REPORT
Burkina Faso environmental impact study of the emergency shelter models

May 2022

croix-rouge luxembourgeoise
Mënschen hëllefen

LUXEMBOURG AID & DEVELOPMENT

Contents

Acknowledgements

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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.[1]

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[2]

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_2 equivalent)[3].

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.

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[4].

CO_2 equivalent A carbon dioxide equivalent or CO_2 equivalent (a.k.a. CO_2 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[5].

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.[6]

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_2 or CO_2 emissions) which is generated in order to produce a material[7].

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[8].

Environmental Impact is defined as any change to the environment, whether adverse or beneficial[9], 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[10].

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[11].

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1 *European Parliament*
2 *Fast Company*
3 *Carbon Trust*
4 *National Geographic*
5 *Energy Manager Canada*
6 *Lynch, Michael D. J.; Neufeld, Josh D. (2015). "Ecology and exploration of the rare biosphere"*
7 *Circular Ecology*
8 *NSW Government*
9 *University of Calgary*
10 *Yale Center for Environmental Law & Policy, and Center for International Earth Science Information Network at Columbia University.*
11 *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[12].

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.[13]

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[14].

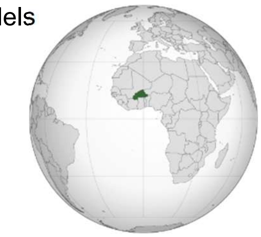
Life cycle assessment (LCA) is a method of evaluating the environmental impact associated with all stages of a product's life, i.e., from the extraction of raw materials, through materials processing, manufacturing, distribution, use, repair and maintenance, to disposal or recycling.

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[15].

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.

12 *NASA*
13 *UNHC*
14 *ISO*
15 *https://assembly.coe.int*

2. General information



Project/mission title: Burkina Faso environmental impact study of the emergency shelter models
Country: Burkina Faso

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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 International Federation of Red Cross and Red Crescent Societies (IFRC) Shelter Research Unit (IFRC-SRU) 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 Burkina Faso, the AI-CRL and the Burkina Faso Red Cross have developed two shelter models. The first model of shelter built is the Sahel Shelter type I developed by AI-CRL in Niger and Burkina Faso. This emergency shelter has a total surface of 21m^2, is made of metal and PVC tubes, a dome-shaped geometry, covered with plastic sheeting, and doum palm mats, built from 2018. Since 2021, a second shelter model, the Sahel Shelter Type II, has replaced Type I. It covers a surface of 14m^2, and the materials are similar to those of the previous model. A total of 4,700 shelters of both types have been installed in the country (62% Type I & 38% Type II), in the border areas with Mali and Niger: in the region of Centre-North (58%), Sahel (37%) and Boucle de Mouhoun (5%).

This experience gained in the field and the feedback collected from targeted populations has helped to evolve 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 comparative 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 drivers of conflict. People all over the world are facing the reality of climate change, and in many parts of the world this manifests as increased volatility of extreme weather events. Only between 2000 and 2019, over 475 000 people lost their lives worldwide[16] due to these. 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[17]. 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[18]. The area of the Sahel desert has increased by 10% in the last 100 years[19].

16 *Global Climate Risk Index 2021*
17 *Global Climate Risk Index 2021*
18 *World Meteorological Organization*
19 *University of Maryland*

Burkina Faso is the 20th most vulnerable country to climate change and the 35th least ready in the world, according to the United Nations Environmental Program[20]. It has been affected by an increase in the scale and intensity of droughts, rain, heat waves, strong winds and dust storms. More than one-third of Burkina Faso's land is degraded, with degradation expanding at a rate of 360,000 hectares (890,000 acres) a year[21]. All of these impacts have made it difficult to manage natural resource-based productive sectors including agriculture, fisheries, and forestry. In Burkina Faso there were more than two million severely food insecure people in mid-2020 – up from more than 680,000 at the same time in 2019[22]. The country is also facing the worst humanitarian crisis in its history due to armed conflicts and terrorist attacks. The rapid deterioration of the security and humanitarian situation has led to significant population movements within the country, especially in the urban context. To date, there are approximately 1,814,283 internally displaced persons in the country, of whom approximately 242,048 were newly displaced during the month of February 2022.[23] A country with limited natural resources, a high pollution growth rate, and it is one of the world's poorest countries in the world, makes the central African nation to be among the most affected by climate change.

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 a 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 Burkina Faso is a contribution to the growing body of work on the environmental impact of humanitarian assistance.

4. Outcome and Outputs[24]

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

Outputs

- A comparative study of different shelter models in Burkina Faso. This individual study is part of a set of such studies in four countries in the region (Niger, Chad, Burkina Faso and Mali)
- Recommendations to reduce the environmental impact of AI-CRL shelter interventions

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. These have been well covered by previous programme evaluations of the Burkina Faso shelter projects.

5. Methodology

This study was conducted remotely, with the support of AI-CRL field staff (shelter, logistics, other); the Shelter Cluster in Burkina Faso; environmental experts from the shelter sector and a local association that specialises in ecological recycling and waste recovery in Burkina Faso[25].

20 *Burkina Faso - Climate (globalsecurity.org)*
21 *ALJAZEERA*
22 *Global Security. org*
23 *Burkina Faso Shelter Cluster*
24 *As included in the Terms of Reference for this study.*
25 *Refer to Annex 2 to see the list of people and organisations contacted.*

The methodology adopted is summarised by the graphic below.

Desk research and problem definition

- Literature review: programme documentation (including logistics/supply chain); environmental profile of Burkina Faso, etc. *(Refer to biblography).*
- Review of emerging best practice in life-cycle analysis / carbon footprinting tools for the Shelter sector.

Data collection

- Key informant interviews (semi-structured): Refer to Annex 2 to see the list of people and organisations contacted.
- A rapid field assessment of shelters was considered, but was not seen as necessary after reviewing the documentation and interviewing the project team.

Review SMAC tool

- Review the SMAC, a new carbon footprint calculation tool for the shelter sector.
- This study is one of the first to use the SMAC, and feedback has been shared with the developers of the tool to improve it.
- Extended engagement with the focal point for the Shelter Cluster Environmental Community of Practice, regarding using the SMAC.

Set Criteria

- Set criteria to compare the environmental impact of the shelter models:
  - (1) Materials consumed
  - (2) Carbon emissions (using the SMAC tool)
  - (3) Impact on local natural resources
  - (4) Waste management
- Score Card Approach

Analysis

- Comparison of the environmental impact of the two shelter models according to the four criteria, analysing each material across its lifecycle from production to disposal.
- Overall (qualitative) comparison using a score card approach

Report writing, conclusions and recommendations

6. Background information

6.1. Country profile

BURKINA FASO

Location
Burkina Faso is a landlocked country in the middle of West Africa with an area of 274,200 square kilometres.

Geography
It is bordered by Mali to the northwest, Niger to the northeast, Benin to the southeast, Togo and Ghana to the south, and the Ivory Coast to the southwest.

Population
Burkina Faso has a population of 20.4 million.[26]

Income
It ranks 144th among 157 countries (2020) in the new human capital index established by the World Bank. 40.1% of the population lives below the poverty line.[27]

Political situation
Since 2018, the security situation has deteriorated due to the growing active presence of non-state armed groups, along the border with Mali and Niger[28]. It has displaced several communities in Burkina Faso. In January 2019, there were fewer than 50,000 internally displaced persons (IDPs), while in August 2021, this number stood at roughly 1.4 million, representing more than 6% of the population.[29]

Climate[30]
Burkina Faso experiences high temperatures and variable rainfall. Three climate zones split the country from north to south: the Sahelian zone in the north with rainfall less than 600 millimeters per year (mm/year), the Sudano-Sahelian region on a savanna plateau (Mossi Plateau) with rainfall from 600-900 mm/year and slightly cooler temperatures, and the southern more humid Sudanian zone with rainfall averages between 900-1200 mm/year. Each of these zones experiences a pronounced wet and dry season, with the wet season extending over a two-month period in the north and a six-month period in the south. The rainy season starts slowly in late March to early April in the southwest, extending gradually toward the center of the country in May and June, and reaching the northern extents in June or early July. The dry season is influenced by the *harmattans*, dry easterly winds that bring hot air from March to May.

Natural disasters[31]
Burkina Faso is prone to chronic drought, flash floods, windstorms, and disease outbreaks.

26 *WFP*
27 *World Bank*
28 *WFP*
29 *World Bank*
30 *Climate Change Knowledge Portal*
31 *Climate Change Knowledge Portal*

6.2. Environmental Challenges in Burkina Faso

Environmental Challenges

Climate change

Burkina Faso is one of the countries in the world most affected by climate change. It is the 20th most vulnerable country to climate change and the 35th least ready in the world, according to the United Nations Environmental Program.

Increasing Temperature

Temperatures in the Sahel rise 1.5 times faster than the global average, with near surface temperatures increasing over the last 50 years. The Sahel is expected to warm by 3°C to 5°C by 2050. Temperature in Burkina Faso is projected to rise around 2 °C by 2030, compared to pre-industrial levels, with higher temperatures and more temperature extremes projected for the south-western part of the country.[32]

Floods

Floods are a recurring natural hazard in Burkina Faso that are likely to become worse with climate change.[33] Burkina Faso is affected annually by floods and high winds.

Droughts

Burkina Faso is part of the sahelo-sahariane band which is periodically affected by an endemic drought cycle, and accompanying famine and epidemics.[34] Increased levels of heat lead to extreme events, such as droughts, wildfires, and heat waves. One of the primary causes of droughts in the Sahel is temperature rise, in addition to land degradation and dust feedbacks.[35]

Desertification and land degradation

Burkina Faso is one of the countries most severely affected by desertification[36]. Declining productivity and soil structure in Burkina Faso is exacerbated by unpredictable rainfall and drought, resulting in extreme degradation and desertification. 31% of Burkina Faso's land is potentially degraded[37] and the country loses almost 470,000 hectares of land each year[38]

Deforestation

Deforestation in Burkina Faso is estimated to be between 0.91–1.03% per annum[39]

Wind erosion

Wind erosion is an important soil degradation process on agricultural fields in the Sahel and is strongly affected by the scattered woody vegetation.[40]

Water pollution

Almost half the country (8.4 million people) live without clean water.[41]

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32 Climate Risk Profile. Burkina Faso
33 Climate Change Knowledge Portal
34 Globalsecurity.org
35 Climate Change, Food Security and migration in Chad: A Complex Nexus. American University, IOM Chad and the Chad Food Security Cluster
When the desert becomes flooded. OCHA
36 Lifegate.com
37 SITUATION DE REFERENCE DES TERRES DEGRADEES ET DE LA CES AU BURKINA FASO. GIZ. 2018
38 Rapport national sur la neutralité en matière de dégradation des terres (NTD)
39 Land tenure, asset heterogeneit and deforestation in southern Burkina Faso. 2015
40 Wind Erosion Reduction by Scattered Woody Vegetation in Farmers' Fields in Northern Burkina Faso. Jakolien K. Leenders,Geert Sterk, John H. van Boxel
41 Wateraid.org

Solid waste

The system of waste collection, storage, treatment and disposal is not well functioning. The municipal solid waste generated annually is 2,575,251 tons (2010 est.), which only 12% is recycled (2005 est.) [42]

Air Pollution

The air quality in Burkina Faso is considered unsafe. The data indicates the country's annual average concentration of $PM_{2.5}$ is 35.78 $\mu g/m^3$ [43] which exceeds the recommended maximum of 10 $\mu g/m^3$ according to the WHO[44]. Contributors to poor air quality in Burkina Faso include combustion processes, old vehicles, and biomass burning.[45]

42 *CIA*
43 *CIA*
44 *IAMAT*
45 *IAMAT*

6.3. Burkina Faso Shelter models

SAHEL SHELTER TYPE I

The Sahel Type is designed as an emergency to transitional shelter solution, adapted to the Sahel region of the western Africa. Built from 2018, in in the border areas with Mali and Niger: in the communes of Centre-North (Bourzanga, Bouroum, Tougourin, Kaya) and Sahel (Dori, Djibo).

Total area
21 m^2

Occupancy
6 persons

Construction time
6 hours/3 persons

Cost
287 euros

Durability
12 months

Total # Built
2944

To Build
2540

Dimensions
6.50m x 3.50m

Depth of excavation
Depending on the soil context, with a minimum of 25cm depth to a maximum of 40cm for each pillar.

Structure (wall/roof)
The roof geometry is a dome shape created using arches fixed above the column heads. 12 steel tube columns with a minimum section of 30x30mm, e=2 mm.
Additional use of triangulations in the walls to complete the structural system. The material used is semi-rigid PVC with d=32mm and e=2m.

Cladding walls
The walls are made of 14 woven mats of 1x2m from the doum palm tree, directly sewn to the shelter structure.

Roof covering
The inner layer consists of 14 doum palm mats of 1x2m, sewn together, which cover the entire dome structure. The second layer consists of 2 RCRC Movement standards plastic sheets (tarpaulins) of 4x6m.

Openings
The doors are made of 4 plastic mats of 2x1.2m, sewn together.

SAHEL SHELTER TYPE II

This emergency shelter is designed as a variation adapted to the context on central Burkina Faso. Built from 2021, in the communes of Boucle du Mouhoun (Tougan), Centre-Nord (Bourzanga, Bouroum, Pensa), and Sahel (Sebba, Gorgadji).

Total area
14m²

Occupancy
4 persons

Construction time
4 hours / 3 persons

Cost
268 euros

Durability
12 months

Total # Built
1777

To Build
1064

Dimensions
4.00m x 3.50m.

Depth of excavation
The depth of the excavation will be according to the soil context, with a minimum depth of 25 cm for each pillar.

Structure (wall/roof)
The roof geometry is a dome shape created using arches fixed above the column heads. 9 steel tube columns with a minimum section of 30x30mm, e=2 mm.
Additional use of triangulations in the walls to complete the structural system. The material used is semi-rigid PVC with d=32mm and e=2m.

Cladding walls
The walls are made of 11 doum palm mats of 1x2m directly sewn to the shelter structure.

Roof covering
The inner layer consists of 11 doum palm mats of 1x2m, sewn together, which cover the entire dome structure. The second layer consists of 1 RCRC Movement standards plastic sheets (tarpaulins) of 4x6m.

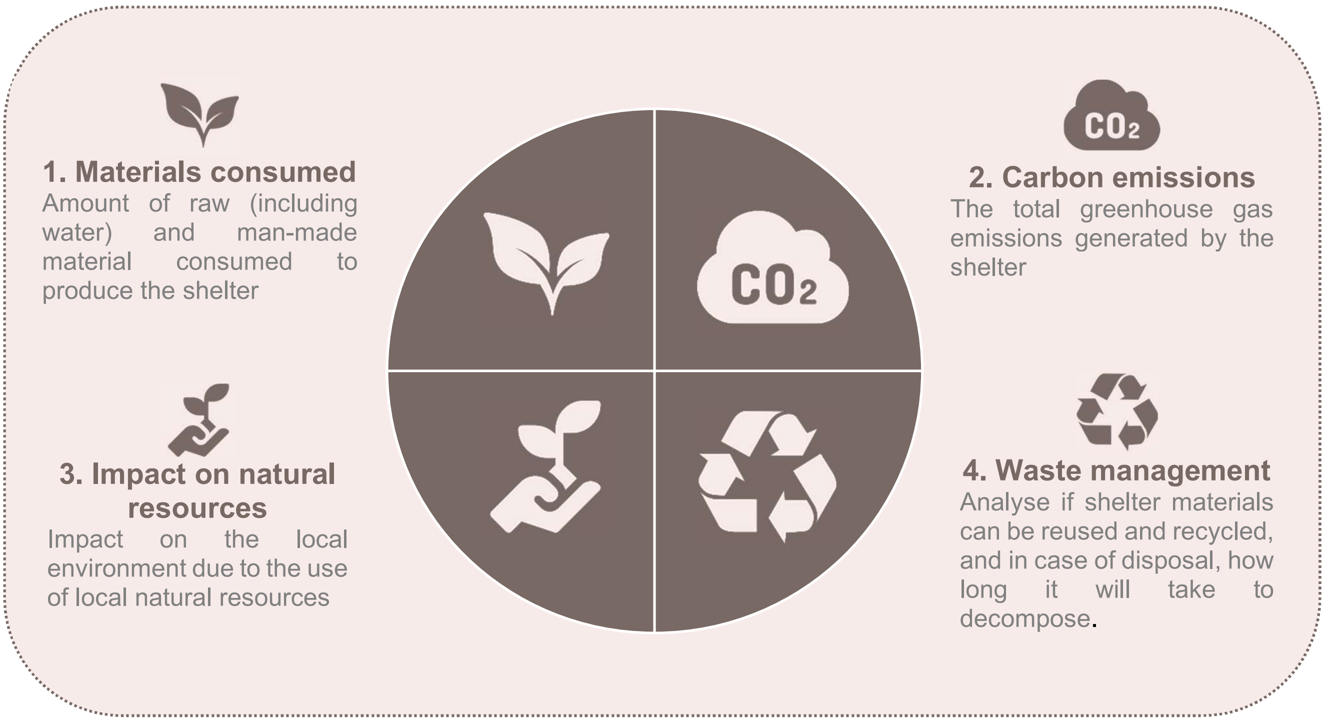
Openings
The doors are made of 1 plastic mat of 2x1.2m, sewn together

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 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 raw materials and 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 tree and 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_2 equivalent).

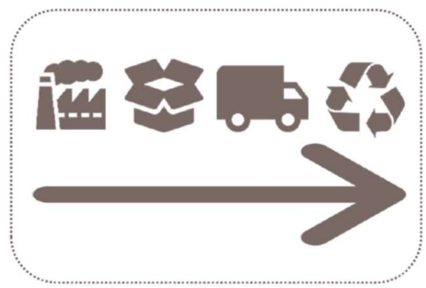
Life cycle analysis (LCA)
LCA is a commonly adopted methodology for quantifying carbon emissions and can be used to help compare shelter options. This 'cradle to grave' assessment evaluates the carbon emissions of the shelter from extraction of raw materials to the end of its life. It is a good starting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

Using CO_2 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[46] (Shelter Methodology for the Assessment of Carbon) tool. It calculates the CO_2 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_2 equivalent emissions from the following factors, or 'life-cycle stages':

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_2 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.

46 *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_2 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.

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. 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^2 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 total distance has been calculated considering the % of the total material that came from each location
- The distances in kilometres have been provided by the field team.
- All materials have been transported by road (as per information provided by the field team), except the plastic sheeting, the wire and sewing thread that have been transported by boat.
- Plastic sheeting, wire and sewing thread was manufactured in China and transported by boat to Port of Abidjan (Ivory Coast)
- 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.
- Since it is not known exactly what happens with disposal, transportation from the site of construction of the shelters for disposal is not included.

iii) End of life

SMAC uses assumptions about the level of recycling and CO^2 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 CO2 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[47] used by the tool. It was not possible to find Environmental Product Declarations (EPD) for all possible shelter materials that are used in

47 *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.*

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, thatch was selected instead of the doum palm trees). Similarly, assumptions are made in the SMAC relating to end of life (recycling options and level of CO^2 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^2 equivalent, which is only one measure of environmental impact, this section 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.

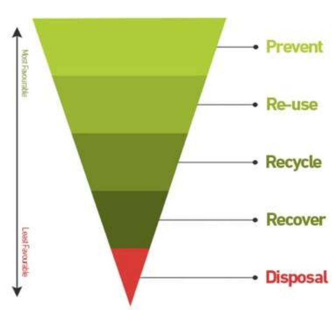
A number of environmental organisations[48] who specialise in the protection of forests and ecosystems in Burkina Faso were contacted for this study, but a reply was only received from one. Literature review[49], feedback from the project team and the perspective of this local organisation has formed 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 through 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 they 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[50]. 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.



48 *Refer to Annex 2*
49 *Refer to biography*
50 *EU Commission, 2014*

A few local private companies, start-up and association that specialises in ecological recycling and waste recovery in the country, were contacted to enquire about waste management in the country[51], but a reply was only received from one. Literature review[52], feedback from the specialist in ecological recycling and waste recovery in Burkina, project team and environmental experts from the shelter sector[53] have been considered for this analysis.

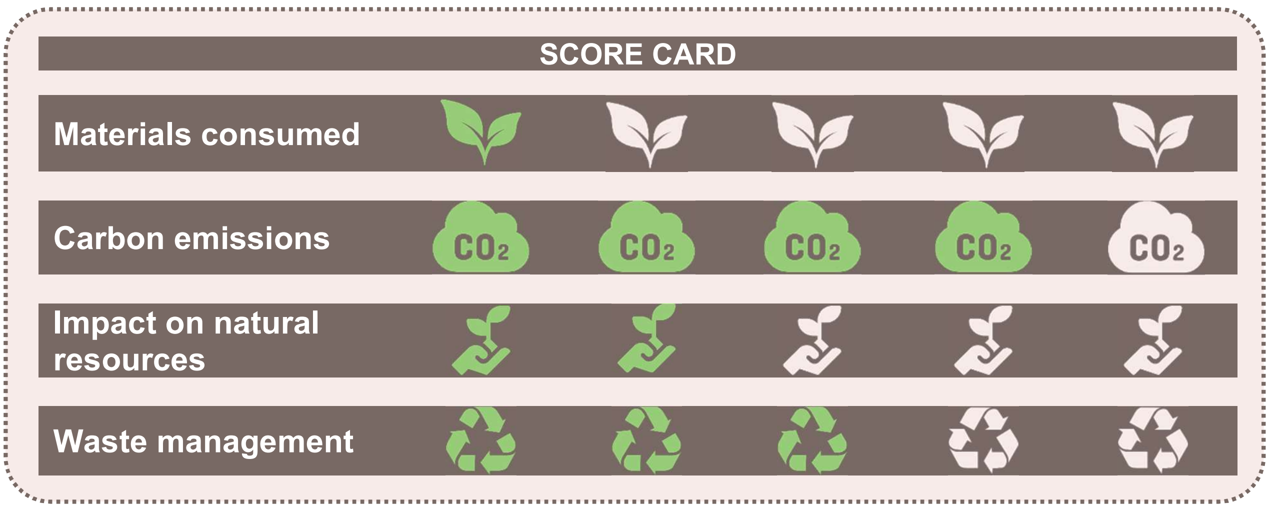
7.5. Score card approach

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

51 *Africa Ecologie, KITA Entreprise, Soburec SARL, TECO*
52 *Refer to biography*
53 *Refer to Annex 2 to see the list of people contacted.*

8. 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.[54] 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.

PVC; Polyvinyl Chloride plastic is the world's third most common plastic. It is inexpensive, durable, strong, and chemically and biologically resistant, as well as easy to install and replace. It is widely used in packaging, home furnishings, children's toys, building materials, etc. It is the most environmentally damaging of all plastics.[55]

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.[56]

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.[57]

Ocean contamination; 10 percent of this plastic ends up in the ocean, where it breaks down into microplastics.[58] 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.[59]

54 *www.aquapakpolymers.com*
55 *www.greenpeace.org*
56 *https://goodonyou.eco*
57 *Center for International environmental law.*
58 *Green Peace*
59 *Stopplastic.ca*
60 *The world counts*
61 *The world counts*
62 *The world counts*

Steel

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.[60]

General environmental impacts[61]

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_2 annually[62]

Doum palm tree

Doum palm tree Hyphaene thebaica, with common name doum palm is a type of palm tree, Individuals can grow to 25 m.[63] It is a native to the Arabian Peninsula and also to the northern half and western part of Africa,[64] 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[65]

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

63 *www.eol.org*
64 *World Check List of Selected Plant Families (WCSP). Kew Sciences.*
65 *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*

Water covers 70% of our planet, however, only 3% of the world's water is fresh water.[66] 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.[67]

Environmental impacts

Water shortage; Water shortages are likely to be the key environmental challenge of this century.[67] 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.[68]

Water pollution; comes from many sources including pesticides and fertilizers that wash away from farms, untreated human wastewater, and industrial waste.[69]

Climate change; is altering patterns of weather and water around the world, causing shortages and droughts in some areas and floods in others.[70]

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 Burkina Faso.

Water consumption is calculated for all the man-made materials used to build the shelter. The water consumed by natural growth of the palm trees and common reed 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[71]
- Production of 1 kg of steel requires 705 litres of water[72]

SAHEL SHELTER Type I- Table 1

Raw material	
Doum palm tree	63 kilos
Water consumption	21,010 liters

Man-made material	
Steel	29.4 kilos
PVC	33 kilos
Plastic	16.65 kilos
Nylon	0.8 kilos

SAHEL SHELTER Type II –Table 2

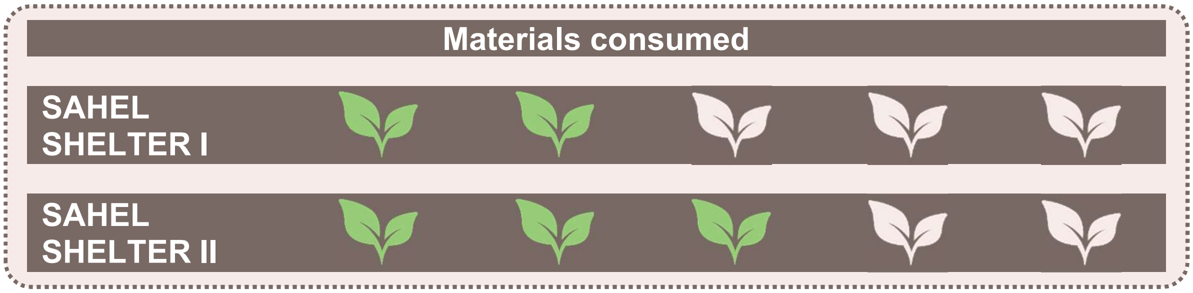
Raw material	
Doum palm tree	49.5 kilos
Water consumption	16,753 liters

Man-made material	
Steel	23.6 kilos
PVC	22.5 kilos
Plastic	6.8 kilos
Nylon	0.8 kilos

66 *WWF*
67 *www.un.org/waterforlifedecade*
68 *NASA*
69 *University of Dundee*
70 *WWF*
71 *Shelter and Sustainability, UNHCR, 2021*
72 *Shelter and Sustainability, UNHCR, 2021*

8.1.1. Interpretation of the results

The Sahel Shelter Type I model scored 2 out 5 and the Sahel Shelter Type II scored 3 out 5



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

Both models used exactly the same materials, the only difference being the amount. The Sahel shelter type II uses lower quantities, therefore it scores better. However both used a considerable amount of man-made material, especially steel and plastic. Note that under this first criteria only the quantity of materials is considered, and not whether the extraction or harvesting of local raw or natural materials is environmentally harmful, which is considered under Criteria 3.

Both scores could be improved by reducing the amount of man-made materials used in the shelters, especially plastic, steel and PVC, without compromising the functionality.

8.2. Criteria 2: Carbon emissions

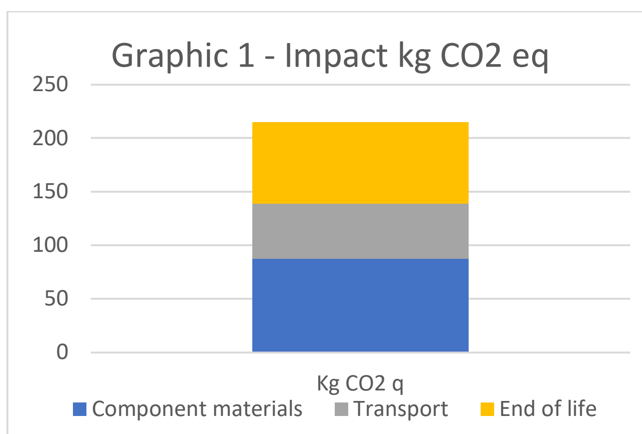
Below are the total carbon emissions generated by each shelter model, in CO_2 equivalent. This is using the SMAC calculator and taking into account all the parameters and assumptions explained above in section 7.2.

8.2.1. Sahel Shelter Type I Model

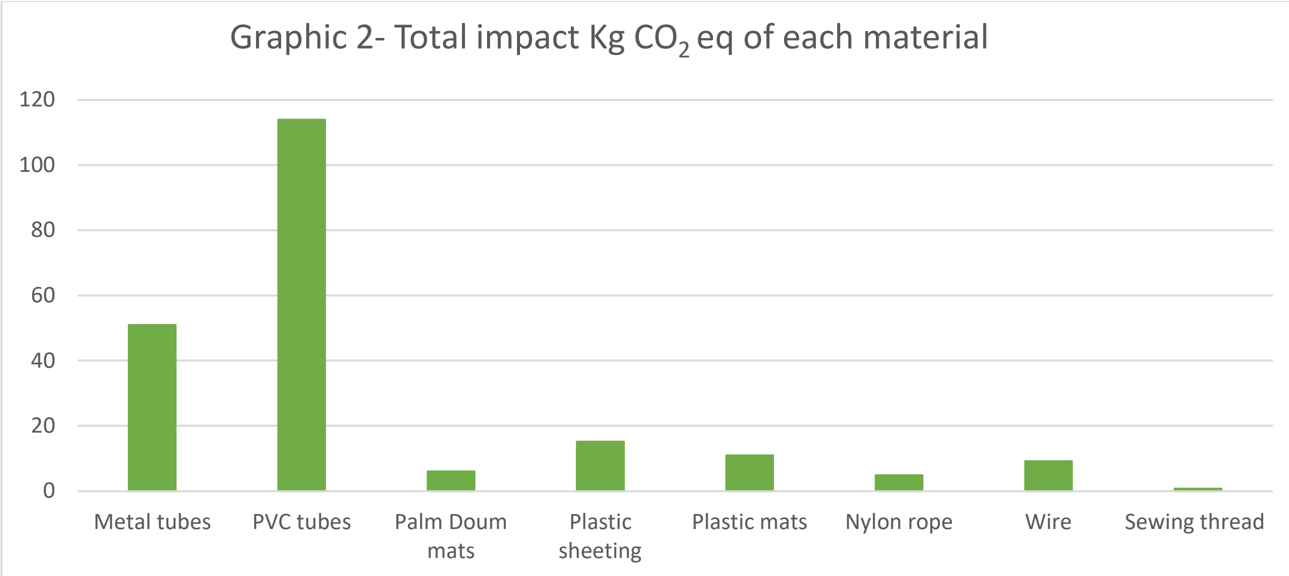
The following Table 3 and Graphic 1 show the breakdown of the carbon emissions, in terms of Kg CO_2 eq. and relative % CO_2 eq., of the shelter unit per the four life cycle stages: 'production of component materials', 'transport' and 'end of life'. Emissions from 'packaging' are not included, as previously mentioned.

Table 3 – Sahel Shelter Type I

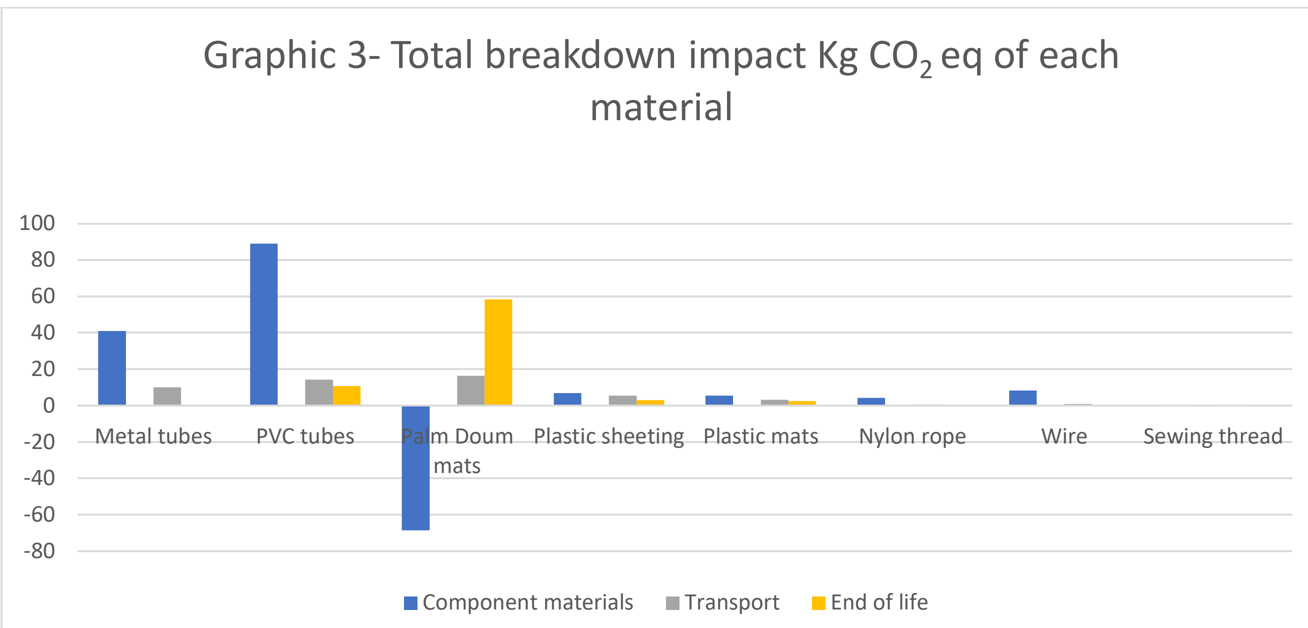
Impact	Carbon Emissions Kg CO_2 eq.
Production of component materials	86
Packaging	*Data not considered*
Transport	51
End of life	75
Total	**212**



The follow Graphic 2 shows the total Kg CO2 eq. impact of each material.



The follow Graphic 3 shows the total Kg CO_2 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 Sahel Shelter Type I

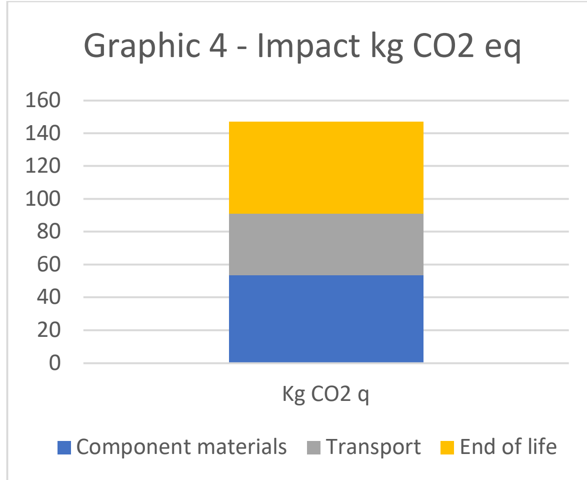
Since the two shelters are composed by exactly same materials, the only difference being the total amount of the materials used, the interpretation of the results are the same for both models. The difference remains in the total carbon emissions generated. Therefore, the interpretation of the result for both types will be done in section 8.2.4.

8.2.3. Sahel Shelter Type II

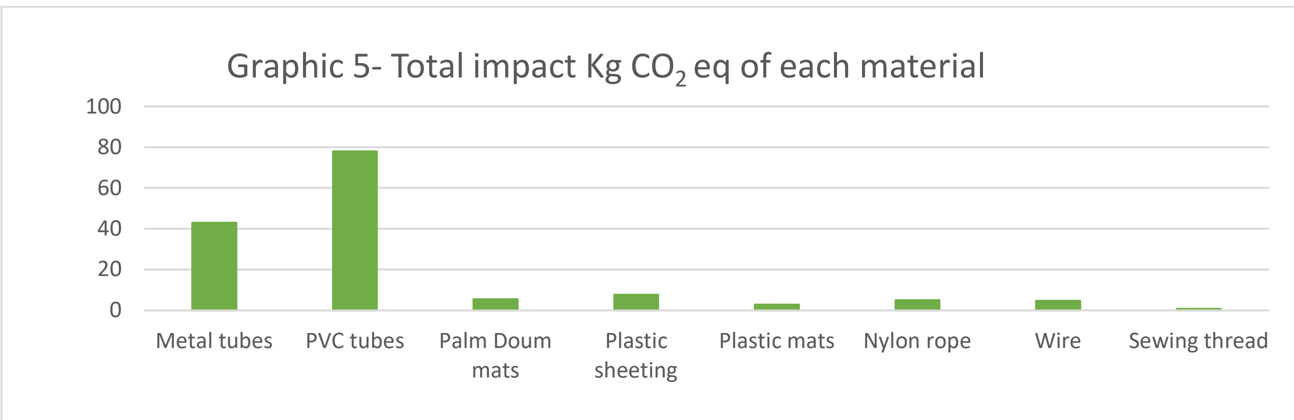
The following Tables 4 and Graphic 5 show the breakdown of the carbon emissions generated, in terms of Kg CO_2 eq. and relative % CO^2 eq., of the shelter unit per life cycle stage: 'production of component material', 'transport' and 'end of life'. Emissions from 'packaging' are not included.

Table 4 – Shale Shelter Type II

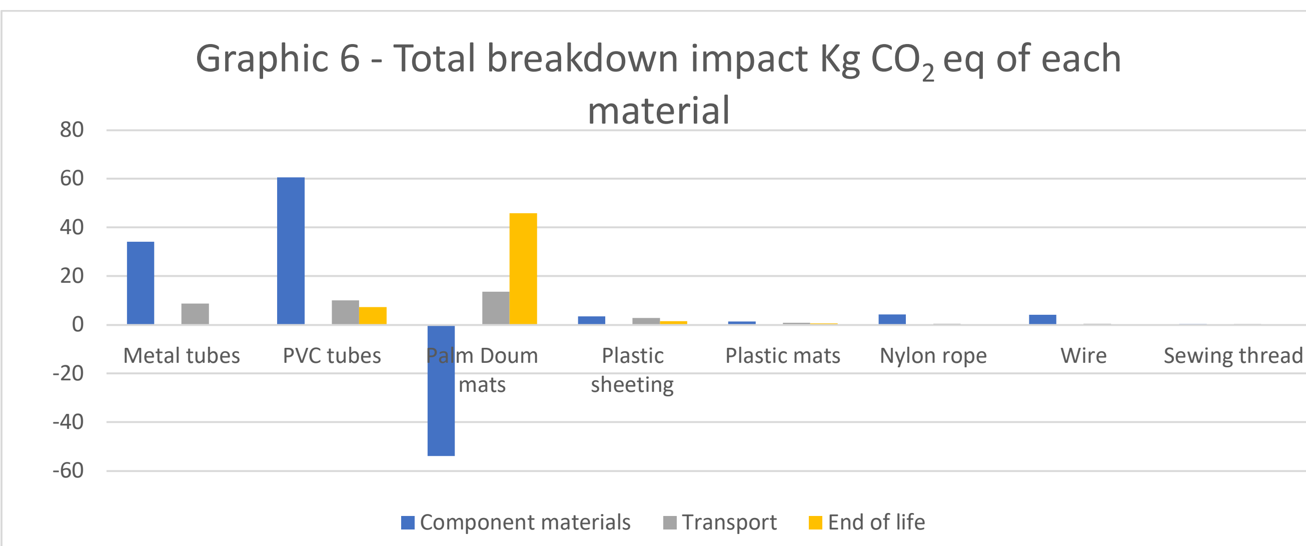
Impact	Carbon Emissions Kg CO_2 eq.
Production of component materials	54
Packaging	*Data not considered*
Transport	37
End of life	56
Total	**147**



The follow Graphic 5 shows the total Kg CO2 eq. impact of each material.



The follow Graphic 6 shows the total Kg CO_2 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 results for both shelters

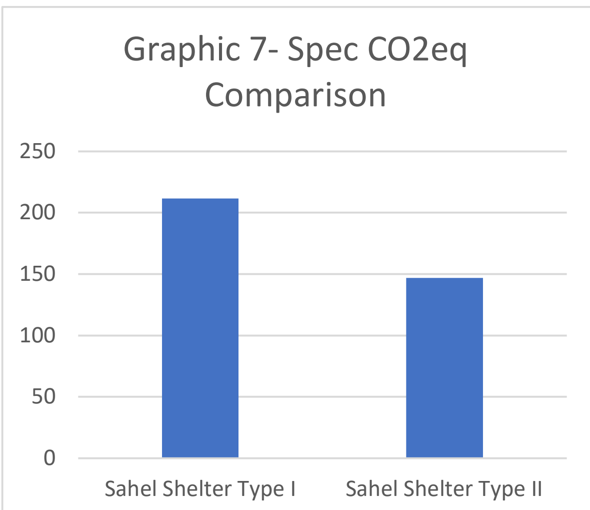
Comparing the result for both models

Table 3 – Sahel Shelter Type I

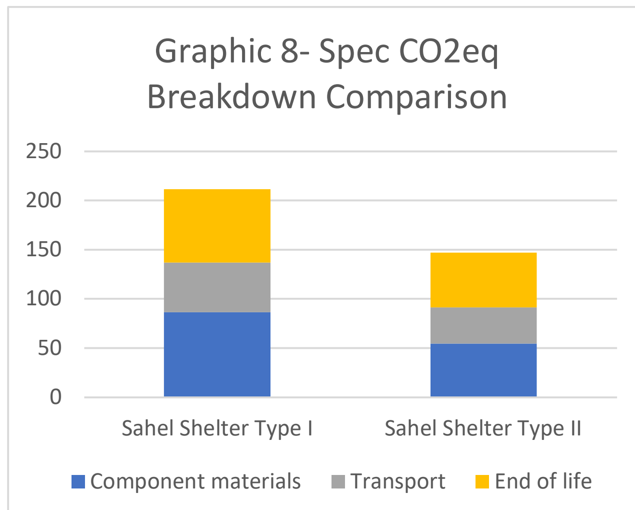
Impact	Carbon Emissions Kg CO_2 eq.
Production of the component materials	86
Packaging	*Data not considered*
Transport	51
End of life	75
Total	**212**

Table 4 – Sahel Shelter Type II

Impact	Carbon Emissions Kg CO_2 eq.
Production of the component materials	54
Packaging	*Data not considered*
Transport	37
End of life	56
Total	**147**

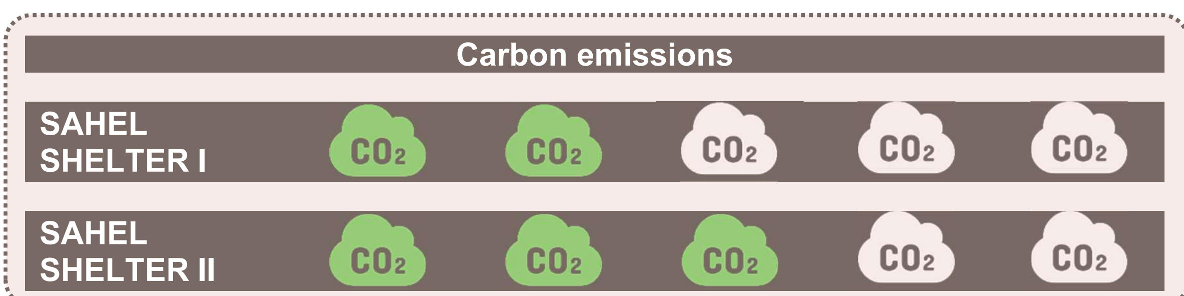


Graphic 7- Spec CO2eq Comparison



Graphic 8- Spec CO2eq Breakdown Comparison

Sahel Shelter Type I scored 2 out 5 and Sahel Shelter Type II scored 3 out 5



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

The overall carbon emissions for the Sahel shelter type II are lower than the Sahel Shelter Type I model. This is obvious, because it uses less materials.

As per Graphic 1 (Sahel Shelter I) and Graphic 4 (Sahel Shelter II) most of the carbon emissions for both shelters are from the ‘production of component materials’ and the ‘end of life’ of the component materials used, with ‘transport’ contributing less. However, in this particular case, the ‘end of life’ carbon emissions are somewhat misleading, and the real carbon footprint should be less as is explained below.

When looking into each of the materials, Graphic 2 (Sahel Shelter I) and Graphic 5 (Sahel Shelter II), PVC is the one that has the biggest emissions, followed by metal tubes and plastic sheeting. As per Graphic 3 (Sahel Shelter I) and Graphic 6 (Sahel Shelter II), most of the emissions from the PVC and metal tubes come from the ‘production of component material’. According to the results, the third biggest contribution to the carbon emissions is from the ‘end of life’ of the palm doum mats. But as mentioned above, in this particular case the “end of life” should be less.

When looking into the palm doum mats, Graphic 3 (Sahel Shelter I) and Graphic 6 (Sahel Shelter II) , the ‘production of component material’ generates negative carbon emissions. This is because natural materials capture carbon (and other greenhouse gases) during their growth. It is important to understand this well since it is not intuitive for many. Using such local natural materials produces ‘negative’ emissions – they do not require any energy to produce (unlike the other materials), and in fact they reduce carbon emissions. However, at ‘end of life’, they are generally assumed to be burned (The SMAC tool assumes that these type of plant materials and wood are burnt at the end of their useful life, as this is usually the case in these humanitarian contexts), and thus release much of that carbon into the air.

However, this is not the real case for these models. When the materials are burnt, the level of CO_2 eq. released into the air is relatively high. Therefore, carbon emissions are released at the end of life as per Graphic 3 (Sahel Shelter I) and Graphic 6 (Sahel Shelter II) , where palm doum mats seem to make a big contribution to emissions . But if the material is allowed to decompose, is composted, or is just buried, little or no CO_2 eq. would be released into the environment. This is what happens in this specific case in Burkina Faso. According to the field team, the families do not burn the material at the end of its life. Instead, they dumped them in an open field. Therefore, the carbon emissions at the “end of life” should be zero, and the overall carbon emissions should be less for both shelters. However the SMAC tool does not allow this to be taken into consideration.

The challenge with “end of life” is that it can be a very local process. As in this example, in one place the materials may be burned (e.g., when a site is abandoned), at another, used for compost (e.g., a well-established camp with a gardening program) and at a 3rd, just dumped in near-by unused land (as it is in this case study). As a result, only one process is considered in the SMAC tool. Therefore some local conditions could increase or decrease the carbon footprint. This is the reason why the SMAC tool cannot be seen as giving an exact answer, but as input into decision making. This is where a score card approach is important, since this can allow for a more explicit inclusion of local factors.

However, in the case where some families burnt the palm doum mats, then the estimation of the carbon emissions by the SMAC tool would be more accurate.

Overall, it is clear that the metal and PVC tubes 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 palm doum mats; similarly the emissions from ‘end of life’ appear much higher due to the emissions released from considering the burning of the palm mats, acknowledging that this is not actually the case for these models in this context. So the total carbon emissions should be less. The biggest impact on transport comes from the palm doum mats, since 85% of the total are imported and are transported by road.

The score card for both models could be improved by:

- Considering to use different materials, especially replacing the PVC and metal tubes which have the highest embodied CO_2 emissions, or reducing the amount used without compromising the quality of the shelter.
- To reduce the emissions from transport. The highest impact came from the doum palm mats, because most come from Mali and Niger. However this would be challenging, since the production of palm doum mats in Burkina Faso does not cover the current demand. Another way to reduce transport emissions is by procuring metal tubes and PVC more locally, if possible.

8.3. Criteria 3: Impact on local natural resources

A common assumption is that the more natural a material it is, the better 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.

In Burkina Faso desertification is on the rise. The government estimates that the country loses just under 110,000 ha of forest cover every year[73.]. Drivers of deforestation and forest degradation include agricultural expansion, overgrazing of livestock, bush fires, and demand for fuelwood and charcoal. 80% of domestic energy needs in the country are met by firewood[74]. Other factors like poor forest governance and population growth in rural areas underlie these drivers[75.]

Also climate change plays an important role on desertification. Rains are rare and when they occur, they wash away the soil exposed to erosion without vegetation cover.

The forestry sector plays an important role in Burkina Faso, including economically, socially and culturally[76]. The forest revenues[77] in Burkina are 4.54% of GDP (2018 est.), which is the 14th highest of 204 countries analysed. The consequences of land degradation are extremely serious, when 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 increased. Therefore the use of local forest resources in shelter construction needs to be carefully analysed.

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, 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 identify and contact local environmental organisations, however without success.

A quick overview about forests, why they are important to fight against climate change, and forest situation in Burkina Faso

Forests play a key role in mitigating climate change[78] 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[79].

Environmental issues[80]

- 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.

73 *Forest Carbon Partnership*
74 *Livelihoods Funds*
75 *Forest Carbon Partnership*
76 *FAO*
77 *CIA. Chad - The World Factbook (cia.gov)*
78 *Forests and climate change. IUCN*
79 *Forests and climate change. IUCN*
80 *State of the World's Trees. Sept 2021. Botanic Gardens Conservation International*

- Around 25% of global emissions come from the land sector. About half of these come from deforestation and forest degradation.

Burkina Faso Forest Information and Data

- Burkina Faso has struggled with desertification, soil degradation, drought and loss of biodiversity for many years.
- In 2020, 23% of Burkina Faso total area was forested[81]
- Between 1990 and 2015, Burkina Faso lost 22% of its forest cover and 18% of other woodlands[82]
- Burkina Faso has 15.5% of terrestrial protected areas[83].
- The forest revenues in Burkina Faso are 4.54% of GDP (2018 est.)[84]
- In 2018, Burkina Faso committed to restoring 5 million hectares of degraded land by 2030[85]

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 across the continent. The small-sized palm tree, the doum, (Hyphaene thebaica), can be found in Dédougou (Région de la Boucle du Mouhoun, province du Mouhoun), Bobo Dioulasso (Région des Hauts Bassins, province du Houet) Léo (Région du Centre-Ouest, province du sissili). It has significant local and regional economic, social and ecological value[86].

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[87].

Harvesting[88]

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[89].

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

81 *World Bank collection of development indicators*
82 *FAO*
83 *Forest Carbon Partnership*
84 *CIA. Chad - The World Factbook (cia.gov)*
85 *UNCCD. Burkina Faso | Knowledge Hub (unccd.int)*
86 *Low extinction risk for an important plant resource: Conservation assessments of continental African palms (Arecaceae/Palmae). April 2018*
87 *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*
88 *Little information has been found on the specific cultivation of the doum palm in Burkina Faso, 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. Also, most of the doum palm mats come from Niger and Mali.*
89 *Low extinction risk for an important plant resource: Conservation assessments of continental African palms (Arecaceae/Palmae). April 2018*

- 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.[90]
- Doum palm is not listed in the Burkina Faso tree species list in the Botanic Gardens Conservation International, so the conservation status in Burkina Faso is unclear. However, at global level it is listed as not under threat of extinction[91]

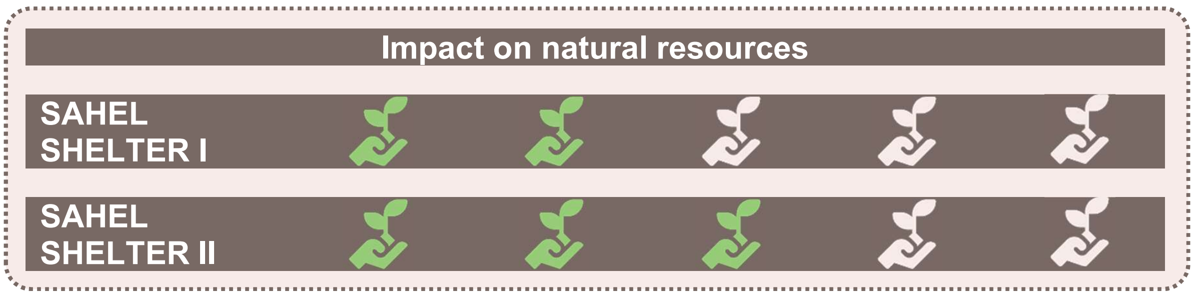
Total amount of doum palm mats in the models

Only around 15% of the doum palm mats used in the models come from Burkina Faso. The rest come from Niger (around 45%) and Mali (around 40%)

- Sahel Shelter Type I: 63 kilos for the wall and roofing
  Sahel Shelter Type II: 49.5 kilos for the wall and roofing

8.3.2. Interpretation of the results

Sahel Shelter Type I scored 2 out 5 and Sahel Shelter Type II scored 2 out 5



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

Both shelter model used doum palm mats. The total amount in the Sahel Shelter model Type I is less that Type II.

On one hand, these natural resources are used traditionally by the communities for many years, and the harvesting and preparation provides a source of income. But as it was pointed out by the Shelter Cluster in Chad, and the same can be said in Burkina Faso "*in principle, the use of construction materials that are being sourced locally from the natural environment is desirable. But in practice, the demand significantly outweighs the resources available. 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. In and around the majority of IDP settlements, severe degradation of trees and plants is already occurring*"[92].

What is clear is that these resources all have multiple benefits for communities, but over-harvesting is a potential problem. So, the question whether the supply of these species could keep up with the demand from the shelters in Burkina Faso is very clear: the answer is no. *"The production of palm doum mats in Burkina Faso does not cover the current demand and humanitarian actors import the mats from other countries, with a consequent overpricing that makes mats an expensive item compared to the same type of shelter used in Niger by the AICRL"*[93]. Only 15% of the

90 *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*
91 *https://www.bgci.org/resources/bgci-databases/globaltree-portal/species-search/?species=Phoenix+dactylifera*
92 *Shelter & Settlements. Environmental Impact Report. Shelter Cluster Chad. February 2021*
93 *Étude d'adaptation des abris de type Sahel Shelter. AI-CRL. 2019*

doum palm mats used in the models, according to the supplier, come from Burkina Faso. The rest come from Niger (around 45%) and Mali (around 40%).

Therefore, it would be advisable to look for local alternatives to this material, or, as a minimum, integrate some kind of replanting or forest protection initiatives as part of the shelter projects. In 2019, a market assessment[94] took place to identify different types of local mats, resulting in the identification of three alternatives: (1) Millet stalk mats -*nattes de tiges de mil* (2) “Andropogon" mats, and (3) Secco mats. According to the result of this assessment, the first two options were discarded because of “*limited availability depending on the season*”. And advice was given to further consider “secco mats” as an alternative "*to check availability and possibilities of support to artisans who supply them"*.

However, according to the field team, “*we have not yet used* secco mats *in our interventions because the problem of the availability of this material is limited availability depending on the season (the plant is becoming increasingly rare), and the same applies for andropogon mats”* However, they found out that “mile stick mats” (*nattes de tiges de mil*) are more available compared to the other two options. Therefore it is planned for this year to build 100 new transitional shelters using this material, which will allow the team to capture further lessons for shelter projects for 2023.

The score card for both models could be improved by:

- 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.
- Considering to use a different local alternative as “Millet stalk mats (*nattes de tiges de mil)*”. However, further study on the impact on the environment and mitigation strategies should also be considered for these alternative materials.

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.

Around 3 billion people 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[95]. As it was mentioned above, in Burkina Faso there is a high demand for fuelwood and charcoal. 80% of domestic energy needs in the country are met by firewood[96]. 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[97].

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

94 *Étude d’adaptation des abris de type Sahel Shelter. AI-CRL. 2019*
95 *Cooking in displacement Setting. Engaging the Private Sector in Non-wood-based Fuel Supply. Laura Patel and Katie Gross. January 2019*
96 *Livelihoods Funds*
97 *IDP Shelter & Settlements. Environmental Impact Report. Shelter Cluster Chad. March 2021*

change, banning in-kind firewood distribution or requesting humanitarian agency support to transition refugees to alternative more sustainable fuels[98].

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 Burkina Faso 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.

As was pointed out in the previous report for Chad, and when asking to Burkina Faso shelter cluster, it was confirmed that the same can be said for Burkina's context "*To date there is no distinct practice of household waste management in IDP settlements, with few or no designated refuse pits or compost piles. The same can be said about local towns and villages. This is especially evident by the amount of waste scattered throughout and near human settlements in the province. Although many durable items are reused and recycled in IDP settlements, solid household waste is typically burnt, buried, or left scattered*" [99]. 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 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. According to the shelter cluster in Burkina Faso *"Not only IDPs have less concern for the impact of waste, but it is cultural and local habit as well"* .

The two tables below examines 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 Burkina Faso (Table 6). It is important to note that the rate of decomposition can depend upon disposal or landfill conditions.
Also, the recycling options are based on potential from the association that specialise in ecological recycling and waste recovery in the country, Africa Ecologie, and ideas shared by some of the interviewees.

As a note, the global *Joint Initiative on Sustainable Humanitarian Assistance Packaging Waste Management*[100] 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 Burkina Faso is not one of them[101].

98 *Cooking in displacement Setting. Engaging the Private Sector in Non-wood-based Fuel Supply. Laura Patel and Katie Gross. January 2019*
99 *Shelter & Settlements. Environmental Impact Report. Shelter Cluster Chad. February 2021*
100 *Information can be found at https://eecentre.org/2019/07/15/https-www-eecentre-org-2019-07-15-sustainable-humanitarian-packaging-waste-management/*
101 *The information is then uploaded onto the Global Logistic Cluster LCA; https://dlca.logcluster.org/display/public/DLCA/LCA+Homepage.*

Table 5

Material	Life expectancy[102]	Time to decompose	Reuse	Recycling
Plastic sheeting	1-2 years	500 to 1000 years	Yes	Yes
Plastic mats	1-2 years	500 to 1000 years	Yes	Yes
PVC poles	Minimum 1 years	450 years[103]	Yes	Yes
Steel poles	*Information not provided*	200 to 500 years[104]	Yes	Yes
Wire	2-3 years	200 to 500 years	Yes	Yes
Nylon	More than 1 years	40 years[105]	Yes	Yes
Doum palm mats	1-2 years	Yes 100%	Yes	Yes

Table 6: Potential options in Burkina Faso

Material	Potential Reuse option[106]	Potential Recycling options[107]
Plastic sheeting	• To reuse for auxiliary construction (e.g.: roofing for showers or shelters, smaller sun shades, walling) • Interior floor mats, covering exterior cooking areas. • As lining for rainwater runoff collection, to be used for watering of community kitchen gardens and/or as drinking water for herds. • Privacy screens around latrine pits.	• Recyclable through the production of latrine slabs, paving stones, school tables and benches
Plastic mats	• To reuse for auxiliary construction (e.g.: roofing for showers or shelter) • Sleeping mats.	• Recyclable through the production of latrine slabs, paving stones, school tables and benches • Biofuel
PVC[108]	• To reuse for auxiliary construction • Handicrafts (earrings, home decorations/accessories, etc.) • Made into various functions; can be cut and glued together	• Ground into granules
Steel poles	• To reuse for auxiliary construction	• Made into various functions if welding is available. Like school tables and benches

102 *Information provided by the field team through direct observation on the field.*
103 *https://expandusceramicsquestions.com/qa/how-long-does-pvc-take-to-decompose.html*
104 *How long does it take for metal to degrade - Riba Farré (ribafarre.com)*
105 https://www.dnr.sc.gov/up2u/decompose.html
106 *Information provided by the field team through direct field observations, and from the Global Shelter Cluster community of practice.* To see some photos of how these materials have been used, please refer to annex 6
107 *Based on potential from other neighbouring countries (Niger) or ideas shared by some of the interviewees*
108 *https://expandusceramicsquestions.com/qa/how-long-does-pvc-take-to-decompose.html*

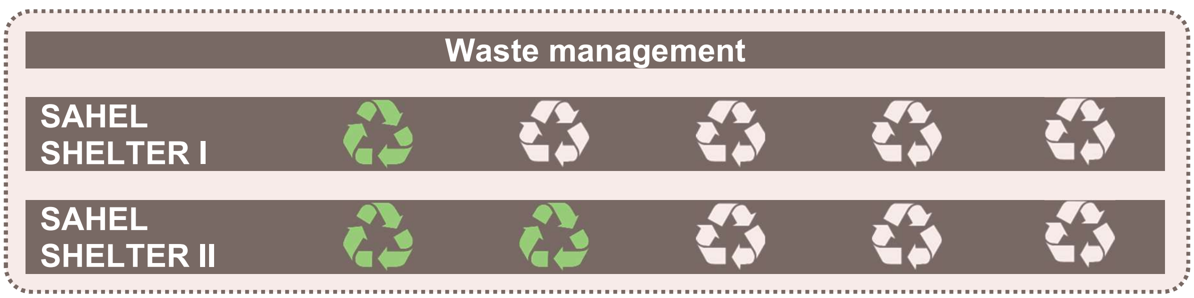
Wire	• To reuse for auxiliary construction • Handicrafts (earrings, home decorations/accessories, etc.) • Used for various functions – can be used for attachments of reused mats, etc	• Made into various functions if welding is available.
Nylon[109]	• To reuse for auxiliary construction • Re-use as rope	• Input for making bags, baskets, satchels, etc.
Doum palm mats	• To reuse for auxiliary construction	• Green charcoal

It is also worth mentioning that Burkina Faso has banned the production, import, marketing and distribution of single-use plastics in packaging and plastic bags[110], which came into force on January 1, 2015. However "this is clearly not being respected on the ground"[111]. Plastic litter, scattered by wind and rain across Burkina Faso, is a major hygiene problem for humans, and a lethal meal for grazing animals[112]. Especially in a country that generates nearly 400,000 tons of plastic waste annually[113]. According to one of the interviewees "*the laws have never been put in place, because border customs are not equipped to identify biodegradable plastic bags from other plastics".*

The field team confirmed that most of the material, except the steel poles, comes packaged in single-use plastic[114]. Attempts could be made to eliminate this, in discussion with suppliers

8.4.1. Interpretation of the result

In the score card, Sahel Shelter Type I scored 1 out 5 and Sahel Shelter Type II scored 2 out 5.



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

As it 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, being Sahel Shelter II higher, due to the lower amount of materials.

From an environmental perspective, answering the question of how long it takes various types of waste to decompose is of great importance. The consumption of products that generate waste that takes a long time in landfill to completely decompose, should be reduced. From this perspective, one of the biggest concerns is plastic, and both models use this material. Not only plastic sheeting, also the very polluting PVC, and the steel tubes, which also take long time to decompose.

109 *https://www.dnr.sc.gov/up2u/decompose.html*
110 *Maps – plasticpollutioncoalition (plasticpollutioncoalitionresources.org)*
111 *Afrik21*
112 *ILO.org*
113 *Afrik21*
114 *Refer to Annex 4*

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. As the Chad Shelter Cluster notes in their report, and the same can be said in this context, "*This gap in construction and maintenance knowledge significantly impacts the durability of the shelters. Poor construction not only poses safety risks but increases the material turnover period, further compounding the environmental impact of shelter construction.*"[115] So promoting this is a must in every programme. The life expectancy of both models is 1 year, which is relatively low.

Many of the materials do have possibilities for reuse and even recycling. However, the reality is that while reuse is already happening, given the Burkina Faso waste management context, recycling is unlikely to take place unless proactive steps are taken.

The score card can be improved in the future by;

- Promoting different waste collection and recycling projects.
- Connecting communities to recycling companies, or helping them put 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.

8.5. Summary: Sahel Shelter Type I vs Sahel Shelter Type II

In this particular study, to talk about a comparison between the two shelter models is not very meaningful. Both models are built with exactly the same materials, sourced from the same origin, following the same design. The difference remains the size, hence the total amount of materials used. Type I (21m^2) has been designed for up to 6 people, and it is best suited in the Sahel region for nomadic populations. Type II (14m^2) is an adaptation of Type I, following feedback from households, and it can accommodate up to 4 people. It is better suited in the Centre-Nord region for sedentary, polygamous populations.

So, if we consider the ratio of material to people sheltered, we can conclude that Type I uses less material per person than Type II, (Type I can accommodate 50% more people than type II, but does not use 50% more material); also Type I produces less carbon emissions per person. Therefore on this simple basis the overall environmental impact of Type I is less. However, when looking only at the total amount of material per shelter or total emissions, Type II of course has a lower environmental impact, since it is smaller.

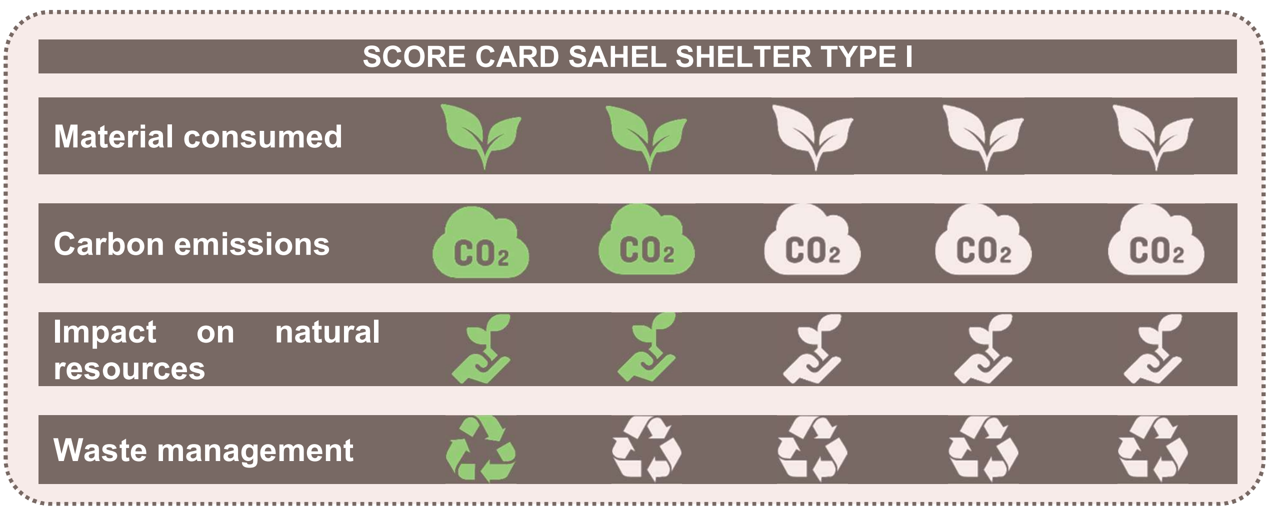
However, this individual study is part of a set of such studies in four countries in the region, each of which has different shelter designs to compare. Differences in sheltering capacity have not been taken into account. In order to ensure consistency and to compare results, Type I and Type II will continue to be treated as separate shelters, with the absolute amount of material used and emissions considered.

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

115 *Shelter & Settlements Environmental Impact Report in the Lac Province of Chad from the Cluster Chad*

SAHEL SHELTER Type I

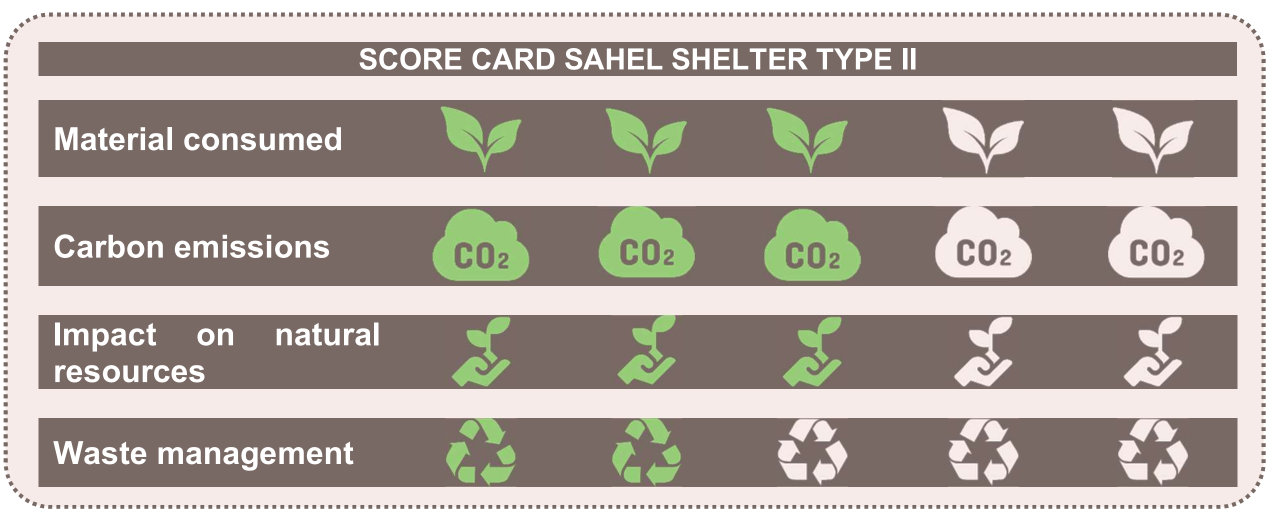
Summary of the environmental impact SAHEL SHELTER TYPE I		
Raw material used	Doum palm tree Water consumption	63 kilos 21,010 litres
Manmade material used in kg	Steel PVC Plastic Nylon	29.4 kilos 33 kilos 16.65 kilos 0.8 kilos
Carbon emissions in kg CO_2 eq	Production of material Packaging Transport End of life Total for shelter	86 *Data not considered* 51 75 **212**
Impact on natural resources	Deforestation and erosion due to the harvesting of natural or farmed vegetation (palm)	
Waste management	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 products.	



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

SAHEL SHELTER Type II

Summary of the environmental impact SAHEL SHELTER TYPE II		
Raw material used	Doum palm tree Water consumption	49.5 kilos 16,153 liters
Manmade material used in kg	Steel PVC Plastic Nylon	23.6 kilos 22.5 kilos 6.8 kilos 0.8 kilos
Carbon emissions in kg CO_2 eq	Production of material Packaging Transport End of life Total for shelter	54 *Data not considered* 37 56 **147**
Impact on natural resources	Deforestation and erosion due to the harvesting of natural or farmed vegetation (palm)	
Waste management	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 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 Burkina Faso 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 shelter models analysed have a lower impact on the local environment due to the small amount of natural resources used (a higher score in the score card), however on waste management they perform worse (a lower score for this criteria), due to the amount of plastic and steel material used. 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+[116], and following that identification of mitigation strategies, should accompany the design of all shelter and site planning activities.

Overall, both shelter models score better regarding the impact on local natural resources, and worse on waste management. They use more long-lasting materials that are unlikely to be recycled, and will take a very long time to decompose, polluting the environment for years to come, but on the other hand making the shelter more resistant with a longer life span. However, both shelters built require reconstruction after 12 months or less of use due to the harsh environmental factors and poor resilience of some of the materials. So, it is important to recognize that the longer a shelter lasts, the more efficient and cost effective it is[117].

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. "*The Sahel shelter models have been designed for populations of nomadic or semi-nomadic origin, which is very suitable for this target population in the Sahelian context; even for those who have settled down, the shelter remains a familiar and culturally accepted housing solution*"[118].

Keeping this in mind, mitigating actions can be taken to reduce the worst environmental impacts as follows:

(1) 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 plastics sheeting, PVC, and metal poles, however, this last material has a good likelihood of continual reuse.

116 *https://neatplus.org/*
117 *In the Shelter & Settlements Environmental Impact Report, Shelter Cluster Chad. February 2021, graph Cost vs Durability*
118 *Étude d'adaptation des abris de type Sahel Shelter. AI-CRL. 2019*

(2) To consider to use different materials, especially replacing the PVC and metal tubes which have the highest embodied CO_2 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) To considering to use a different local alternative to the doum palm such as Millet stalk mats (*nattes de tiges de mil)*. However, further study on the impact on the local environment and possible mitigation strategies should also be considered for these alternative materials.
(4) To reduce the emissions from transport. The highest impact came from the doum palm mats, because most of them come from Mali and Niger by road. Followed by metal tubes and PVC, since both come from Ghana and Ivory Coast. Any alternative sources which require less road transportation will reduce emissions.
(5) 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.
(6) To consider to use more long-lasting material for roofing, which would also be more likely to be reused. An example is metal sheeting for roofing instead of plastic sheeting, which lasts only one year.
(7) To consider to invest in purchasing carbon off-sets for the CO_2 eq. produced (following one of the many internationally recognised certification standards).

This study does not make a definitive recommendation of one shelter over the other. As explained under 8.5 above, to talk about a comparison between the two shelter models is not very meaningful, since they utilise the same design and materials, and only differ in size, quantity of materials, and sheltering capacity. Naturally, Type II has a lower environmental footprint, but only because it is smaller. In terms of the ratio of materials to capacity (people sheltered), Type I would have the smaller relative impact. However, regardless of which of the two sizes is used, by adopting some of these mitigating solutions in future, both shelters can incorporate the environmentally ‘best’ aspects in their designs.

10. Recommendations

Recommendations from the environmental analysis

A. Materials

1. Consider to avoid using PVC, since it is one of the most polluting materials and which has the highest embodied CO2 emissions. Same can be said under point “B” below.
2. To explore other local alternatives to the doum palm, like “millet stalk mats”. However, further study on the impact on the local environment and mitigation strategies should also be considered for these alternative materials.
3. Consider other alternatives to the plastic sheeting by using metal sheeting for roofing. However, further study on the impact on the environment and mitigation strategies should also be considered.

B. Reduce carbon emissions

1. Procure more “locally”. The highest impact from transport came from the doum palm mats, because most of them come from Mali and Niger. Followed by metal tubes and PVC, since both come from Ghana and Ivory Coast.
2. To consider to decrease the amount of materials if possible, specially metal and PVC, without compromising the quality and durability of the shelter.
3. Carbon offsetting: Another way to pursue carbon neutrality is to offset emissions generated by reducing them somewhere else, or by purchasing carbon credits[119] from a project that has been accredited by a recognised standard[120].
4. In case some families are burning the natural materials at their end of life: it is advisable to advocate with communities to avoid burning these materials once they are no longer needed, due to the amount of CO_2 eq

119 *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 CooKit Solar Cooker, which utilised carbon credits from saving CO2 emissions to facilitate expansion of the programme https://www.fairclimatefund.nl/en/projects/chad-solar-cookers-for-refugee-families*
120 *European Parliament*

that is released during this process, by promoting composting or natural decomposition. This could be difficult to implement in a country like Burkina Faso, where families often rely on burning organic matter for cooking fuel. This can be partially addressed by integrating some activities on household energy into the shelter project (see point E below).

C. Waste management practices

1. Raising awareness of environmental sanitation and the pollution generated by the disposal of the materials, though 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 to unlock value in waste (see #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 (natural materials) into compost. Other things, like plastic sheeting can be transformed into bags, coats, etc.[121].
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 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.
9. Promote composting of the palm-doum mats, consider to use the compost in urban gardens or household 'kitchen gardens', or transform them into "green charcoal"[122]

D. Protecting / restoring local eco-systems

1. To 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. 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 Burkina Faso. 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 Burkina Faso 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. There are many remnant tree plots across West Africa which fall into this "not ours" category. Also note that field research in the 1980s in West Africa demonstrated that household tree planting was much more successful than village forests.
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*[123] approach.

E. Household energy and cooking stoves

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121 *recycling_reuse_and_disposal_of_plastic_sheeting.pdf (sheltercluster.org)*
122 *The associations "Africa Ecologie" produced "green charcoal". However some considerations should be taken into account. Practicality, acceptability and cost. Here is a guidance of producing "green carbon" https://fscluster.org/sites/default/files/documents/fuel_efficiency_strategy.pdf*
123 *(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-in-barrel approach is that all the materials needed, knowledge of what to grow and seeds or cuttings are available in Burkina Faso. It is the kind of thing where you get 10 families doing it and others will figure it out.*

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 or other biomass. It will reduce the dependency on firewood and take pressure off of 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 (e.g., gas). 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[124]; 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 a lot 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 for distribution.
4. A link to livelihoods is often encouraged – where people can be trained to manufacture fuel-efficient cookstoves locally, as a livelihood. However, there are many examples in Africa where this has not been very successful nor sustained beyond the project's life.
5. UNHCR's Cooking Options in Refugee Situations Handbook[125] particularly Annex A, shows a cooking energy checklist, which highlights some of the key considerations for practitioners looking to implement cooking-related programmes.

F. Others

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

General recommendations to consider for future programmes

G. 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.

H. Materials

1. To encourage the use of construction materials of an appropriate quality and which consider climate, culture, durability, local supply and environmental impact[126]. 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[127]. Local procurement is often, but not always, more sustainable, so careful analysis is needed.
3. Use long lasting products and materials, to minimize the replacement and allow a second life through reuse.

I. Reduce carbon emissions

1. Procurement choices:
    - 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.

124 Standardizing the Performance of Clean Cooking Solutions, Clean Cooking Alliance, Clean Cooking Catalogue https://cleancooking.org/research-evidence-learning/standards-testing/
125 https://www.unhcr.org/uk/protection/environment/406c368f2/handbook-experiences-energy-conservation-alternative-fuels-cooking-options.html.
126 Further information can be found at QSAND manual MW01 Material Properties / Specifications
127 Further information can be found at QSAND manual MW02 Material sourcing

- Ensure that acquired products were manufactured under acceptable conditions in terms of environmental compliance.
- Purchase locally produced shelter materials, if acceptable quality can be guaranteed.

2. Transportation routes.
   - Optimize the logistics supply chain to reduce the carbon emissions from transport.
   - Reduce weight and volume, noting that packaging can be relevant here also.
   - 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:
   - 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. The carbon emitted by the felled trees will be sequestered by the growing trees, hence use of sustainably sourced timber can potentially be carbon neutral or even carbon negative (D'Arrigo et al. 1987). 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 natural 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.

J. 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.[128] Even segregating waste into organic, non-organic and recyclable, can be a big improvement.
3. No single-use plastic wrapping or packaging on any materials, work with suppliers to eliminate this. Reduce other types of packaging as much as possible.

K. 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[129]. 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[130].

L. Others

To consider to do an environmental impact assessment or at least environmental screening using a tool such as the NEAT+[131], during the design of all shelter and site planning activities.

128 *Further information can be found at QSAND manual MW05 Operational Waste Management*
129 *Further information can be found at QSAND manual NE01 Human Relationships to Ecological Services*
130 *Further information can be found at QSAND manual NE03 Ecological Restoration and Rehabilitation*
131 *https://neatplus.org/*

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12. Annexed documents

ANNEX 1 – Term of Reference

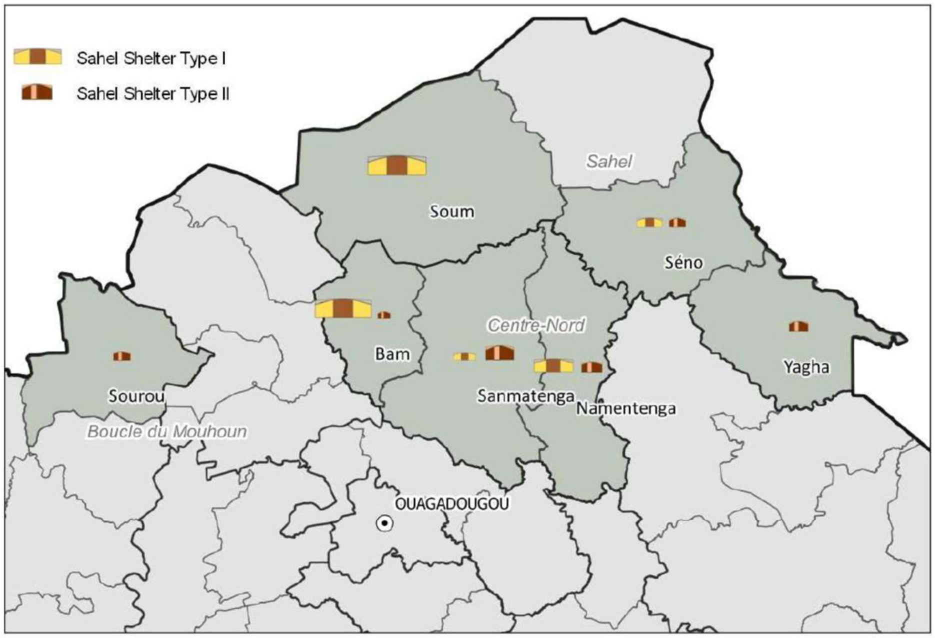
TdR étude comparative de l'impact environnemental des modèles d'abris au Burkina Faso

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 adaptès 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 Burkina Faso, l'AICRL et la Croix-Rouge Burkinabè ont réalisé 2 modèles d'abris. Le premier modèle d'abri construit au Burkina Faso est le **Sahel Shelter Type I**, de 21m^2, avec une capacité maximale de 6 personnes construit avec des tubes métalliques et tubes de PVC, une géométrie en forme de dôme, avec des bâches en plastique, et nattes végétales. Le deuxième modèle d'abri est le **Sahel Shelter Type II** de 14m^2 , capacité pour hébergé 4 personnes et des matériaux similaires à ceux du modèle précédent

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.

L'AICRL a participé à l'installation de plus de 4700 abris depuis 2018, 62% de Type I et 38% de type II. C'est à partir de 2021 que le type I a été complètement remplacé par le type II car il est mieux adapté aux besoins exprimés par les bénéficiaires. Les activités ont eu lieu zones frontalières avec le Mali et le Niger, dans le nord du pays, dans les communes de Centre-Nord (58%), Sahel (37%) et Boucle de Mouhoun (5%)



Region	Commune	Ville	Sahel Shelter **Type I** (21m²) 2018	2019	2020	2021	TOTAL 2944
Centre-Nord	Bam	Bourzanga	200	514	300		1014
Centre-Nord	Namentenga	Bouroum			300		300
Centre-Nord	Namentenga	Tougouri			260		260
Centre-Nord	Sanmatenga	Kaya			100		100
Sahel	Séno	Dori			200		200
Sahel	Soum	Djibo	200	300	570		1070

Region	Commune	Ville	Sahel Shelter **Type II** (14m²) 2018	2019	2020	2021	TOTAL 1777
Boucle du Mo	Sourou	Tougan				225	225
Centre-Nord	Bam	Bourzanga				30	30
Centre-Nord	Namentenga	Bouroum				362	362
Centre-Nord	Sanmatenga	Pensa				660	660
Sahel	Yagha	Sebba				300	300
Sahel	Séno	Gorgadji				200	200

En 2021 l'AICRL a mené une étude équivalente pour le Niger dont les résultats sont disponibles. La même analyse est en cours au Tchad (résultat bientôt disponible) 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 Burkina Faso. Cette étude individuelle (Burkina Faso) 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
- Une étude portant notamment sur l'utilisation de la bâche en plastique et son impact sur l'environnement ainsi que sur les alternatives possibles si pertinent.

Produit et format a livrée

- Rapport d'Etude.
- Format prédéfini.
- Taille a4.
- Langue française et anglais.

Approche méthodologique

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 l'étude 2022 au Tchad. 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 Burkina Faso, 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.
  - La durabilité des sources des ressources naturelles utilisées
  - 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, tissues, matériaux naturels)
  - 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.

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.

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 Burkina Faso, etc.).

Agenda calendrier et activités

La date limite pour présenter les résultats de l'étude est le 25 mai 2022

	Semaines				
	S1	S2	S3	S4	Total
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

Budget

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

ANNEX 2 – Informants

International Aid of Luxemburg Red Cross

- Haphane Serge CISSE, Chef des projets Urgences /Croix-Rouge Burkinabè
- Karim SANKARA, Suivi-Evaluateur et Reporting des Projets Urgences/Croix-Rouge Burkinabè
- Dr. LIGBAN Raymond, Chef de Mission Burkina Faso - Aide Internationale de la Croix-Rouge Luxembourgeoise
- Leandro FERNANDEZ-JARDON, Délégué Régional Habitat Humanitaire

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, Consultant SMAC et responsable du programme QSAND.

Shelter Cluster Burkina Faso

- ABDELSADICK Youssouf Ahmat, Associate Shelter Cluster Coordination Officer
- Brice DEGLA, Coordonnateur du Cluster Abri au Burkina Faso

Global Shelter Cluster

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

Other person contacted:

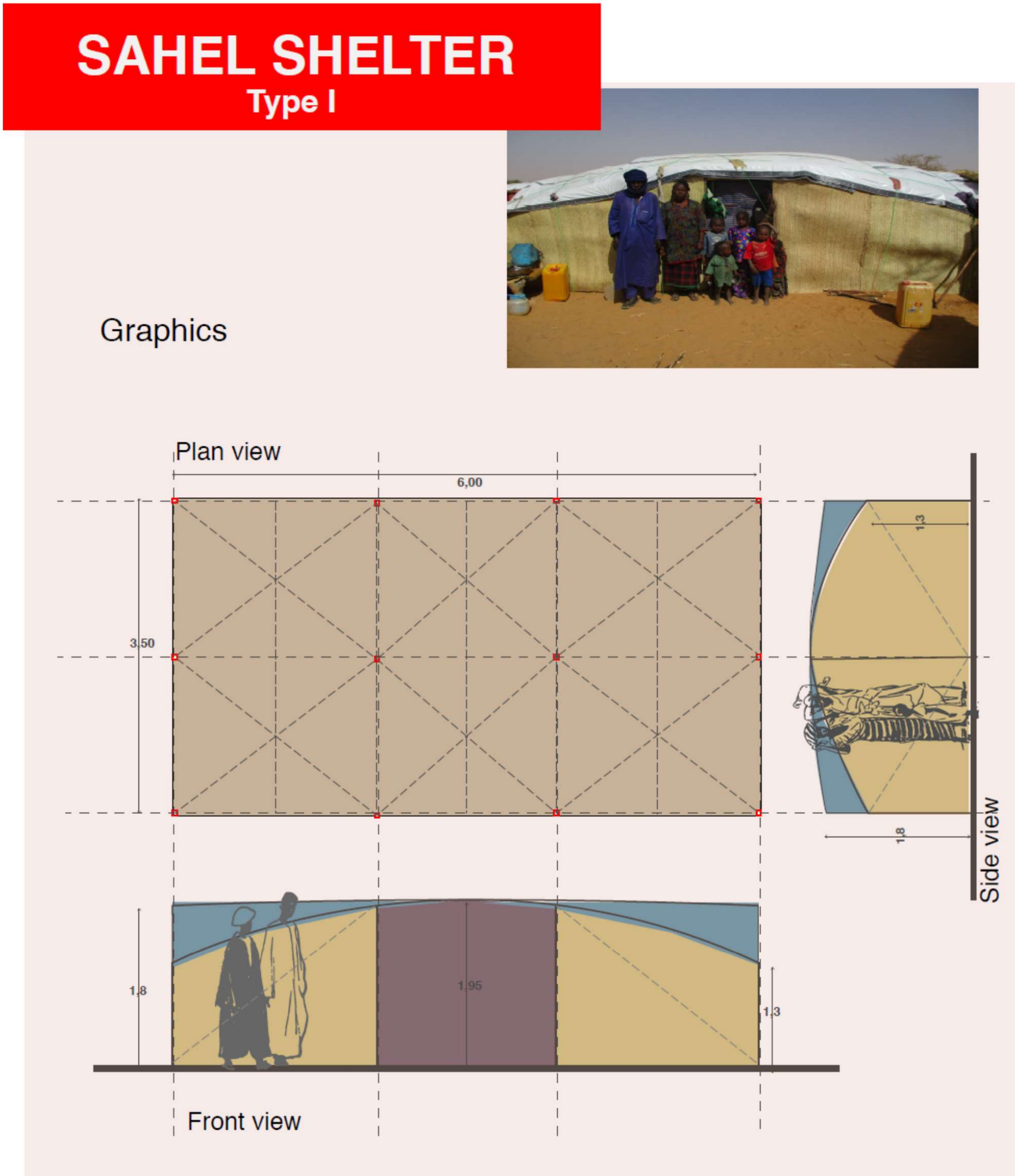
- Samantha brangeon. Consultant- JI Sustainable Humanitarian Packaging Waste Management

Other organisation contacted:

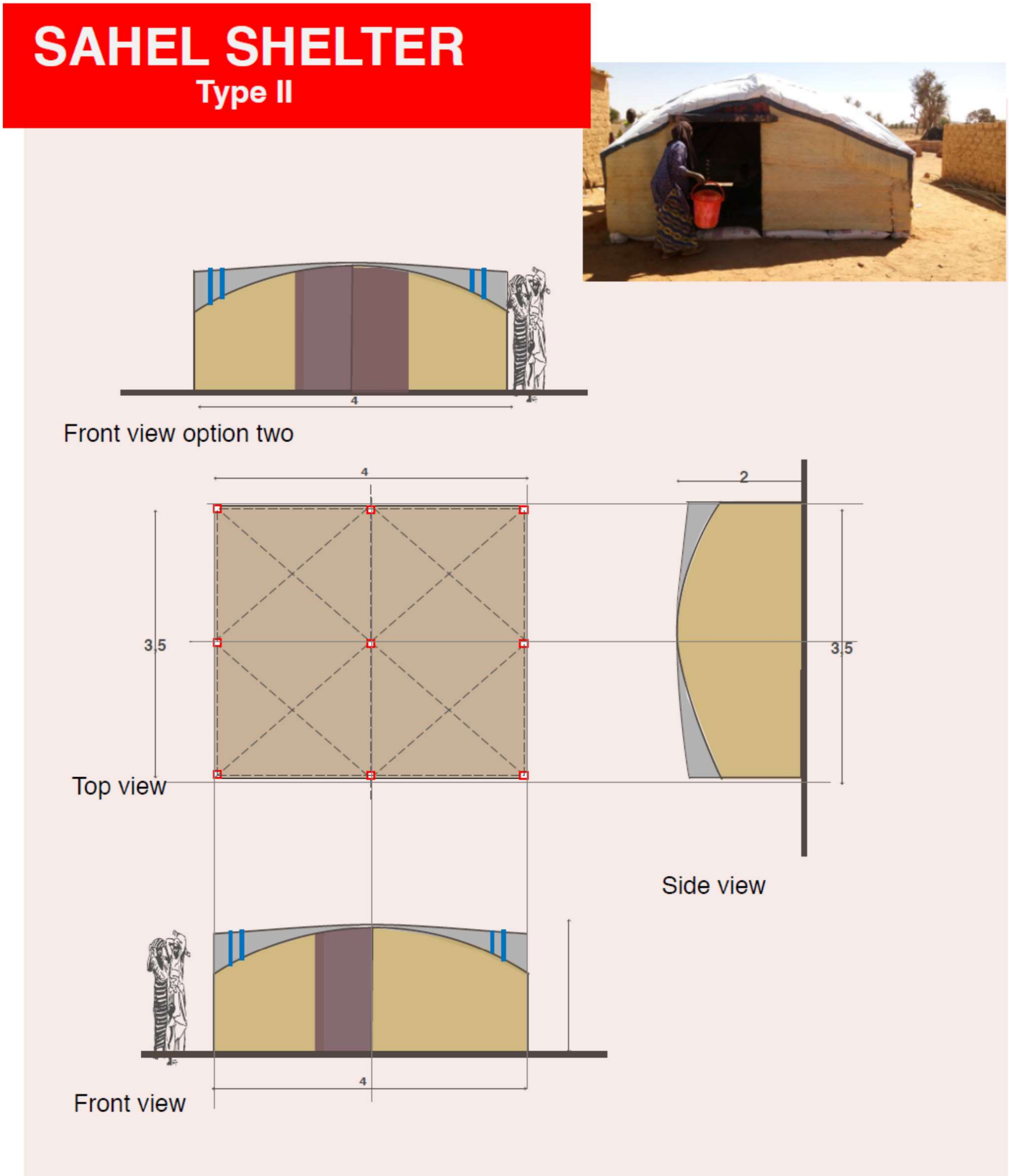
- Africa Ecologie: Azize Diloma HEMA. Association is a waste sorting and recovery centre with other partner associations
- KITA Entreprise
- Soburec SARL
- TECO^2

ANNEX 3 – Shelter Models Technical Information

SAHEL SHELTER I



SAHEL SHELTER II



ANNEX 4- Shelter components material, packaging, quantity and country of origin[132]

Sahel Shelter Type I model

Name	Raw material	Quantity/ Kg	Country of origin	Packeting
Steel poles	Steel	26.4	Ghana	None
PVC poles	PVC	33	Ivory Coast	Polyethylene
Plant mats	Palm doum	63	Burkina Faso (15%) Mali (40%) Niger (45%)	Polyethylene
Plastic sheeting	Polyethylene	9	China	Polyethylene
Plastic mats	Polyethylene	7.2	Ivory Coast	Polyethylene
Synthetic rope	Nylon	0.8	China	Polyethylene
Wire	Iron	3	Burkina Faso	Polyethylene
Sewing thread	Polyethylene	0.45	China	Polyethylene

Sahel Shelter Type II model

Name	Raw material	Quantity/ Kg	Country of origin	Packeting
Steel poles	Steel	22.05	Ghana	None
PVC poles	PVC	22.5	Ivory Coast	Polyethylene
Plant mats	Palm doum	49.5	Burkina Faso (15%) Mali (40%) Niger (45%)	Polyethylene
Plastic sheeting	Polyethylene	4.5	China	Polyethylene
Plastic mats	Polyethylene	1.8	Ivory Coast	Polyethylene
Synthetic rope	Nylon	0.8	China	Polyethylene
Wire	Iron	1.5	Burkina Faso	Polyethylene
Sewing thread	Polyethylene	0.45	China	Polyethylene

132 *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	Ivory Coast - Port Abidjan	19000 km[133]

Distance by road

Departing point	Arrival point	Distance
Ivory Coast (Abidjan)	Ouagadougou	1154 km
Ghana	Ouagadougou	996 km
Mali	Ouagadougou	900 km
Niger	Ouagadougou	513 km

Origin to point to Warehouse (km)

Area	Location warehouse	Distance
Dédougou	Ouagadougou	233 km
Léo	Ouagadougou	168 km

ICRC warehouse to IALRC warehouse (km)

Area	Location warehouse	Distance
Ouagadougou (Warehouse ICRC)	Ouagadougou (Warehouse IALRC)	7 km

Point of Arrival (Warehouse) to Construction Site (km)

Departing point	Arrival point	Distance
Ouagadougou	Bouroum	188 km
Ouagadougou	Pensa	161 km
Ouagadougou	Barao	233 km
Ouagadougou	Tougouri	168 km
Ouagadougou	Bourzanga	157 km
Ouagadougou	Kaya	105 km
Ouagadougou	Djibo	210 km
Ouagadougou	Gorgadji	326 km
Ouagadougou	Dori	268 km
Ouagadougou	Sebba	363 km
Ouagadougou	Tougan	236 km
Ouagadougou	Ouaihigouya	236 km
Ouagadougou	Silmagué	233 km

133 *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.*

ANNEX 6 - Examples of materials reused

Materials reused for latrines

PVC

Palm doum mats

Materials reused as a door

Palm doum mats

PVC

Shade structures

steel pole

PVC