 8.1.2. Data and analysis of the materials in the shelters

Below are the tables showing the materials used in each of the shelter models, by weight (kilograms). The data was provided by the AI-CRL logistics team in Mali.

Water consumption is calculated for all the man-made materials used to build the shelter. The water consumed by natural growth of the doum palm trees, the eucalyptus and the basswood is not considered. To calculate the water in litres, the following baseline assumptions have been used:

- Production of 1 kg of plastic requires 17 litres of water<sup>80</sup>
- Production of 1 kg of steel requires 705 litres of water<sup>81</sup>
- Production of 1 kg of cotton takes 10,000 litres of water<sup>82</sup>

**CASE VÉGÉTALE- Table 1**

Raw material	
Doum palm tree	68.5 kilos
Eucalyptus wood	188 kilos
Water consumption	17,761 litres

Man-made material	
Steel	25 kilos
Plastic	8 kilos
Nylon Fabric	1 kilo

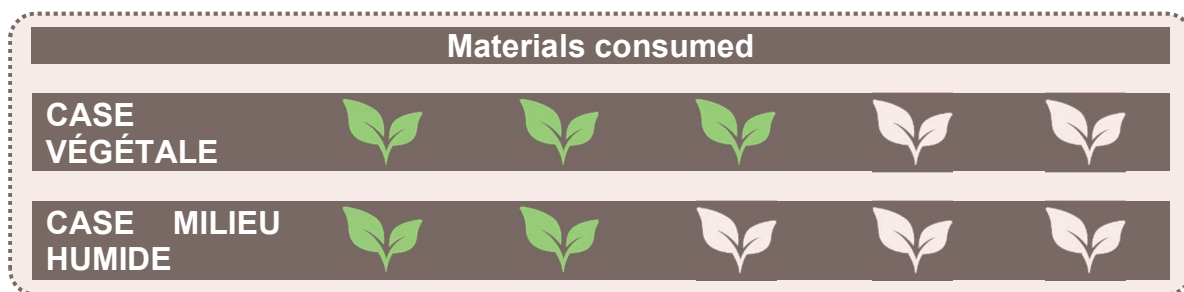
**CASE EN MILIEU HUMIDE –Table 2**

Raw material	
Basswood	41.2 kilos
Cotton fabric	4.5 kilos
Water consumption	107,108 litres

Man-made material	
Steel	81 kilos
Iron	7 kilos
Plastic	4 kilos
Nylon Fabric	10.5 kilos

#### 8.1.1. Interpretation of the results

The Case Végétale model scored 3 out 5 and the Case en Milieu Humide model scored 2 out 5



1 poor, 2 average, 3 medium, 4 good, 5 very good

The Case Végétale model used a high amount of raw material, specially eucalyptus wood and doum palm tree. However the Case en Milieu Humide model consumed a larger amount of water, the difference is significant, 17,761 liters vs 107,108 liters, due to the production of cotton for the fabric which is used (30% cotton, 70% nylon). Also, the Case en Milieu Humide shelter used a higher amount of man-made material, especially steel. Overall, the Case Végétale model is using less materials.

Note that under this criteria the quantity of materials is considered, and not whether the extraction of local raw materials is environmentally harmful, which is considered under Criteria 3.

Both scores could be improved by reducing the amount of materials, especially steel, plastic and eucalyptus wood, used in the shelters, without compromising the functionality. The Case en Milieu Humide model could also be improved in the future by using a different material for the fabric instead of cotton, or to decrease the amount in kilos by using a

<sup>80</sup> Shelter and Sustainability, UNHCR, 2021

<sup>81</sup> Shelter and Sustainability, UNHCR, 2021

<sup>82</sup> www.theworldcounts.org

lighter fabric. However, another material could not perform as well, or be more costly. For instance, organic cotton, which consumes only 10% of the water that normal cotton does, costs around 20% to 30% more.

## 8.2. Criteria 2: Carbon emissions

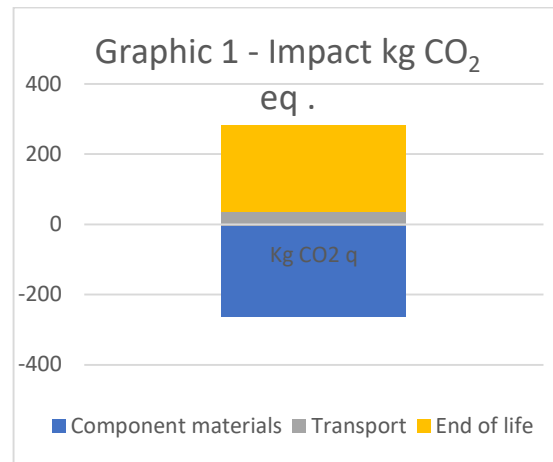
Below are the total carbon emissions generated by each shelter model, in CO<sub>2</sub> equivalent. This is using the SMAC calculator and taking into account all the parameters and assumptions explained above in section 7.2.

### 8.2.1. Case Végétale Model

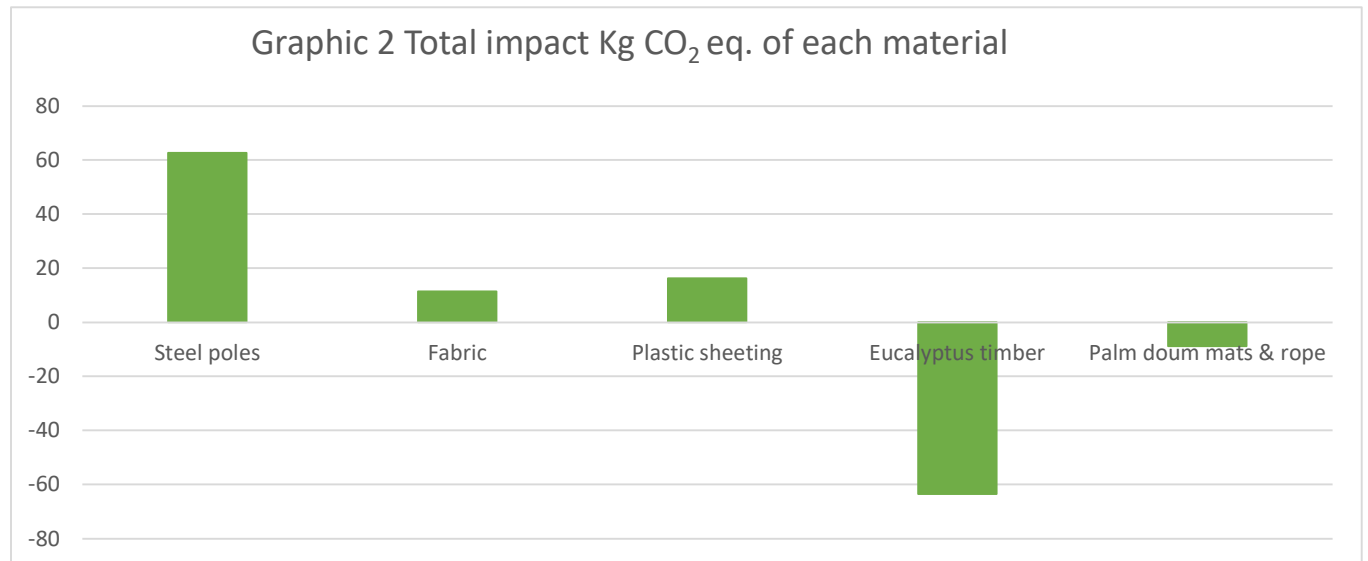
The follow Table 3 & and Graphic 1 show the breakdown of the carbon emissions, in terms of Kg CO<sub>2</sub> eq. and relative % CO<sub>2</sub> eq., of the shelter unit per life cycle stage: 'production of the component materials', 'transport' and 'end of life'. Emissions from 'packaging' are not included as information was not available.

Table 3 - Case Végétale

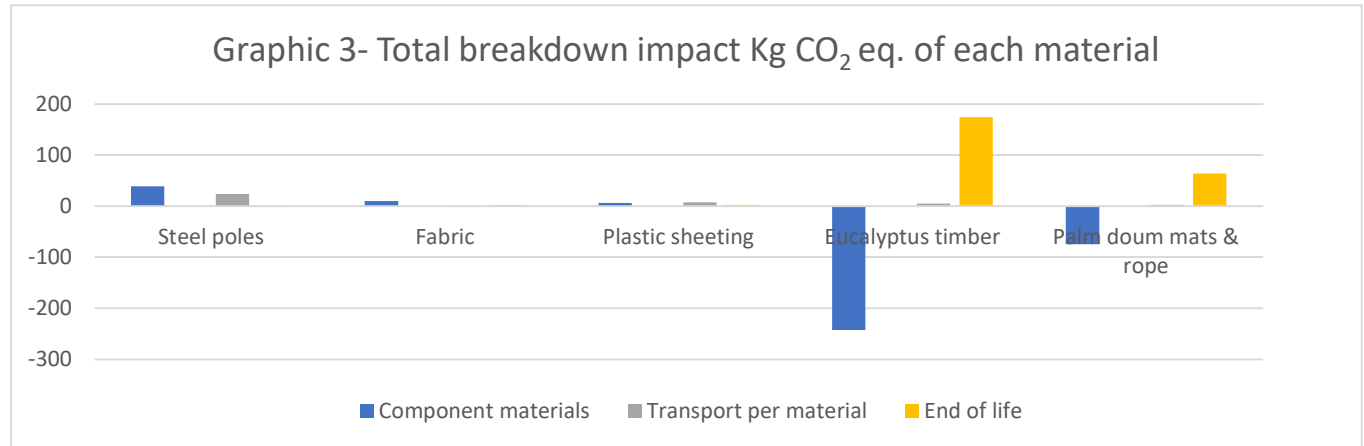
Impact	Carbon Emissions Kg CO <sub>2</sub> eq.
Production of component materials	-263
Packaging	<i>Data not considered</i>
Transport	39
End of life	241
<b>Total</b>	<b>18</b>



The follow Graphic 2 shows the total Kg CO<sub>2</sub> eq. impact of each material.



The follow Graphic 3 shows the total Kg CO<sub>2</sub> eq. emissions of each material, broken down into the emissions generated by 'production of the component materials', 'transport' and 'end of life'.



### 8.2.2. Interpretation of the result for Case Végétale model

Overall all, the Case Végétale model generates little carbon emissions, due to the amount of natural materials it used like eucalyptus wood and palm doum. Steel poles are the only material which generates any significant emissions, but these are offset by the carbon captured during the growth of the natural materials.

Considering the total impact of each of the materials used in the shelter (Graphic 2), the biggest impact is the steel poles, followed by plastic sheeting and fabric. The emissions generated by the steel poles are due mostly to the 'production of the component material' (Graphic 3).

As per Table 3 & Graphic 1 most of the carbon emissions for this shelter are from the 'end of life' of the component materials used, with 'transport' making a smaller contribution and 'production of the component material' actually generates negative carbon emissions. However, as will be explained, this overall picture is slightly misleading, because the use of the natural materials, as eucalyptus timber and palm doum mats has the effect of offsetting many of the emissions from the other materials like steel poles or plastic sheeting.

When looking into the eucalyptus timber and palm doum mats & rope (Graphic 3), the 'production of the component material' actually generates negative carbon emissions, because natural materials capture carbon (and other greenhouse gases) during their growth. However, this captured carbon is released at the end of life (Graphic 3), where the eucalyptus timber has the biggest impact on emissions, follow by the palm doum mats & rope. This is because these materials are usually burnt, therefore the level of CO<sub>2</sub> eq. released into the air is relatively high. The SMAC tool assumes that these type of plant materials and wood are burnt at the end of their useful life. If the material is allowed to decompose, is composted, or is just buried, little or no CO<sub>2</sub> eq. would be released into the environment.

So, initially, the CO<sub>2</sub> eq. number for eucalyptus wood and palm doum mats may be negative as producing the material takes less CO<sub>2</sub> eq. than, for instance, plastic sheeting. But these negative emissions are 'balanced out' when considering what happens at the end of life of the material, when carbon is emitted, and also due to the emissions from transportation.

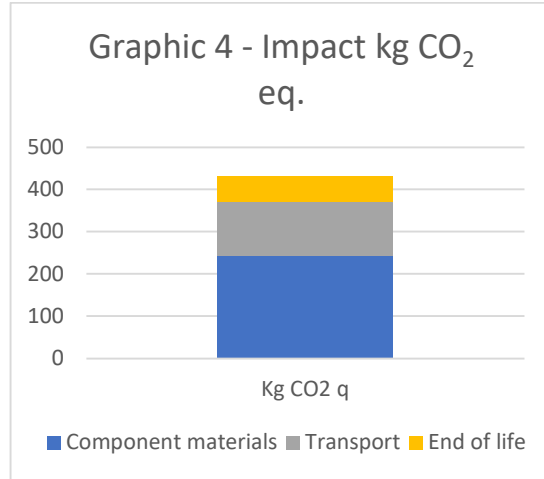
Overall, it is clear that the steel poles, and also the plastic sheeting, are driving most of the carbon emissions; however, for the entire shelter the emissions from production appear lower due to the 'carbon capture' effect of the natural materials; similarly the emissions from 'end of life' appear high due to the emissions released from the burning them.

### 8.2.3. Case en Milieu Humide Model

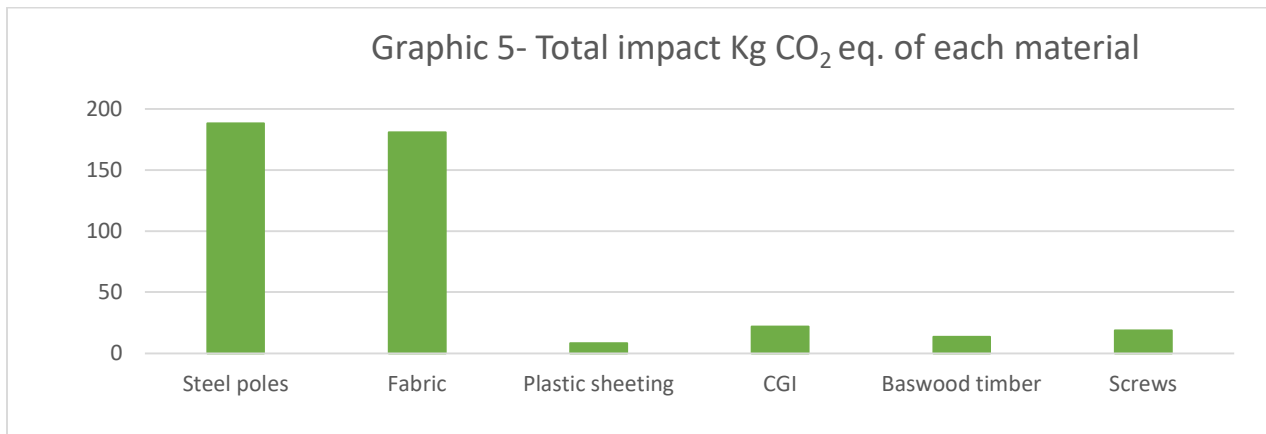
The follow Table 4 and Graphic 5 show the breakdown of the carbon emissions generated, in terms of Kg CO<sub>2</sub> eq. and relative % CO<sub>2</sub> eq., of the shelter unit per life cycle stage: 'production of the component material', 'transport' and 'end of life'. Emissions from 'packaging' are not included as information was not available.

Table 4 - Case en Milieu Humide

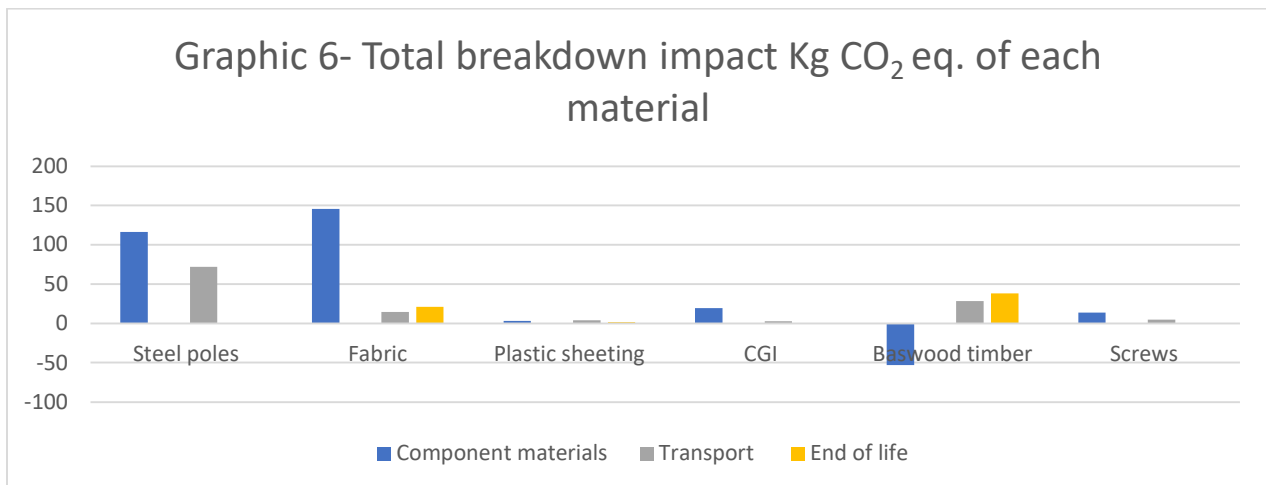
Impact	Carbon Emissions Kg CO <sub>2</sub> eq.
Production of component materials	245
Packaging	<i>Data not considered</i>
Transport	126
End of life	60
<b>Total</b>	<b>431</b>



The follow Graphic 5 shows the total Kg CO<sub>2</sub> eq. impact of each material.



The follow Graphic 6 shows the total Kg CO<sub>2</sub> eq. emissions of each material, broken down into the emissions generated by 'production of the component materials', 'transport' and 'end of life'.



### 8.2.4. Interpretation of the result for Case en Milieu Humide model

As per table 4 & Graphic 4 most of the carbon emissions for this shelter are from the 'production of the component material' followed by 'transport', with 'end of life' making the least contribution.

When looking into each of the materials, Graphic 5, steel poles and fabric are the ones that have the biggest emissions, followed by the screws and iron (CGI). As per Graphic 6 most of the emissions from the steel poles and fabric are from the 'production of the component material'. 'Transport' also adds substantial emissions from the steel poles.

Regarding basswood timber, Graphic 6, it captures carbon during the 'production of the component material'. This is because all natural materials capture carbon (and other greenhouses gases) during their growth. However, this number is almost balanced out when considering what happens at the 'end of life' of the materials, when carbon captured is released (Graphic 6). This is because these materials, as explained in section 8.2.2., are usually burnt (and the SMAC tool assumes the same), therefore the level of CO<sub>2</sub> eq. released into the air is relatively high. If the material is allowed to decompose, or is just buried, little or no CO<sub>2</sub> eq. would be released into the environment. This would further increase the 'positive' impact on emissions of the carbon captured by the natural materials used.

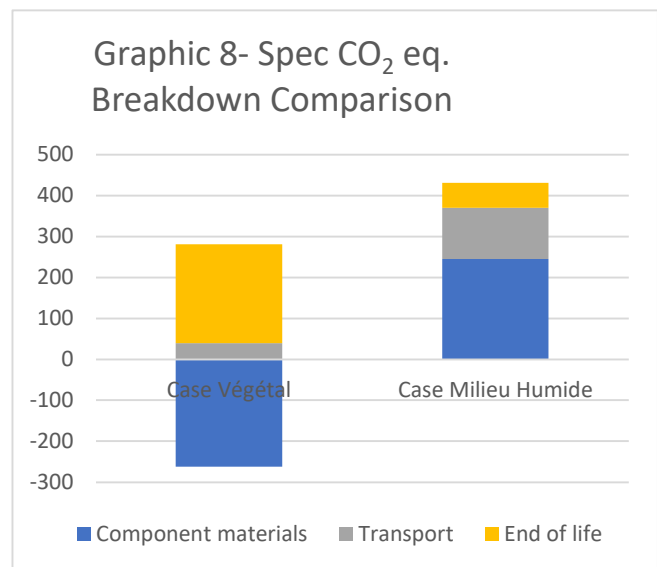
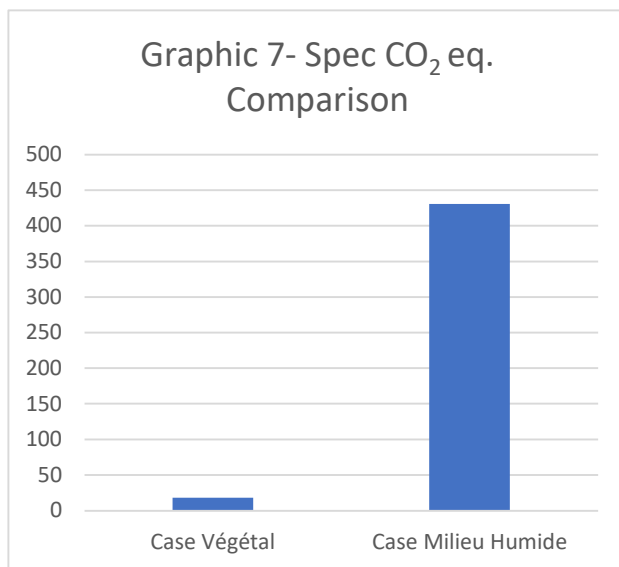
Comparing the result for both models:

Table 3 - Case Végétale

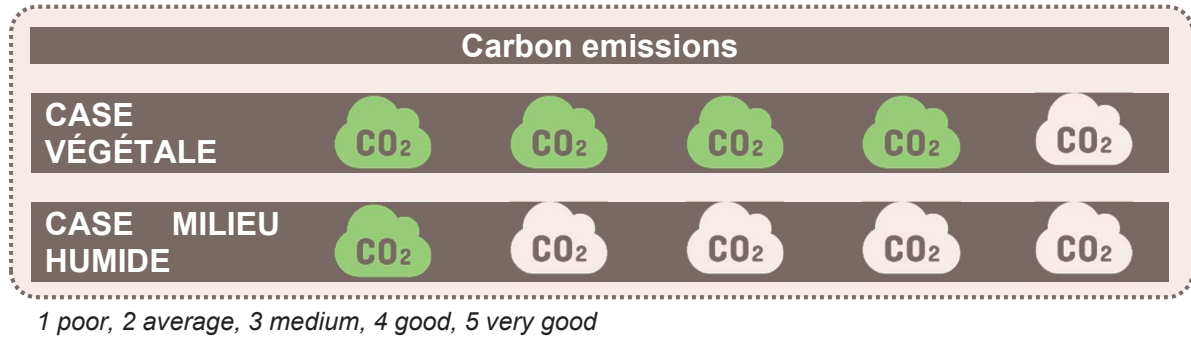
Impact	Carbon Emissions Kg CO <sub>2</sub> eq.
Production of the component materials	-263
Packaging	<i>Data not considered</i>
Transport	39
End of life	241
<b>Total</b>	<b>18</b>

Table 4 - Case en Milieu Humide

Impact	Carbon Emissions Kg CO <sub>2</sub> eq.
Production of the component materials	245
Packaging	<i>Data not considered</i>
Transport	126
End of life	60
<b>Total</b>	<b>431</b>



Case Végétale model scored 4 out 5 and Case en Milieu Humide model scored 1 out 5



The comparison of overall carbon emissions is very clear, with the Case Végétale model considerably better than the Case en Milieu Humide. Obviously, this is due to its reliance on natural materials like eucalyptus and palm doum products, rather than steel and fabric made of nylon and cotton.

For Case Végétale model, the overall result is “almost carbon neutral”, due to the use of natural materials. However it can also be improved by:

- Ensuring that the natural materials are not burnt at the end of their useful life, and are composted instead. So the total amount of captured carbon could be even higher.

The score card for the Case en Milieu Humide model could be improved by:

- To consider to use different materials, especially replacing the fabric and the steel poles which have the highest embodied CO<sub>2</sub> emissions, or reducing the amount used without compromising the quality of the shelter.
- To ensure that basswood timber is not burnt at the end of its useful life, and are composted or left to degrade instead.
- To reduce the emissions from transport. The highest impact came from the steel poles, since they come from China. Procuring the metal tubes more locally should be considered.

### 8.3. Criteria 3: Impact on local natural resources

A common assumption is that the more natural a material it is, the better it is for the environment. However, when selecting a natural resource, there are certain impacts on the local ecosystem that need to be considered, such as deforestation and vegetation removal, soil erosion, degradation of water quality, pollution etc. Where possible, options to mitigate these effects should be considered as part of project design.

Mali has been suffering from worsening water scarcity and recurring droughts for decades now and it is seriously affecting the country, as a result, desertification is one of its major environmental issues. Together with soil erosion, deforestation, and loss of pasture land, Mali also has a shrinking water supply<sup>83</sup>. Over the last three decades, nearly two million hectares<sup>84</sup> of forest have been lost from Mali, mostly to make space for farmland<sup>85</sup>, but also, according to the Ministry of the Environment, Mali’s population consumes 6 million tons of wood per year for timber and fuel. To meet this demand, 4,000 square kilometers of tree cover are lost annually, virtually ensuring destruction of the country’s savanna woodlands<sup>86</sup>.

<sup>83</sup> Mali- Environment." Encyclopedia of The Nations. N.p., n.d. Web. 16 May 2013

<sup>84</sup> <https://www.treeaid.or>

<sup>85</sup> <https://www.treeaid.or>

<sup>86</sup> Wikipedia

With rainfall becoming more unpredictable, and soil losing its fertility, people are struggling to grow trees and crops, something which they depend on for food and income<sup>87</sup>. The forest revenues<sup>88</sup> in Mali are 2.02% % of GDP (2018 est.), which is the 35<sup>th</sup> highest of 204 countries analysed. The consequences of land degradation are extremely serious, where more than 80% of the population's livelihood depends on agriculture and livestock. Land productivity declines, rural communities have poorer and poorer harvests. Food insecurity and malnutrition are increasing. Mali is highly vulnerable to the negative effects of climate change, resulting in overexploitation of natural resources and land degradation<sup>89</sup>. Tensions and conflicts are a direct translation of these growing pressures on resources. Therefore the use of local forest resources in shelter construction needs to be carefully analysed.

To help sustain Mali's ever-growing problem the government has designated 3.7 percent of Mali's total land area as protected. It has ratified international environmental agreements pertaining to biodiversity, climate change, desertification, endangered species, and ozone layer protection<sup>90</sup>. However, it will take time for this to improve the situation.

In the context of climate change and pressure on local natural resources, it is important to analyse whether the shelter models contribute to this degradation of the environment. To do a proper study of potential harm done to the environment, it should really go beyond the local natural resources used, in this case the doum palm tree, and look into the overall sheltering strategy and implementation (site selection, access, infrastructure and services, environmental protection, etc.). However, this is beyond the scope of this study and so analysis is restricted to the local materials used.

Attempts were made to contact some Regional Authorities<sup>91</sup> from the Government unsuccessfully.



## **A quick overview about forests, why they are important to fight against climate change, and forest situation in Mali**

Forests play a key role in mitigating climate change<sup>92</sup> and increase the resilience of rural communities. They regulate ecosystems, protect biodiversity, play an integral part in the carbon cycle, support livelihoods, protect homes from major weather events, improve health and can help drive sustainable growth<sup>93</sup>.

### **Environmental issues<sup>94</sup>**

- 30 % of global tree species are threatened with extinction. And over the past 300 years, the global forest area has decreased by about 40%.
- The main threats to tree species are forest clearance and other forms of habitat loss, direct exploitation for timber and other products. Climate change, like fire, extreme weather and sea level rise, is also having a clearly measurable impact.
- Around 25% of global emissions come from the land sector. About half of these come from deforestation and forest degradation.

### **Mali Forest Information and Data**

- 10.9% of Mali is forested<sup>95</sup>
- Between 1990 and 2010, Mali lost an average of 79,100 ha or 0.56% per year<sup>96</sup>

<sup>87</sup> <https://www.treeaid.org>

<sup>88</sup> CIA. Mali - The World Factbook ([cia.gov](http://cia.gov))

<sup>89</sup> USAID (2018). Climate Risk Profile. April 2018: Mali. <https://tinyurl.com/smx7f3sc>

<sup>90</sup> Land and Resources, Environmental Issues." countries quest. N.p., n.d. Web. 17 May 20

<sup>91</sup> Refer to Annex 2

<sup>92</sup> Forests and climate change. IUCN

<sup>93</sup> Forests and climate change. IUCN

<sup>94</sup> State of the World's Trees. Sept 2021. Botanic Gardens Conservation International

<sup>95</sup> World Bank collection of development indicators

<sup>96</sup> FAO

- The forest revenues in Mali contribute 2.02% of GDP (2018 est.)<sup>97</sup>
- 7% of Mali's total land area is protected<sup>98</sup>
- Mali has at least 1741 species of plants, of which 0.6% are endemic<sup>99</sup>.

### 8.3.1. Overview of the local natural resources



#### Doum palm tree in the shelter model

The palm flora of continental Africa are amongst the most useful plants found across the continent. The small-sized palm tree, the doum, (*Hyphaene thebaica*), can be found around Tombouctou, Diré and Niafunfé. It has significant local and regional economic, social and ecological value<sup>100</sup>.

Most of its parts are used by local people. The trunk is used as timber. The pulp of its fruit is eaten, dried palm cores produce flour, several parts are used as fuel, palm trees have a favourable influence on associated crops or pastures and above all the leaves are used for numerous craft products. These leaves are normally purchased by craftswomen to make mats, commonly used in these semi-arid regions, which serve to sit on and to make the walls and roofs of housing. Other different uses are basketry and ropes<sup>101</sup>.

#### Harvesting<sup>102</sup>

Leaf harvesting is very intensive, but collecting practices can differ from one region to another. The mats are made after cutting the leaves of the doum or dwarf palm tree, which are left to dry in the open air for three or four days. It is usually done during the rainy season. Professional artisans, usually women, weave the fibres into strips of about ten centimetres wide and two meters long. In general, twelve strips are needed to make a mat the size of two people<sup>103</sup>.

Labour productivity is low: on average, it can take one person more than a day to make a rectangular mat, to which must be added cutting, drying, transporting and processing of the necessary palms. There is no industrial production of these mats.

#### Environmental impacts

- Palm trees promote soil fertility. In cultivated fields, farmers have found that the soil is more fertile inside doum patches than outside.
- In the dry season, the leaf traps the fine elements transported by the wind. This contributes effectively to the fight against wind erosion and the desertification of certain fields.<sup>104</sup>
- Today, the *Hyphaene thebaica* is rated as one of the tree types at “the least concern” from extinction in Mali<sup>105</sup>. However, the general degradation of the Sahelian environment and its desertification, on account of climate uncertainties and the commercial exploitation of the doum palm tree, will lead to the disappearance of adult seed trees, then to sprout exhaustion and disappearance of young seedlings<sup>106</sup>, if measures are not taken.

<sup>97</sup> CIA. Mali - The World Factbook ([cia.gov](http://cia.gov))

<sup>98</sup> Land and Resources, *Environmental Issues.* "countries quest. N.p., n.d. Web. 17 May 20

<sup>99</sup> <https://rainforests.mongabay.com/>

<sup>100</sup> Low extinction risk for an important plant resource: Conservation assessments of continental African palms (*Arecaceae/Palmae*). April 2018

<sup>101</sup> Valoriser les produits du palmier doum pour gérer durablement le système agroforestier d'une vallée sahélienne du Niger et éviter sa désertification Régis Peltier, Claudine Serre Duhem et Aboubacar Ichaou

<sup>102</sup> Little information has been found on the specific cultivation of the doum palm in Mali, so some of this information comes from the previous report « Comparative study of the environmental impact of Niger emergency shelter models », where the same natural material is also used.

<sup>103</sup> Low extinction risk for an important plant resource: Conservation assessments of continental African palms (*Arecaceae/Palmae*). April 2018

<sup>104</sup> Valoriser les produits du palmier doum pour gérer durablement le système agroforestier d'une vallée sahélienne du Niger et éviter sa désertification. Régis Peltier, Claudine Serre Duhem et Aboubacar Ichaou

<sup>105</sup> Botanic Gardens Conservation International. <https://www.bgci.org/resources/bgci-databases/globaltree-portal/>

<sup>106</sup> Valoriser les produits du palmier doum pour gérer durablement le système agroforestier d'une vallée sahélienne du Niger et éviter sa désertification. Régis Peltier, Claudine Serre Duhem et Aboubacar Ichaou

### Total amount of palm doum mats in the models

In this specific case, the palm doum mats used in the Case Végétale shelter came from around Tombouctou, Niafunfé and Diré.

- Case Végétale model uses 68.5 kilos for the wall and roofing



### Eucalyptus wood in the shelter models

The introduction of the eucalyptus was in the 1950s in African countries<sup>107</sup>. In the Sahel, the surface area of plantation is estimated at 300,000 ha, and 61,657 ha only in Mali<sup>108</sup>. In Mali, the monetary income after 5 years of exploitation of Eucalyptus plantations amounts to 3,465,240 CFA franc ( around 5413 US Dollars) per ha and plantation costs represent only 11% of this amount<sup>109</sup>.

Eucalyptus plantations are easily established and fast growing, and can be highly profitable, even in areas that are traditionally poor in timber production. Eucalyptus wood is commonly used in the Sahel as firewood and building material for houses, sheds, furniture and railway sleepers. In Mali, extracts of the plant are used to treat diseases such as cholera, plague and malaria.<sup>110</sup> However, there are also negative environmental impacts from planting eucalyptus.<sup>111</sup>

#### Harvesting

Timber cutting usually starts after 4 years of hedge planting (i.e., eucalyptus)<sup>112</sup>. Pruning is carried out at the end of each rainy season to allow the plants to develop properly.

#### Environmental impacts

- Growing Eucalyptus in low rainfall areas may cause adverse environmental impacts due to competition for water with other species and an increased incidence of allelopathy (which is a survival mechanism that allows certain plants to compete with and often destroy nearby plants by inhibiting seed sprouting, root development, or nutrient uptake). The harmful effect on the environment is that it uses a lot of nutrients which leads to soil exhaustion and reduction of crop yields, secretion of allelochemicals and decreasing crop production<sup>113</sup>.
- However, these plantations also help for land delimitation, crop protection against animals and erosion (defensive hedges) as well as the production of timber, etc.
- The eucalyptus camaldulensis is not listed in the Mali tree species list in the Botanic Gardens Conservation International, So the conservation status in Mali is unclear. However, at global level it is listed as “Near Threatened” of extinction<sup>114</sup>.
- The environmental impact is also in terms of changes in land use and transport distances between a production site and the sites where the wood is used. Local production of wood close to where it is used reduces costs and environmental impacts (pollution, road construction, etc.) while promoting local employment. This is a factor in favour of the existence of dedicated plots near processing sites.

### Eucalyptus timber in the models

<sup>107</sup> Expansion, research and development of the eucalyptus in Africa Wood production, livelihoods and environmental issues: an unlikely reconciliation. Dominique Louppe and Denis Depommier. 2010.

<sup>108</sup> Les plantations d'Eucalyptus au Sahel : distribution, importance socio-économique et inquiétude écologique. 2017. Abdoulaye SOUMARE, Abdala G. DIEDHIYOU Aboubacry Kane

<sup>109</sup> Expansion, research and development of the eucalyptus in Africa Wood production, livelihoods and environmental issues: an unlikely reconciliation. Dominique Louppe and Denis Depommier. 2010.

<sup>110</sup> Expansion, research and development of the eucalyptus in Africa Wood production, livelihoods and environmental issues: an unlikely reconciliation. Dominique Louppe and Denis Depommier. 2010.

<sup>111</sup> Chaojun Chu, P.E. Mortimer, P.E. Mortimer, Hecong Wang, Yongfan Wang, Xubing Liu, Shixiao Yu. 2014

<sup>112</sup> National Network of Chambers of Agriculture in Niger. June 2019

<sup>113</sup> BIO-PHYSICAL AND ENVIRONMENTAL IMPACTS OF EUCALYPTUS PLANTATIONS. FAO

<sup>114</sup> Species Search | Botanic Gardens Conservation International (bgci.org)

The eucalyptus wood (*Eucalyptus camaldulensis*) that was used in the Case Végétale shelter come from around Tombouctou and Diré.  
 The Case Végétale model uses around 188 kilos of eucalyptus.

### 8.3.2. Interpretation of the results

Case Végétale model scored 2 out 5 and Case en Milieu Humide model scored 4 out 5



1 poor, 2 average, 3 medium, 4 good, 5 very good

The Case en Milieu Humide model does not use Mali’s local natural resources, which is why it has a score of 4. However, thi model uses basswood timber sourced from Ivory Coast and Guinea, And even if it does not directly affect the local natural habitat, it is advisable to ensure that the exploitation of any natural material does not affect the local environment of the country of origin. However, this is beyond the scope of work of this study.

So only the Case Végétale used natural materials from from Mali, the eucalyptus timber and the palm doum products. On one hand these natural resources are used traditionally (especially palm doum tree) by the communities for many years, and their harvesting and preparation provides a source of income. So in principle, the use of construction materials that are being sourced locally from the natural environment is desirable. But in practice, if the demand significantly outweighs the resources available, it could be problematic. The number of shelters needed in comparison to the density of vegetation in the region poses a high risk of environmental degradation and accelerated desertification. Also eucalyptus is an introduced species, requires irrigation techniques in a country with scarce water supplies, and has an impact on soil degradation and deforestation. On the other hand, the palm doum tree is an endemic species, well mastered by the communities for years, and appears to help to fight against wind erosion and fertilises the soil.

So, the question whether the supply of these species could keep up with the demand from the shelters in Mali, when considering thousands of shelters in a crisis that keeps growing, remains unanswered. Overexploitation and climate change could have a negative impact on growth of the plants. While the quantities used for the shelters already built are unlikely to exhaust supply, it is difficult to estimate what the implication of many more shelters might be. However, the analysis is already sufficient to raise questions in future about a shelter model which uses so much local natural materials.

The score can be improved in the future by promoting mitigation strategies for some of these negative impacts, like including a reforestation/replanting or forest protection project, or advocating for such a project or partnering with a suitable local organisation who can make this happen in the relevant area. Note that this would also offset the overall carbon emissions generated, as well as ensuring protection of the local eco-system.

### 8.3.3. Household Energy and Fuel efficient cookstoves

Strictly speaking, the question of household energy and the use of wood biomass for cooking fuel is not an aspect of the shelter project being considered in this study. However, it is closely linked to the household needs of the displaced and it is too important an environmental issue to ignore. In one hand, burning of the shelter wood products release carbon emissions (meaning worse environment impact from the shelter), but on the other, it also provides a source of fuel for households, avoiding more deforestation, by cutting down more trees. If we want to advocate to not burn the wood from the shelter, to avoid emissions, and also to avoid deforestation, then the household energy question (especially for cooking) needs to be considered.

Around 3 billion people globally still cook over an open fire, usually using some form of biomass (wood, charcoal etc.). In 2019 the Moving Energy Initiative (MEI) estimates that forcibly displaced families living in camps are burning 64,700 acres of forest (equivalent to 49,000 football pitches) each year<sup>115</sup>. As it was mentioned above, in Mali there is a high demand for fuelwood and charcoal. The predominant use of firewood directly accelerates the rate of deforestation and desertification already occurring in the region. Furthermore, the increasing scarcity of trees and wood can prompt an increase in inter-community clashes over resources<sup>116</sup>.

The question of household energy is a cross-cutting issue, often ignored by humanitarian agencies because it does not easily fit into one sector. There are the issues of health (indoor smoke pollution, harmful particulates in the air); environment (deforestation); protection (women and girls spending a lot of time collecting wood in insecure contexts); and also, the extensive time spent collecting wood and cooking on an open fire. However it is also closely linked to the shelter and settlements sector.

Where more sustainable fuels are not an option, fuel efficient cookstoves are a well-recognised solution to improve the sustainability of household energy. Affected populations generally have limited access to modern cooking solutions. Most either depend on insufficient humanitarian agency handouts of 'in-kind' firewood or have to travel long distances to collect firewood (in the latter case, exposing themselves to the risk of attack and/or sparking conflict with host communities). In many cases, host governments are recognising the environmental damage and are now pushing for change, banning in-kind firewood distribution or requesting humanitarian agency support to transition refugees to alternative more sustainable fuels<sup>117</sup>.

As well as considering the impact of use of wood and other plants for the construction of shelters, future projects should also consider the use of wood for cooking fuel by the displaced living in the shelters, the impact on local forests, and how it can be reduced. Even if initiatives to provide alternative fuels or fuel-efficient stoves are not integrated, partnerships with organisations who can do this could be promoted.

#### 8.4. Criteria 4: Waste Management

When designing a shelter and choosing the construction materials, what happens to each material at the end of its useful life should be considered. Prolonging the life of each material by looking at the options for reusing or recycling contributes to reducing waste. The task is to find value in the waste, but unfortunately, once these materials are no longer used, most of them will end up discarded in open fields or unsafely burnt, contributing to pollution. In a country like Mali with a very weak waste collection, storage and treatment system, this is a major concern. This is especially relevant for those materials which take many years to decompose, potentially harming the environment for years to come. Thinking in advance of all the different waste management options in place should be a must for all programs.

The analysis suggests that there is no waste management system covering IDP settlements. Even if many durable items are reused and recycled, much of the solid household waste is typically burnt, buried, or left scattered. Another challenge in IDP settlements, as pointed out by one of the interviewees, is that "*IDPs may have less direct concern for the impact of waste on the land as they don't perceive it as "their" land, but just a place where they are stopping before going back home*". This perspective can be a source of tension with the resident or 'host' population, adding conflict prevention to the waste management issue. As IDP settlements become more long-term, there should be more options to move toward sustainability and local ownership and responsibility.

The two tables below examine for each of the shelter materials how long it takes for them to decompose, if they can be reused and recycled, and what the options are – both in theory (Table 5), and the potential in Mali (Table 6). It is important to note that the rate of decomposition can depend upon disposal or landfill conditions.

The recycling options are based on potential from the "groupements d'intérêt économique" (GIE), specialised in ecological recycling and waste recovery in the country, and ideas shared by some of the interviewees.

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<sup>115</sup> *Cooking in displacement Setting. Engaging the Private Sector in Non-wood-based Fuel Supply. Laura Patel and Katie Gross. January 2019*

<sup>116</sup> *IDP Shelter & Settlements. Environmental Impact Report. Shelter Cluster Chad. March 2021*

<sup>117</sup> *Cooking in displacement Setting. Engaging the Private Sector in Non-wood-based Fuel Supply. Laura Patel and Katie Gross. January 2019*

As a note, the global *Joint Initiative on Sustainable Humanitarian Assistance Packaging Waste Management*<sup>118</sup> was also contacted. One of the activities they are working on in partnership with the Global Logistics Cluster is to map out recycling and waste management infrastructures in countries with humanitarian contexts. However, whilst they are doing this for some African countries, at the moment Mali is not one of them<sup>119</sup>.

Table 5

Material	Life expectancy <sup>120</sup>	Time to decompose	Reuse	Recycling
Steel poles	1-2 year	200 to 500 years <sup>121</sup>	Yes	Yes
CGI	1 year	200 to 500 years	Yes	Yes
Plastic sheeting	1-2 year	500 to 1000 years	Yes	Yes
Doum palm mats and rope	1 year	Yes 100%	Yes	Yes
Eucalyptus wood	6 months -1 year	Yes 100%	Yes	Yes
Basswood timber	3-5 years	Yes 100%	Yes	Yes
Screw	3-5 years	200 to 500 years <sup>122</sup>	No	Yes
Nylon fabric	1-2 years	30-40 years <sup>123</sup>	Yes	Yes
Nylon and cotton fabric	2-3 years	Over 100 years <sup>124</sup>	Yes	Yes

Table 6: Potential options in Mali

Material	Potential Reuse option <sup>125</sup>	Potential Recycling options <sup>126</sup>
Steel poles	<ul style="list-style-type: none"> <li>To reuse for auxiliary construction (e.g.: animal pens)</li> </ul>	<ul style="list-style-type: none"> <li>Production of carts; wheelbarrows, keys, shovels; pickaxes; hoes; machetes, chair, etc</li> </ul>
CGI	<ul style="list-style-type: none"> <li>To reuse for auxiliary construction (e.g.: animal pens)</li> <li>Handicrafts (earrings, home decorations/accessories, etc.)</li> </ul>	<ul style="list-style-type: none"> <li>Production of carts; wheelbarrows, keys, shovels; pickaxes; hoes; machetes, chair, etc</li> </ul>

<sup>118</sup> Information can be found at <https://eacentre.org/2019/07/15/https-www-eacentre-org-2019-07-15-sustainable-humanitarian-packaging-waste-management/>

<sup>119</sup> The information is then uploaded onto the Global Logistic Cluster LCA; <https://dlca.logcluster.org/display/public/DLCA/LCA+Homepage>.

<sup>120</sup> Information provided by the field team through direct observation on the field.

<sup>121</sup> How long does it take for metal to degrade - Riba Farré (ribafarre.com)

<sup>122</sup> How long does it take for metal to degrade - Riba Farré (ribafarre.com)

<sup>123</sup> How Long It Takes 50 Common Items to Decompose | Stacker

<sup>124</sup> How Long It Takes 50 Common Items to Decompose | Stacker

<sup>125</sup> Information provided by the field team through direct field observations, and from the Global Shelter Cluster community of practice.

<sup>126</sup> Based on potential from other neighbouring countries (Niger) or ideas shared by some of the interviewees

<b>Plastic sheeting</b>	<ul style="list-style-type: none"> <li>• To reuse for auxiliary construction (e.g.: roofing for showers or shelters, smaller sun shades, walling)</li> <li>• Interior floor mats, covering exterior cooking areas</li> <li>• As lining for rainwater runoff collection, to be used for watering of community kitchen gardens and/or as drinking water for herds.</li> <li>• Privacy screens around latrine pits</li> </ul>	<ul style="list-style-type: none"> <li>• Production of paving stones</li> </ul>
<b>Doum palm mats and rope</b>	<ul style="list-style-type: none"> <li>• They are not reused</li> </ul>	<ul style="list-style-type: none"> <li>• Organic fertiliser</li> </ul>
<b>Eucalyptus timber</b>	<ul style="list-style-type: none"> <li>• To reuse for auxiliary construction</li> <li>• Combustible wood</li> </ul>	<ul style="list-style-type: none"> <li>• Art objects</li> </ul>
<b>Basswood timber</b>	<ul style="list-style-type: none"> <li>• To reuse for auxiliary construction</li> <li>• Combustible wood</li> <li>• Art objects</li> </ul>	<ul style="list-style-type: none"> <li>• Art objects</li> </ul>
<b>Screw</b>	<ul style="list-style-type: none"> <li>• They are not reused</li> </ul>	<ul style="list-style-type: none"> <li>• Production of carts; wheelbarrows, keys, shovels; pickaxes; hoes; machetes, chair, etc</li> </ul>
<b>Nylon Fabric</b>	<ul style="list-style-type: none"> <li>• Re-use as rope</li> </ul>	<ul style="list-style-type: none"> <li>• Production of paving stones</li> <li>• Input for making bags, baskets, satchels, etc.</li> </ul>
<b>Nylon and cotton fabric</b>	<ul style="list-style-type: none"> <li>• Re-use as rope</li> </ul>	<ul style="list-style-type: none"> <li>• Production of paving stones</li> <li>• Input for making bags, baskets, satchels, etc.</li> </ul>

According to the field team, most of the materials are discarded once they are no longer used or reach an advanced state of deterioration (plastic sheeting, CGI, screws, fabrics), used as firewood (eucalyptus and basswood timber) or directly burnt (palm doum mats and ropes). Such burning contributes to air pollution.

It is also worth mentioning that Mali<sup>127</sup> has banned the production, import, and marketing of non-biodegradable plastic bags (LOI N° 2014-024/ DU 03 JUILLET 2014)<sup>128</sup>. The field team confirmed that a few of the materials come packaged in single-use plastic<sup>129</sup>. Attempts could be made to eliminate this, in discussion with suppliers.

<sup>127</sup> Maps – plasticpollutioncoalition ([plasticpollutioncoalitionresources.org](http://plasticpollutioncoalitionresources.org))

<sup>128</sup> [mli152392.pdf](#) ([fao.org](http://fao.org))

<sup>129</sup> Refer to Annex 4

#### 8.4.1. Interpretation of the result

In the score card, Case Végétale model scored 3 out 5 and Case en Milieu Humide scored 2 out 5.



As can be seen from the two tables, most of the materials have the potential for reuse or recycling, and on top of this, both shelter models have been designed to be easily dismantled and transported, enabling the material to be easily reused, recycled or even sold. But when thinking about disposal options, it became more challenging, and that is why both shelter scores relatively low.

From an environmental perspective, answering the question of how long it takes various types of waste to decompose is of great importance. The use of products that generate waste that takes a long time in landfill to completely decompose should be reduced. From this perspective, the Case en Milieu Humide model uses a higher quantity of long-lasting materials, especially steel. The Case Végétale uses more natural resources, for which the time of decomposition is much less of a concern.

Also, good quality materials and construction practices are important. Both affect the durability of the shelter, and therefore the materials, by increasing their life expectancy *“Poor construction not only poses safety risks but increases the material turnover period, further compounding the environmental impact of shelter construction.”*<sup>130</sup> So promoting this is a must in every programme.

However, in this case, many of the materials do have possibilities for reuse and even recycling. But the reality is that while reuse is already happening, given the Mali waste management context, recycling is unlikely to take place unless proactive steps are taken. So taking into account what happens with the materials at the end of their useful life, is why the score is relatively lower for the Case en Milieu Humide.

The score card can be improved in the future by :

- Promoting different waste collection and recycling projects.
- Connecting communities to the “groupements d’intérêt économique” (GIE), or helping them putting a system in place, will not only improve the waste management situation, it can also create income generating opportunities for the communities.
- All efforts to reduce or eliminate plastic packaging should be made
- Raising awareness of the pollution generated by the disposal of the products, though advocacy with communities, or projects in partnerships with other organisations, would also be a way of mitigating the waste impact.
- Promoting the composting of the organic materials, or re-use it for various purpose, would make a big difference, instead of burning them. As seen under Criterion Two, that would avoid the release of sequestered carbon emissions in the timber. But this would require parallel efforts to decrease the dependency of families on firewood for cooking, by promoting cleaner fuels or more fuel-efficient cookstoves.

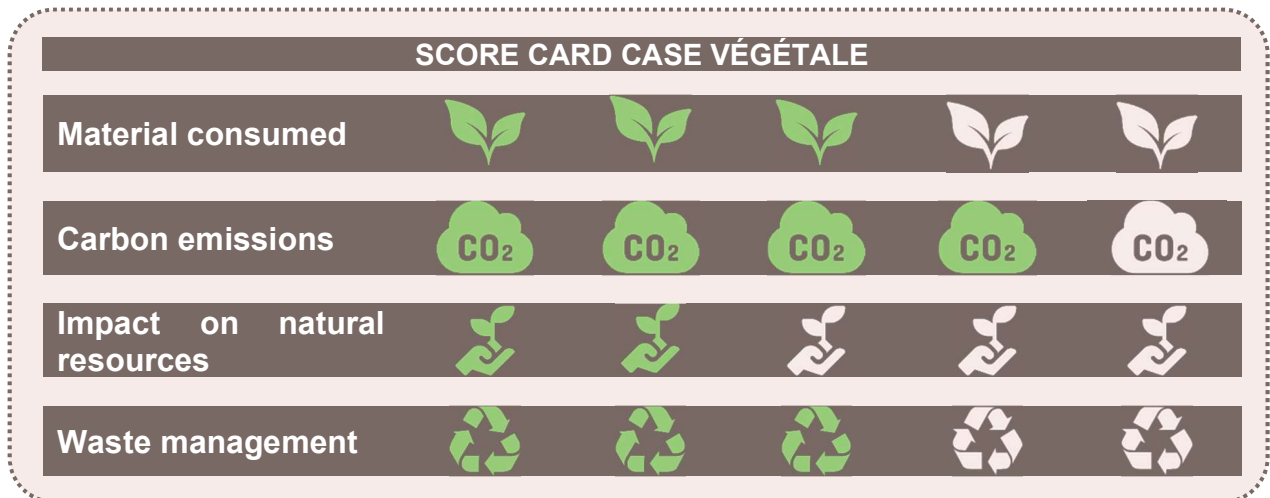
<sup>130</sup> Shelter & Settlements Environmental Impact Report in the Lac Province of Chad from the Cluster Chad

## 8.5. Summary: Case Végétale vs Case en Milieu Humide Models

Summary of the results for each model, conclusions are drawn in section 9.

### CASE VÉGÉTALE MODEL

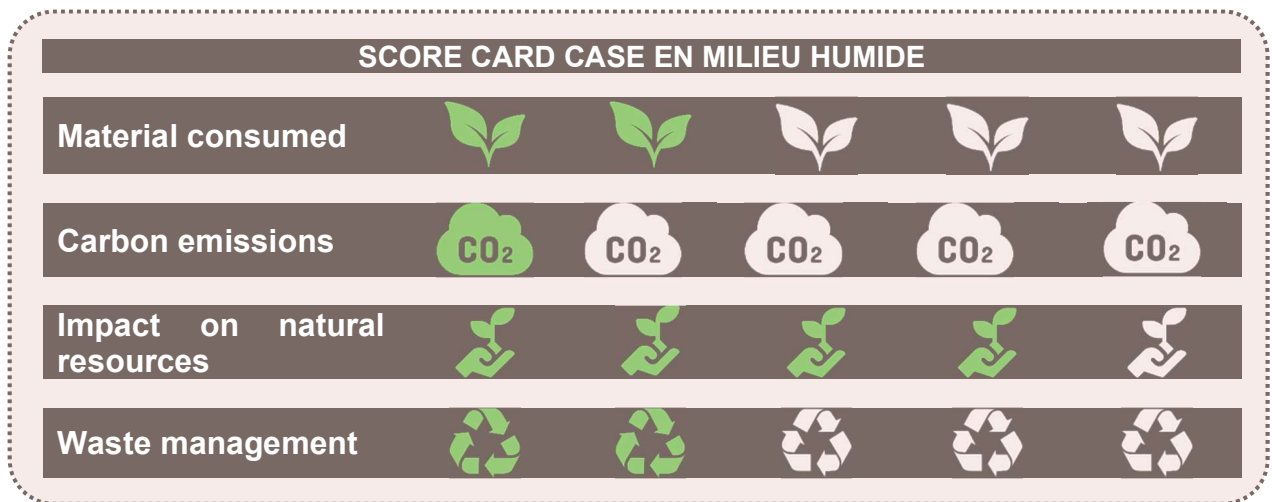
Summary of the environmental impact CASE VÉGÉTALE		
<b>Raw material used</b>	Doum palm tree leaves	68.5 kilos
	Eucalyptus wood	188 kilos
	Water consumption	17,761 liters
<b>Manmade material used in kg</b>	Steel tubes	25 kilos
	Plastic	8 kilos
	Nylon	1 kilos
<b>Carbon emissions in kg CO<sub>2</sub> eq.</b>	Production of materials	-263
	Packaging	<i>Data not considered</i>
	Transport	39
	End of life	241
	<b>Total for shelter</b>	<b>18</b>
<b>Impact on natural resources</b>	Deforestation and erosion due to the harvesting of natural or farmed vegetation (doum palm tree and eucalyptus wood)	
<b>Waste management</b>	Almost all the materials have potential for reuse or recycling. However, in practice much is discarded. Also the organic materials end up being burnt, polluting the air.	



1 poor, 2 average, 3 medium, 4 good, 5 very good

**CASE EN MILIEU HUMIDE MODEL**

Summary of the environmental impact CASE EN MILIEU HUMIDE		
<b>Raw material used</b>	Basswood timber Cotton fabric Water consumption	41.2 kilos 4.5 kilos 107,108 liters
<b>Manmade material used in kilos</b>	Steel Iron Plastic Nylon	81 kilos 7 kilos 4 kilos 10.5 kilos
<b>Carbon emissions in kg CO<sub>2</sub> eq.</b>	Production of materials Packaging Transport End of life Total for shelter	245 <i>Data not considered</i> 126 60 <b>431</b>
<b>Impact on natural resources</b>	<i>The model does not use any local materials. However uses basswood timber sourced from Ivory Coast and Guinee. Even if it does not directly affect the local natural habitat, it is always advisable to ensure that the exploitation of any natural material does not affect the local environment of the country of origin</i>	
<b>Waste management</b>	Almost all the materials have potential for reuse or recycling. However, in practice much is discarded. The biggest concern is the time that most of the materials take to decompose, especially the plastic and steel products.	



1 poor, 2 average, 3 medium, 4 good, 5 very good

## 9. Conclusion

The importance of examining in detail the entire life cycle of each shelter and each material, from production through to end of life, has been emphasised throughout this study. The criteria consider not only carbon emissions, but other factors, like use of local natural resources and waste management. While the need to reduce carbon emissions is critical and increasingly well acknowledged today, it is also clear that waste is one of the hidden problems of the humanitarian world. It is usually ignored during project design, and rarely discussed at more strategic levels.

Comparing different shelter models requires us to balance relative sources of environmental harm across the different criteria. The scope of this remote study and the limited access to environmental information from Mali does not allow for a quantitative weighting for each criteria, leading to a numerical score. An overall qualitative comparison is all that is feasible.

The idea that there is a perfect shelter solution that ticks all the boxes is not realistic. Not only regarding the environment, but also the other factors that need to be considered: technical performance, durability, habitability, affordability, cultural aspects, etc. Between the different options the “least harmful solution” should be adopted.

So, while one solution complies better with some of these factors, another is better according to other factors. The same can be said about the criteria analysed. For example, the Case Végétale shelter has much lower carbon emissions (a higher score in the score card), however its impact on the local environment due to the amount of natural resources used is worse (a lower score for this criteria). This is one of the benefits of using the score card approach, to highlight which shelter complies better with which criteria, as well as to help identify mitigating solutions.

The final verdict rests on the available options to mitigate some of the worst concerns, which if adopted in future could reduce the overall environmental impact of the shelters. When there is damage to the environment due to our actions, for example deforestation or over-harvesting of the palm doum, mitigation measures should be adopted, like reforestation or replanting projects. It is recommended that an environmental impact assessment or at least environmental screening using a tool such as the NEAT+<sup>131</sup>, and following that identification of mitigation strategies, should accompany the design of all shelter and site planning activities.

It is important to recognise that the longer a shelter lasts, the more efficient and cost effective it is<sup>132</sup>. This semi-permanence may not be initially acceptable as it implies that the reasons for displacement will continue beyond tomorrow. But it makes sense when the designs are such that they can be deconstructed and become movable assets for their owners. In this sense, both models have been designed for this purpose.

Overall, the Case Végétale model scores better regarding the materials consumed, carbon emissions and waste management, while the Case en Milieu Humide model scores better on local natural resources.

The biggest challenge with the Case Végétale model is the amount of local natural materials used, and what impact their harvesting can have on the already fragile environment on Mali. But its biggest benefit is that once the materials are no longer needed, most of them will decompose rapidly. On the other hand, the Case Végétale has a shorter life span – which is directly linked to the type of materials used. Keeping this in mind, mitigating actions can be taken to reduce its worst environmental impacts as follows:

- (1) Carefully examining sustainability issues with the suppliers for the sourced eucalyptus timber and palm doum tree, to ensure over-extraction or other environmental damage is not happening.
- (2) Promoting reforestation and replanting projects. Small-scale projects could be included as part of the shelter programme, such as supporting communities to replant palm doum. Larger scale efforts could be in partnership with specialist organisations.

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<sup>131</sup> <https://neatplus.org/>

<sup>132</sup> *In the Shelter & Settlements Environmental Impact Report, Shelter Cluster Chad. February 2021, graph Cost vs Durability*

- (3) Advocating with communities to avoid burning the natural materials once they are no longer needed, due to the amount of CO<sub>2</sub> eq. that is released during this process. It is better the wood is reused, and the palms is allowed to decompose.
- (4) Set up a project component for reusing, repurposing or recycling (R3) the materials once the shelter gets to the state it has to be replaced. The R3 process can be a livelihoods generator as well. This is especially for the plastic sheeting, because it can be assumed that the metal tubes have a good likelihood of continual reuse.

The Case en Milieu Humide model has a longer life span since it uses more long-lasting materials. These are unlikely to be recycled, and will take a very long time to decompose, polluting the environment for years to come, as well as generating more carbon emissions, but on the other hand making the shelter more resistant with a longer life span (2-3 years). The project should consider some of the following mitigating actions which could significantly reduce the environmental impact of the shelter:

- (1) Set up a project component for reusing, repurposing or recycling (R3) the materials, especially the plastic sheeting once it gets to the state it has to be replaced. The R3 process can be a livelihoods generator as well.
- (2) To consider to use different materials, especially the steel poles which have the highest embodied CO<sub>2</sub> emissions, or reducing the amount used without compromising the quality of the shelter. Of course this must be balanced against reducing the life-span of the shelter.
- (3) Advocating with communities to avoid burning the natural materials (basswood) once they are no longer needed, due to the amount of CO<sub>2</sub> eq. that is released during this process. It is better the wood is reused, or allowed to decompose.
- (4) Carefully examining sustainability issues with the suppliers for the sourced basswood timber, even if it is not purchased locally, to ensure over-extraction or other environmental damage is not happening. The alternative could be identifying a supplier that can source wood locally. The wood should come from a sustainable plantation and it should also ensure over-extraction or other damage won't happen. This would also reduce carbon emissions from transportation of the timber.

This study does not make a definitive recommendation of one shelter over the other. However by adopting some of these mitigating solutions in future, both shelters can incorporate the environmentally 'best' aspects in their designs.

The difference in life span of the two shelter models is also an important factor. Which is most appropriate will depend on the displacement context, expected length of displacement etc. On one hand Shelter A (Case Végétale) may appear to have a lower environmental footprint, but if it has to be replaced twice during a shelter project while only one of Shelter B (Case en Milieu Humide) would have to be built, then this clearly affects the analysis. In that case the project team should compare the impact on local natural resources from construction of two units of Shelter A against the apparent higher carbon emissions and waste generated by Shelter B.

## 10. Recommendations

### Recommendations from the environmental analysis

#### A. Materials

1. Further study on the risks of overexploitation of the doum palm, and eucalyptus timber, and explore other alternatives if necessary. Include reforestation or replanting projects within the shelter programme. Either directly with communities, or if on a bigger scale through partnerships with other specialist organisations. See below recommendation on protecting / restoring local eco-systems.
2. Consider to avoid using steel poles, since it is one of the most polluting materials and which has the highest embodied CO<sub>2</sub> emissions.
3. Carefully examining sustainability issues with the suppliers for the sourced basswood timber, even if is not purchased locally, to ensure over-extraction or other environmental damage is not happening. The alternative could be identifying a supplier that can source wood locally. The wood should come from a sustainable plantation and it should also ensure over-extraction or other damage won't happen. This would also reduce carbon emissions from transportation of the timber.
4. To contemplate to use other materials instead of cotton for the fabric in Case Végétale, since that comes with a heavy environmental footprint. Other material like hemp, linen, etc could be considered.

## B. Reduce carbon emissions

1. Advocate with communities to avoid burning the natural materials once they are no longer needed, due to the amount of CO<sub>2</sub> eq. that is released during this process. By promoting composting. This could be difficult to implement in a country like Mali, where families often rely on burning organic matter for cooking fuel. This can be partially addressed by integrating some activities on household energy (see point E below).
2. To procure more “locally”, especially the steel poles.
3. To consider to decrease the amount of materials if possible, without compromising the quality and durability of the shelter.
4. Carbon offsetting: Another way to pursue carbon neutrality is to offset emissions generated by reducing them somewhere else, or by purchasing carbon credits<sup>133</sup> from a project that has been accredited by a recognised standard<sup>134</sup>.

## C. Waste management practices

1. Raising awareness of environmental sanitation and the pollution generated by the disposal of the materials, through the programme (link to WASH), or through advocacy in partnership with other organisations.
2. Cataloguing the type and quantity of waste. This is useful in defining what can be done under #3
3. Defining how to turn waste into value. Materials can be collected and reused as raw materials in other products, especially those materials that take a long time to decompose, like plastic sheeting or steel tubes. This can easily be linked with livelihood or education programmes. The most common is to turn organic waste (human and animal) into compost. Other things, like plastic sheeting can be transformed into bags, coats, etc.<sup>135</sup>.
4. Through community engagement, encouraging people to brainstorm what can be done with the items.
5. Set up a reuse/recycling/repurposing site to sort and process the waste. A bit away from the main camp, preferably with a water supply or water storage.
6. Hire people to run the waste processing. This can be a good “cash” transfer/livelihoods support option.
7. If possible, link communities to private waste companies to collect materials which are not reused, for recycling. There is also the possibility to generate income for communities from this.
8. Reduce the packaging for all material, or support the reuse of this for other purposes.

## D. Protecting / restoring local eco-systems

1. To encourage planting trees as part of a compensation effort for the wood used in shelter construction. But it is important to be aware that actions involving reforestation and land can be seen as statements of ownership from a cultural perspective. This could be an issue in Mali. Planting trees could be a source of conflict if not well managed. There is also ongoing care and maintenance required for such initiatives, which is never easy to sustain.

To engage in such an initiative in an IDP or refugee context:

- a) All actions should be approved by local government and traditional leaders. (Each village in Mali has one or more individuals charged with allocating land and adjudicating land disputes. If they exist, they need to approve any plans.)
- b) Ownership of the land, trees and produce from the trees, including branches and when a tree is coppiced, needs to be agreed with local leaders and land owners. For instance, an IDP-planted tree may be owned by the land owner, but the fruit can be used by the IDP as long as they are present at the location. These types of agreements may seem complicated, but are normal within a society.
- c) Any environmental improvements should not be done by the IDPs alone. If this is the case, then the local host community will not have ownership and any actions will probably not be maintained after the IDPs leave.
- d) Another solution for IDP camps, is not to place plants in the ground, but to do something less fixed, like a *permaculture-in-drum*<sup>136</sup> approach.

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<sup>133</sup> One potentially interesting case study in Chad that might be of use as an example of how the provision of stoves can impact refugee settings is the CookKit Solar Cooker, which utilised carbon credits from saving CO<sub>2</sub> emissions to facilitate expansion of the programme <https://www.fairclimatefund.nl/en/projects/chad-solar-cookers-for-refugee-families>

<sup>134</sup> European Parliament

<sup>135</sup> [recycling\\_reuse\\_and\\_disposal\\_of\\_plastic\\_sheets.pdf \(sheltercluster.org\)](#)

<sup>136</sup> (Example: 2000-liter drum, cutting it in half, filling it with rocks and soil and planting a tree). Waste water is used to water the tree and tree can be moved (or even sold off) when the IDPs move. The tree itself can provide shade, provide fruit or be coppiced to provide wood for making things. An advantage of a garden-

2. Explore whether linkages can be made to Mail RC's tree planting initiative They are contributing to 'Green Wall' reforestation efforts in the Sahel (to plant 200,000 trees) with support from the Italian Red Cross".

### Household energy and cooking stoves

The project could consider to provide families with access to cooking stoves that do not rely on organic materials, and rely more on solar power or alternative fuels; or at least are more fuel-efficient if they have to burn wood fuel. It will reduce the dependency on firewood and pressure on forest resources:

1. First priority is to work with the current practices (e.g., reduce demand, change behaviour where possible) and then encourage a more sustainable type of fuel. But if this is not possible then improved cook stoves can make a difference, some can reduce fuel (wood) consumption by up to 60% compared to an open fire.
2. There are many cook stoves available on the market<sup>137</sup>; also, there are various simple designs that can be manufactured from locally available materials. There are also devices (like insulated cooking bags) that are not stoves, but also speed up the cooking time and use less wood.
3. A choice must be made between procurement of stoves; and encouraging local production of fuel-efficient stoves. Either way extensive market analysis is required. It is not just a case of buying stoves and distributing to communities, as this seldom has a sustainable outcome. Many cook stove projects have not delivered the improvements they should have, due to poor design. Again, careful analysis of local preferences, what is available on local markets, what could be produced is required. Not just blindly importing new cook stoves.
4. A link to livelihoods is often encouraged – where people can be trained to manufacture cookstoves locally, as a livelihood. However, there are many examples in Africa where this has not been very successful.
5. UNHCR's Cooking Options in Refugee Situations Handbook<sup>138</sup> particularly Annex A, shows a cooking energy checklist, which highlights some of the key considerations for practitioners looking to implement cooking-related programmes.

### E. Others

1. Advocate and work with the Shelter Cluster working group and other partners in Mali to pass key environmental messages.
2. Advocating for reforestation and ecosystem restoration programmes more broadly, to help with Mali's environmental problems. This requires a nexus approach to deploy longer-term funding for climate change adaptation and environmental protection and restoration.

## General recommendations to consider for future programmes

### F. Design

1. Design a shelter that allows the materials to be easily dismantled and transported if relocation occurs, to enable reuse.
2. Incorporating vegetation on the site can promote water retention and reduce flooding. This can be done by promoting replanting projects; also by careful protection of any existing ground cover and vegetation.

### G. Materials

1. To encourage the use of construction materials of an appropriate quality and which consider climate, culture, durability, local supply and environmental impact<sup>139</sup>. This does require some research on the ground.
2. To encourage and promote procurement of construction materials based on quality, environmental, social and economic considerations<sup>140</sup>. Local procurement is often, but not always, more sustainable, so careful analysis is needed.

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*in-barrel approach is that all the materials needed, knowledge of what to grow and seeds or cuttings are available in Mali. It is the kind of thing where you get 10 families doing it and others will figure it out.*

<sup>137</sup> Standardizing the Performance of Clean Cooking Solutions, Clean Cooking Alliance, Clean Cooking Catalogue <https://cleancooking.org/research-evidence-learning/standards-testing/>

<sup>138</sup> <https://www.unhcr.org/uk/protection/environment/406c368f2/handbook-experiences-energy-conservation-alternative-fuels-cooking-options.html>.

<sup>139</sup> Further information can be found at QSAND manual MW01 Material Properties / Specifications

<sup>140</sup> Further information can be found at QSAND manual MW02 Material sourcing

3. Use long lasting products and materials, with clear opportunities for reuse, to minimize the replacement and allow a second life through reuse.
4. Further study if there are other alternatives to the plastic sheeting for durable housing (e.g.: metal sheeting for roofing). However, further study on the impact on the environment and mitigation strategies should also be considered for these alternative materials.
5. No single-use plastic wrapping or packaging on any materials, work with suppliers to eliminate this.

#### H. Reduce carbon emissions

1. Procurement choices:
  - o Select manufacturing companies that produce 'green' products or from countries that have demonstrated results in terms of lower carbon emissions through good governance and investment in clean energies.
  - o Ensure that acquired products were manufactured under acceptable conditions in terms of environmental compliance.
  - o Use locally produced and purchased shelter materials, if acceptable quality can be guaranteed.
2. Transportation routes.
  - o Optimize the logistics supply chain to reduce the carbon footprint from transport.
  - o Reduce weight and volume, noting that packaging can be relevant here also.
  - o Take into account that transportation by road, sea and air can also lead to significantly different emissions. In the African case, ocean shipping is better than long distances by road, while of course air transportation is the worst.
3. Manufacturing phase: There are fewer opportunities to reduce carbon emissions at the manufacturing phase, but influence can be exerted by:
  - o Try to support wood suppliers with FSC certification, which can reduce carbon emissions indirectly as plantations growing trees sustainably means that each felled tree is replaced with new trees. Or by favouring manufacturing processes that facilitate pollution control.
3. 'End of Life' phase: emissions from natural materials can be greatly reduced if composting or decomposition is promoted, instead of burning.
4. Carbon offsetting: purchasing carbon credits from a project that also delivers benefits to local communities, and has accreditation from a recognised international standard.

#### I. Waste management practices

1. Waste management practices should be taken into consideration, ideally early in the planning phase. This means selecting materials with higher probability of reuse, and investigating how communities can be linked to private sector recycling firms for those materials which can be recycled locally.
2. Integrate solid waste management initiatives in disaster-affected communities, at least with community education, waste reduction, waste collection and sorting. Promote the concept of the circular economy, and that waste can have a value if appropriate linkages are made to external partners and companies.<sup>141</sup>

#### J. Local natural environment

1. To advocate for, and if possible participate in the development and implementation of a locally appropriate Action Plan which will identify existing ecosystem services and facilitate effective management of human activity in the natural environment<sup>142</sup>. Given that this is outside the normal expertise of humanitarian actors, it will require a Nexus approach, working in partnership with development and environmental stakeholders.
2. To encourage the protection, restoration, rehabilitation and enhancement of the ecological value of the site during settlement or re-settlement and the operation of the site<sup>143</sup>.

#### K. Others

To consider to do an environmental impact assessment or at least environmental screening using a tool such as the NEAT+<sup>144</sup>, during the design of all shelter and site planning activities.

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<sup>141</sup> Further information can be found at QSAND manual MW05 Operational Waste Management

<sup>142</sup> Further information can be found at QSAND manual NE01 Human Relationships to Ecological Services

<sup>143</sup> Further information can be found at QSAND manual NE03 Ecological Restoration and Rehabilitation

<sup>144</sup> <https://neatplus.org/>

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## 12. Annexed documents

### ANNEX 1 – Term of Reference

# TdR Etude comparative de l'impact environnemental des modèles d'abris au Mali. Rapport Final comparative des différents types d'abris construit par AICRL au Sahel

## Contexte et Justification

L'Aide Internationale de la Croix-Rouge luxembourgeoise (AICRL) intervient depuis plusieurs années dans le domaine des abris d'urgence et de l'habitat durable dans la région du Sahel. Elle collabore étroitement avec le IFRC Shelter Research Unit (IFRC-SRU) dans le cadre de développements de modèles d'abris adaptés aux conditions climatiques et contextes culturels sahéliens. De nombreuses missions de recherche ont permis de développer des modèles d'abris tenant compte des spécificités (contextes) et de la disponibilité du matériel au niveau local. Dans le cas particulier du Mali, l'AICRL et la Croix-Rouge Malienne ont réalisé **2 modèles** d'abris. Le premier modèle d'abri construit au Mali est de type **Case Végétale (ou Cases Peulh)**, un abri de 24m<sup>2</sup> pour six personnes construit avec des tubes métalliques et une géométrie en forme de dôme avec des bâches en plastique, bois d'eucalyptus et nattes végétales. Représente 89% des abris installés au Mali par l'AICRL depuis 2018. Le deuxième modèle d'abri est ledit **Case en Milieu Humide**, de 20m<sup>2</sup> et capacité pour loger 5 personnes. Adaptation d'un modèle du HCR, il a une structure métallique, un toit à deux pans (chevron) et des fermetures avec des bâches en plastique et du tissu.

L'expérience acquise sur le terrain et des retours des bénéficiaires recueillis par les équipes projets et les volontaires formés, AICRL souhaite de capitaliser ces expériences et les ressentis des bénéficiaires sur les modèles conçus par l'AICRL et adoptés par tous les acteurs humanitaires aux différentes payses du Sahel. Cependant, un facteur clé n'a pas été analysé en détail, l'impact environnemental comparatif des différents modèles d'abris. Ceci est nécessaire pour comprendre quelle sont réellement les options les mieux adaptés au contexte sahélien et alignée sur la tendance mondiale actuelle à améliorer la durabilité environnementale de l'aide humanitaire.

AICRL développe des projets de logement au Mali depuis 2014, cependant, pour cette étude, nous ne considérerons que ceux réalisés depuis 2018. Les activités d'abris d'AICRL ont toujours eu lieu dans la région nord du pays, à Tombouctou, dans les Cercles de Tombouctou, Goudam, Niafunke et Gourma-Rharous.

	Case Vegetale (24m <sup>2</sup> )				TOTAL
Region	2018	2019	2020	2021	1355
Tombouctou	400	196	404	355	1355

	Case en Milieu Humide (20m <sup>2</sup> )				TOTAL
Region	2018	2019	2020	2021	163
Tombouctou	0	11	122	30	163

En 2021 l'AICRL a mené une étude équivalente pour le Niger dont les résultats sont disponibles. La même étude a été menée au Tchad et au Burkina Faso en 2022. La présente étude cherche à s'appuyer sur la même méthodologie afin d'obtenir des résultats comparables et de pouvoir analyser l'impact environnemental et fournir des recommandations pour l'ensemble de la région.

## Outcome

- Avec le soutien de l'SRU, l'AICRL cherche à réaliser et améliorer la qualité de la réponse en matière d'abris dans le pays et minimiser l'impact environnemental de nos opérations.

## Output

- Une étude comparative des différents modèles d'abris au Mali. Cette étude individuelle (Mali) fait partie d'un travail comparatif dans quatre pays de la région (Niger, Tchad, Burkina Faso, et Mali)
- Recommandations pour réduire l'impact environnemental des interventions d'abris de l'AICRL
- Etude comparative des modèles d'abris objet des différentes analyses dans la région (Niger, Tchad, Burkina Faso et celui-ci au Mali)
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## Produit et format a livrée

- **Rapport d'Etude individuel du Mali.**
- **Rapport Final** d'Etude comparatif des modèles du quatre payses (Niger, Tchad, Burkina Faso et Mali)
- Format prédéfini.
- Taille a4.
- Langue française et anglais.
- 

## Approche méthodologique

Pour **l'étude individuel du Mali**, ce qui suit est une proposition initiale de méthodologie. Elle pourra être ajustée au fur et à mesure de l'avancement de la consultation, en discussion avec le responsable technique du AICRL, en fonction des informations trouvées, des délais disponibles et de toute contrainte liée au travail à distance. Cette méthodologie correspond à celle utilisée dans l'étude 2021 au Niger et dans les études 2022 au Tchad et Burkina Faso. Pour maintenir la cohérence de l'étude comparative entre les quatre pays du Sahel qui font l'objet de ce projet, la même méthodologie doit être suivie, en l'adaptant aux circonstances particulières de chaque contexte lorsque cela est nécessaire et justifiable.

### Recherche documentaire et définition du problème

- Analyse documentaire : documentation du programme (y compris la logistique/chaîne d'approvisionnement) ; profil environnemental du Mali, etc.

### Collecte et analyse des données

- Entretiens avec des informateurs clés (semi-structurés) : avec le personnel de la AICRL (abris, logistique, autres) ; d'autres agences d'abris / cluster ou secteur Abris ( ou le groupe de travail abris) ; acteurs locaux / gouvernement (si nécessaire).
- Brève revue des nouvelles meilleures pratiques en matière d'analyse du cycle de vie / outils d'empreinte carbone.
- Discuter et préparer avec l'équipe de terrain pour un suivi léger des abris sur le terrain (en particulier pour déterminer la durée de vie utile des abris ; également la réutilisation des matériaux). Supposons que ce ne soit pas quantitatif
- Calculs des émissions de carbone des différents types d'abris.
- Analyse des autres facteurs environnementaux des abris.
  - o La durabilité des sources des ressources naturelles utilisées
  - o Options d'élimination et/ou de réutilisation en fin de vie des matériaux (perspective de gestion des déchets).
- Analyse de différents types de couverture (bâche, tissus, matériaux naturels)
  - o Prise en compte du processus de fabrication, des ressources naturelles utilisées, des émissions de carbone, de la biodégradabilité, de la durée de vie utile, etc.
- Rédiger le rapport et le partager avec le responsable technique du AICRL.

#### Conclusions et rapport

- Commentaires et validation du rapport.
- Présentation des résultats au personnel du AICRL et groupes sectoriels abris, réunions de suivi
- Rédaction finale

Un suivi détaillé sur le terrain, des enquêtes, etc. ne sont pas prévus et n'entrent pas dans le cadre de cette étude.

Pour le **Rapport Final** des modèles des quatre pays, la même méthodologie sera utilisée, à la différence que la base de données sera les différentes études individuelles de chaque pays (données secondaires). Le Rapport Final des quatre pays sera présenté dans un document individuel et devrait être compréhensible de manière autonome, sans qu'il soit nécessaire de lire les quatre rapports individuels par pays séparément. Il comprendra un profil environnemental de la région et une liste de recommandations en termes de soutenabilité environnementale et de réduction de l'empreinte carbone pour guider les futures interventions du AICRL. Si cela est méthodologiquement possible, une carte de pointage globale de tous les modèles d'abris utilisés dans la région sera présentée.

## Soutien des équipes sur le terrain

#### Opérations

- Être disponible pour des entretiens semi-structurés.
- Remplir les formulaires si cela s'avère nécessaire après l'analyse documentaire : et la préparation des outils de travail.

#### Disponibilité pour discuter et préparer une évaluation rapide avec l'équipe de terrain

- Référencer ou mettre en contact avec les acteurs clés sur le terrain que l'équipe considère nécessaires pour la réalisation de l'étude (groupe sectoriel Abris) ; acteurs locaux / gouvernement (si nécessaire) etc.

#### Ressources humaines

- Disponibilité d'une équipe de terrain pour effectuer une évaluation rapide. On ne prévoit pas plus d'une journée. Les détails seront définis une fois que le consultant et l'équipe de terrain auront échangé leurs idées.

## Agenda calendrier et activités

**La date limite pour présenter les résultats de l'étude de Mali est le 30 mai 2022**

**La date limite pour présenter le Rapport Final des 4 pays le 30 juin 2022**

	Semaines						Total
	S1	S2	S3	S4	S5	S6	
Analyse documentaire et élaboration des outils de travail	1,0 jours						1,0 jours
Entretiens avec des informateurs clés / Préparer a l'équipe de terrain pour un suivi léger des abris sur le terrain	1,0 jours	0,5 jours	1,0 jours				2,5 jours
Collecte des données et analyse comparative des différents facteurs environnementaux	2,0 jours	2,5 jours	3,0 jours				7,5 jours
Préparation du projet de rapport et validation			3,0 jours	3,0 jours			6,0 jours
Présentation des résultats / réunions de suivi				1,0 jours			1,0 jours
							18,0 jours
Analyse des données des rapports de chaque pays (4) et etude comparative					4,0 jours		4,0 jours
Préparation du rapport final et validation						4,0 jours	4,0 jours
							8,0 jours
							8,0 jours

## Budget

	Tarif	Jours	Total
Etude comparative d'impact environnemental Mali		18,0 jours	€ -
Etude comparative des 4 pays		8,0 jours	€ -
Revue de langue française		1,0 jours	€ -
			€ -

## Logistique

- Préparer toute la documentation nécessaire à la réalisation de l'étude environnementale.
- Être disponible pour des entretiens semi-structurés.
- Remplir les formulaires si cela s'avère nécessaire après l'analyse documentaire : et la préparation des outils de travail. Référencer ou mettre en contact avec les acteurs clés sur le terrain que l'équipe considère nécessaires pour la réalisation de l'étude (fournisseurs, etc)

## Documentation.

- Fournir toutes les informations détaillées et accessibles sur les matériaux utilisés dans les différents types d'abris (BoQ, fournisseurs, chaîne d'approvisionnement, emballage, etc.),
- Fournir tous les rapports que l'équipe juge nécessaires à la réalisation de cette étude (Impact study, etc.).
- Si disponible, recommandez ou fournissez plus de sources de données secondaires (profil environnemental du Mali, etc.).

## ANNEX 2 – Informants

### International Aid of Luxembourg Red Cross

- DIALLO Harouna, Logisticien du projet
- Issa TRAORE, point focal de l'évaluation environnementale au Mali.
- Leandro FERNANDEZ-JARDON, Délégué Régional Habitat Humanitaire
- Luc AHANHANZO , Chef de mission Mali
- Oumar Ag IDBALY, Chef de projet urgence abris Tombouctou

### Technical support in the use of SMAC for the report was provided by:

- Charles KELLY, Co-Chair, Environment Community of Practice, Global Shelter Cluster.
- George FODEN, Independent Consultant.

### Cluster Abris et BNA Mali

- Anicet Adjahossou, Senior Shelter & NFI Cluster Coordination Officer

### Global Shelter Cluster

- Madelaine MARARA, Global Shelter Cluster Environmental Focal Point.
- Mandy GEORGE, Senior Environmental Advisor

### Other person contacted:

- Samantha Brangeon. Consultant- JI Sustainable Humanitarian Packaging Waste Management

### GIE's contacted:

- GIE Alahidou
- GIE Nouveau visage de Tombouctou
- GIE Nouveau visage de Tombouctou

### Regional Authorities contacted:

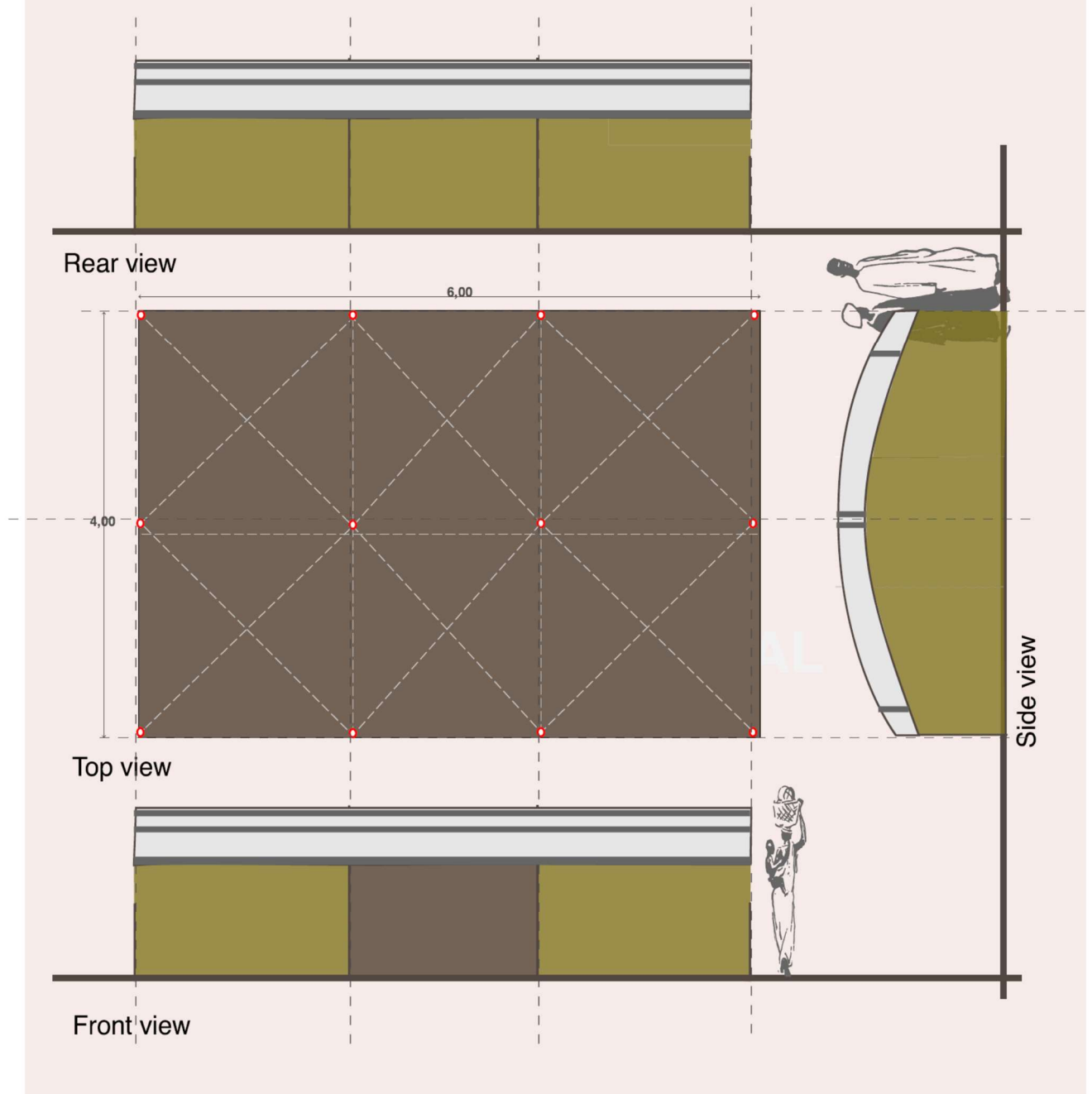
- Direction Régionale de l'Assainissement et du Contrôle des Pollutions Nuisance Tombouctou
- Direction Régionale de la Conservation de la Nature Tombouctou
- Direction Régionale de Génie Rural Tombouctou

# ANNEX 3 – Shelter Models Technical Information

## CASE VÉGÉTALE

# CASE VEGETALE

## MALI

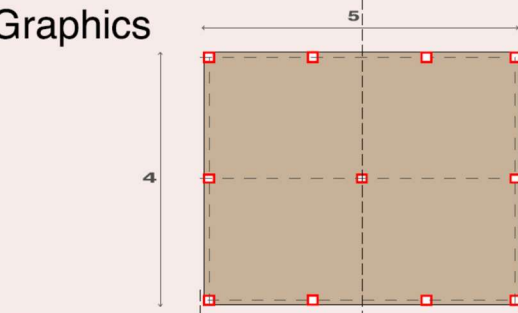


CASE EN MILIEU HUMIDE

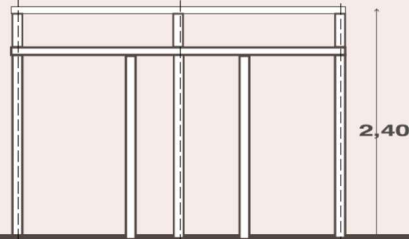
# CASE EN MILIEU HUMIDE



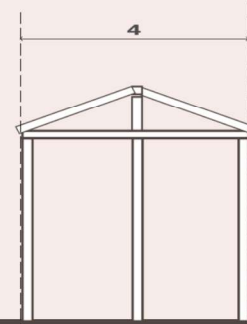
Graphics



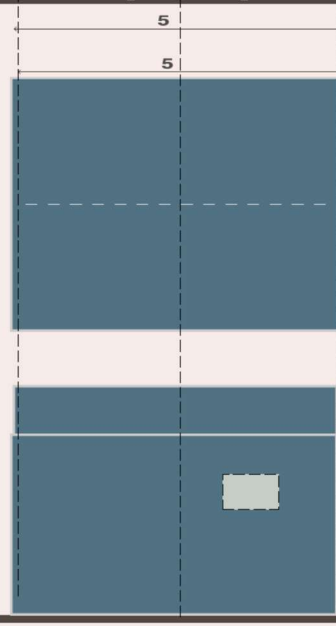
Plan view



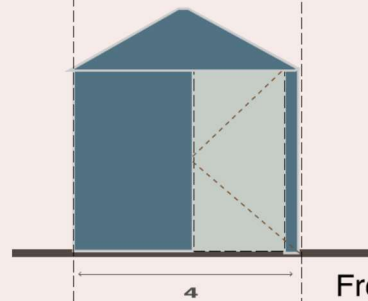
Structure  
Side view



Structure  
Front view



Side view



Front view

## ANNEX 4- Shelter components material, packaging, quantity and country of origin

### Case Végétale Model<sup>145</sup>

Name	Raw material	Quantity/ Kg	Country of origin	Packeting
Steel poles	Steel	25	China	No packeting
Fabric	Nylon	1	Mali (Bamako)	Polyethylene
Plastic sheeting	Polyethylene	8	China (China)	Polyethylene
Timber	Eucalyptus wood	188	Mali (around Tombouctou & Diré)	Rope (palm doum)
Plant mats	Palm doum	68	Mali (around Tombouctou & Niafunfé)	Rope (palm doum)
rope	Palm doum	0.5	Mali (around Diré & Niafunfé)	Rope (palm doum)

### Case en Milieu Humide Model

Name	Raw material	Quantity/ Kg	Country of origin	Packeting
Steel poles	Steel	75	China	No packeting
Fabric	70% Nylon & 30% Cotton	15	China	Polyethylene
Plastic mats	Polyethylene	4	China	Polyethylene
CGI	Iron	7	Bamako	No packeting
Timber Wood	Tila Americana (Basswood)	41.2	60% Guinea (Conakry) & 40% Ivory Coast (Abidjan)	Polyethylene
Screw	Steel	5	China	Polyethylene

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<sup>145</sup> All this information was provided by the AICRL team in country

## ANNEX 5 - Transport distances

### Country of origin to point of arrival in country

#### Distance by boat

Departing point	Arrival point	Distance
China	Senegal (Dakar)	19,000 km <sup>146</sup>

#### Distance by road

Departing point	Arrival point	Distance
Senegal (Dakar)	Bamako	1360 km
Ivory Coast (Abidjan)	Bamako	1157 km
Guinea (Conacry)	Bamako	974 km

### Point of Arrival to Warehouse / Store

Departing point	Arrival point	Distance
Bamako	Tombouctou	1015 km

### Warehouse to Construction Site (km)

Departing point	Arrival point	Distance
Warehouse (Tombouctou)	Tombouctou	5 km
Warehouse (Tombouctou)	Goudam	91 km
Warehouse (Tombouctou)	Niafunke	163 km
Warehouse (Tombouctou)	Gourma Rharous	121 km
Warehouse (Tombouctou)	Around Diré; <i>Niafunké, Koumaira, Saraféré, N'gorkou &amp; Banikane</i>	120 km
Warehouse (Tombouctou)	Around Niafunfé; <i>Kourmaira, Saraféré, N'gorkou &amp; Banikane</i>	163 km
Warehouse (Tombouctou)	Around Tombouctou; <i>Toya, Daye, Hondoubormo &amp; Bourem Inaly</i>	60 km
Warehouse (Tombouctou)	Around Diré; <i>Kirchamba, Dangha &amp; Garbakoira Koiratao</i>	120 km

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<sup>146</sup> Since the exact location of the Chinese factory wasn't available, the suggested approximate distance baseline provided by the SMAC guidelines from Asia to West Africa has been used.