

WaterWise Dwelling



SAHEL REGION

The Sahel region of Africa is a transitional ecological and geographical zone stretching across North Africa, from the Atlantic Ocean in the west to the Red Sea in the east. The name "Sahel" means "coastal belt" or "edge" in Arabic, highlighting its position between the Sahara Desert to the north and the Sudanese savannah to the south. **The Sahel region, with its harsh environment and dynamic social structures, is one of Africa's most challenging areas.**

GEOGRAPHICAL FEATURES:

Location: The Sahel stretches through parts of Senegal, Mauritania, Mali, Burkina Faso, Niger, Nigeria, Chad, Sudan, and Eritrea.

Climate: The Sahel area is characterized by a semi-desert climate with highly seasonal rainfall. The rainy season lasts from June to September, while the rest of the year is dry.

SOCIAL AND ECONOMIC FEATURES:

Population: The Sahel is home to diverse ethnic groups, including the Fulani, Hausa, and Tuareg. The population primarily engages in animal husbandry and agriculture, relying on seasonal rains.

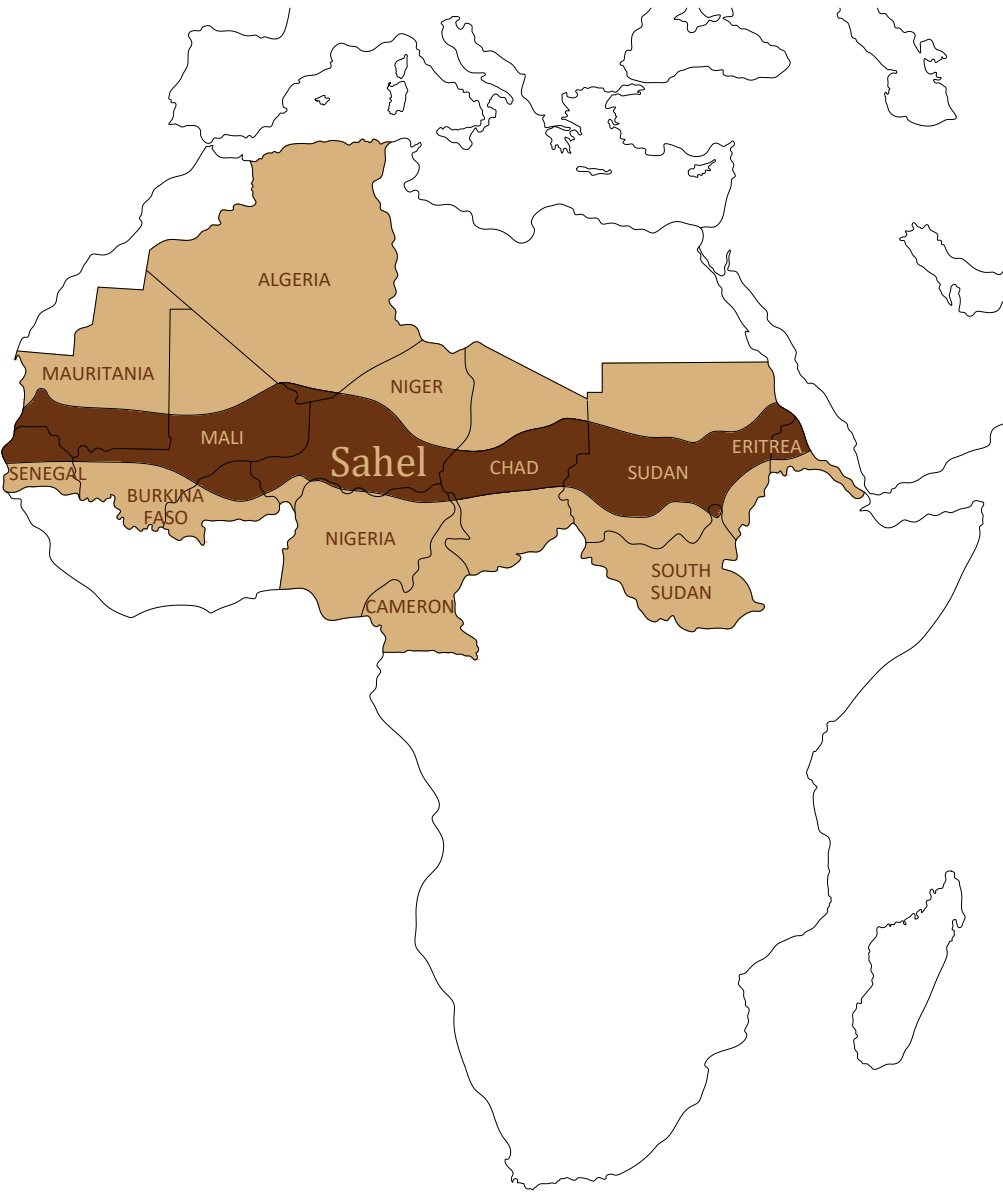
Economy: The Sahel's economy is primarily agricultural, but frequent droughts, land degradation, and political instability pose significant challenges. Nomadic lifestyles remain traditional in many areas.

Religious practices: Islam dominates daily life in the Sahel, shaping social norms, rituals, and governance.

CULTURAL ASPECTS:

Traditional way of life: Many Sahelians practice traditional ways of life, including nomadic pastoralism and agriculture.

Culture and Customs: The Sahel has a rich cultural tradition of music, dance, and festivals.



MODULAR VILLAGE

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Considering this, both the village and the houses themselves are modular and can be arranged in various ways, as a terraced house or a detached house, without or with an inner yard. This design maximizes flexibility in settlement planning and construction.

SOCIAL AWARENESS AND EDUCATIONAL INSTITUTIONS:

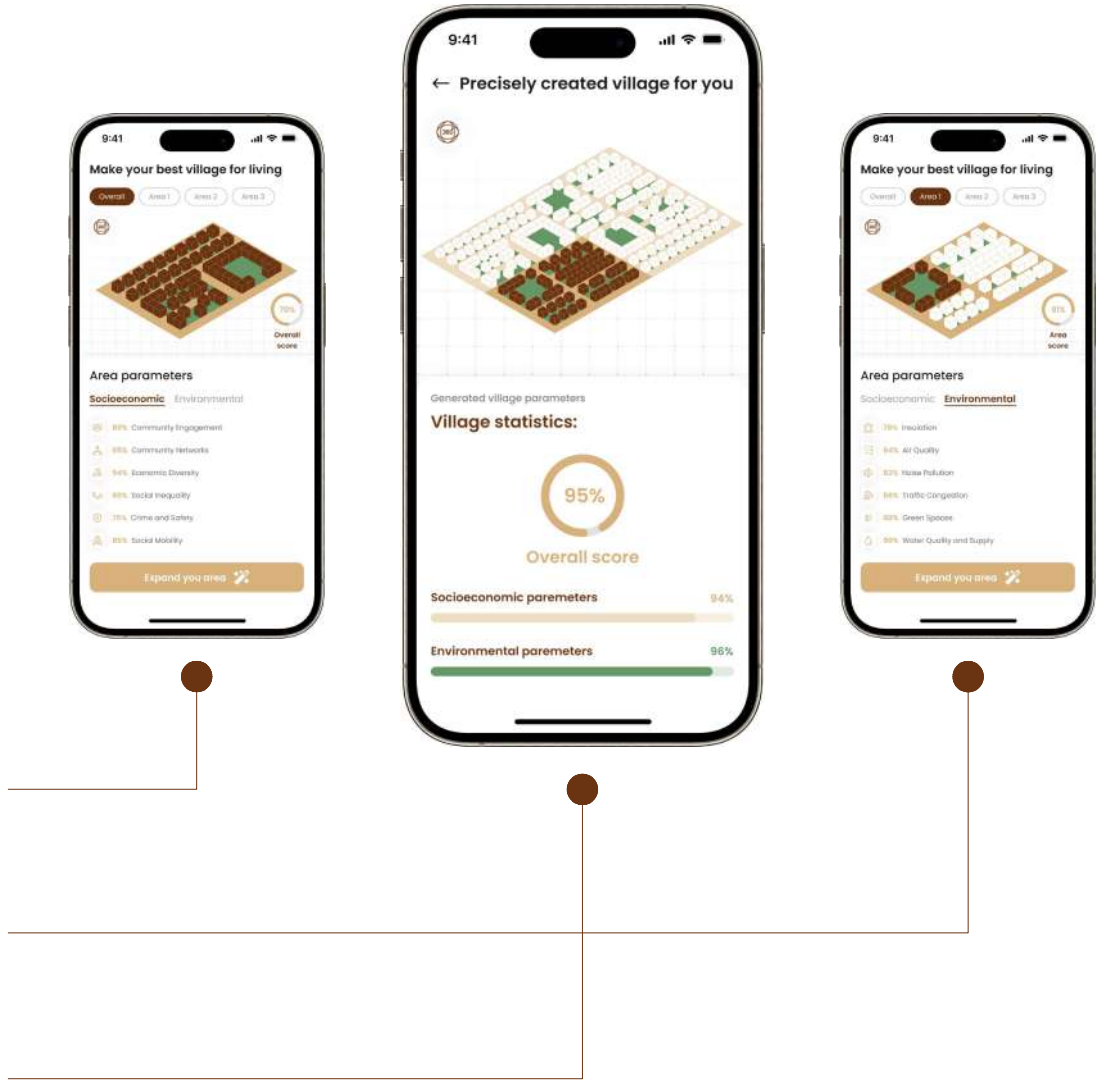
In the Sahel region, where settlements lack organized urban structures, there's an emerging concept: engaging every individual and educational institution in the planning process through an application. This innovative tool generates settlements based on parameters analyzed as percentages, fostering a collaborative approach to community development and urban planning.

"A COLLABORATIVE PLANNING APP"

Socioeconomic and Cultural Parameters: The application analyzes: community engagement, networks, economic diversity, social inequality, crime and safety, and social mobility. This guides interventions for community cohesion, equity, and opportunities.

Physical and Environmental Parameters: Beside socioeconomic and cultural parameters the application analyzes: insulation, air quality, noise pollution, traffic congestion, green spaces, water quality and supply.

AI generative tool: The application can use AI to generate the entire village based on the selected area.



MODULAR FURNITURE DESIGN

INDOOR FURNITURE

In Sahelian communities where a nomadic lifestyle is common, it's important to design spaces that can be versatile and adaptable to accommodate the various needs and activities of the residents. Nomadic lifestyles often involve a constant movement between different locations, and the design of living spaces should be flexible to cater to the changing requirements.

MODULAR FURNITURE:

Modular, lightweight furniture made from locally available acacia wood is used. It can be easily assembled, disassembled, and rearranged, allowing for quick and efficient space transformation based on current needs.

PORTABLE ELEMENTS:

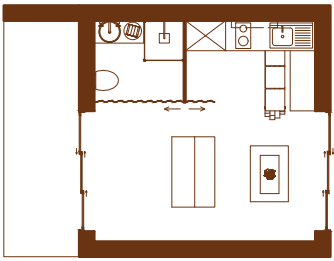
Foldable tables, chairs, shelves and other furniture items are incorporated, designed for easy collapse and transport. This simplifies carrying essentials for nomadic communities during migrations. Hidden desk bed and sofa efficiently optimizes space.

MOBILE SHELving AND STORAGE:

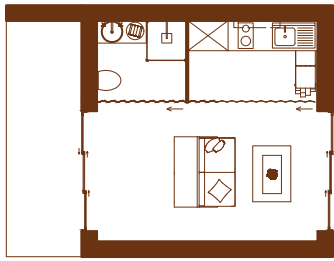
The number of furniture elements has been efficiently optimized by removing unnecessary parts like fronts and shelves. This streamlines organization and makes it easier for nomadic households to pack and unpack quickly.

MODULARITY OF SPACE

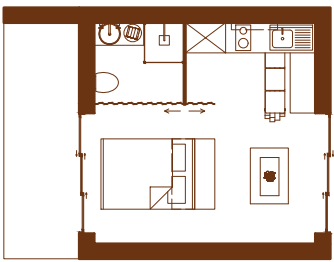
1.VARIATION



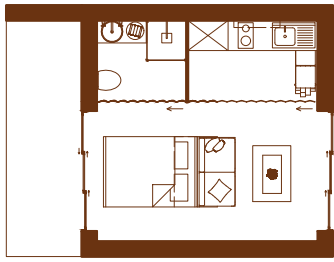
2.VARIATION



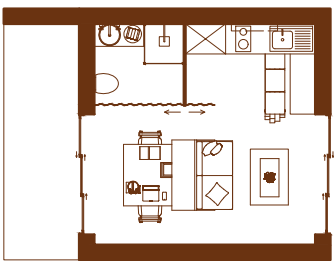
3.VARIATION



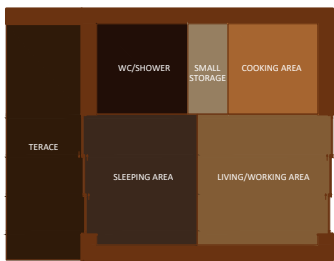
4.VARIATION



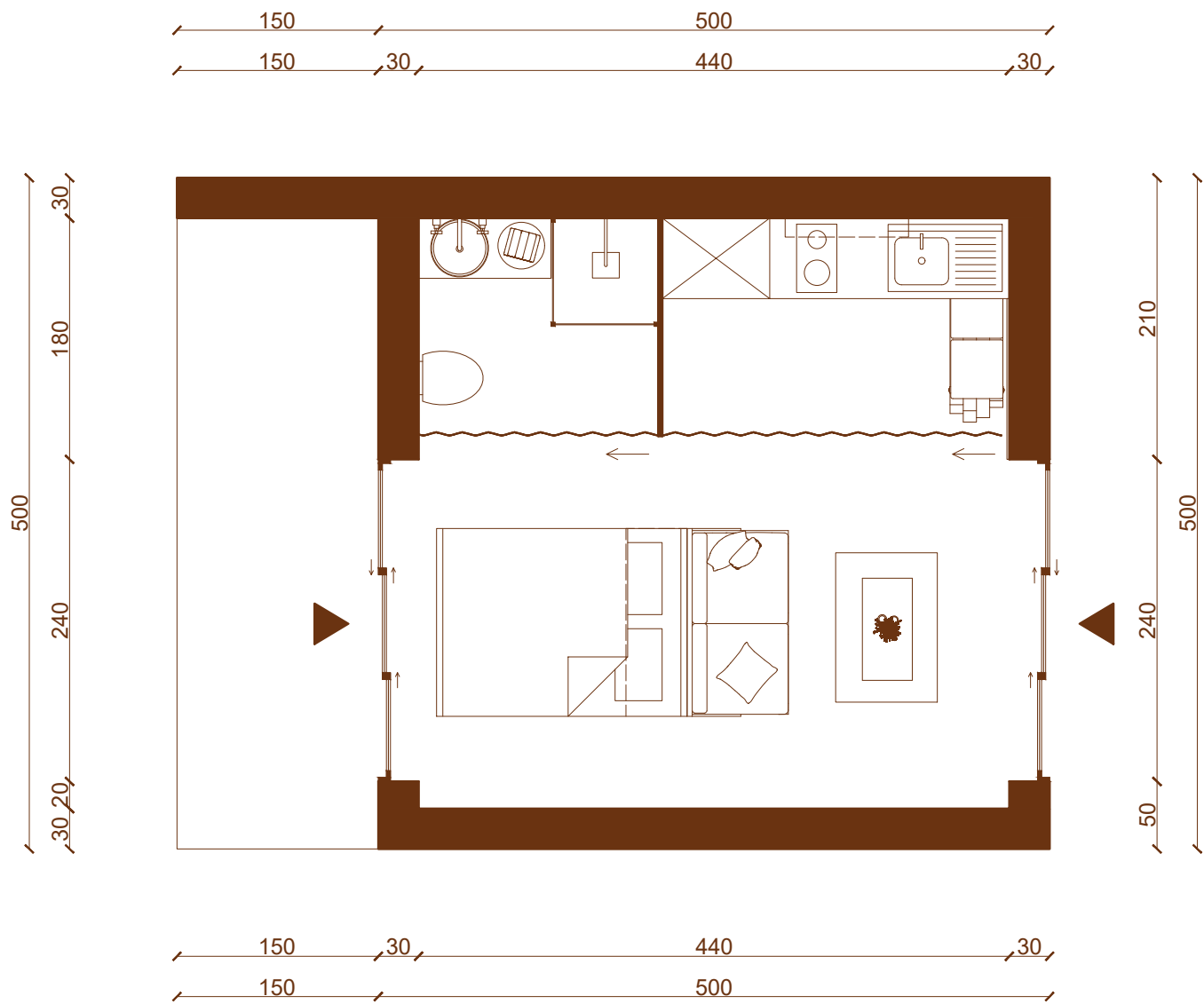
5.VARIATION



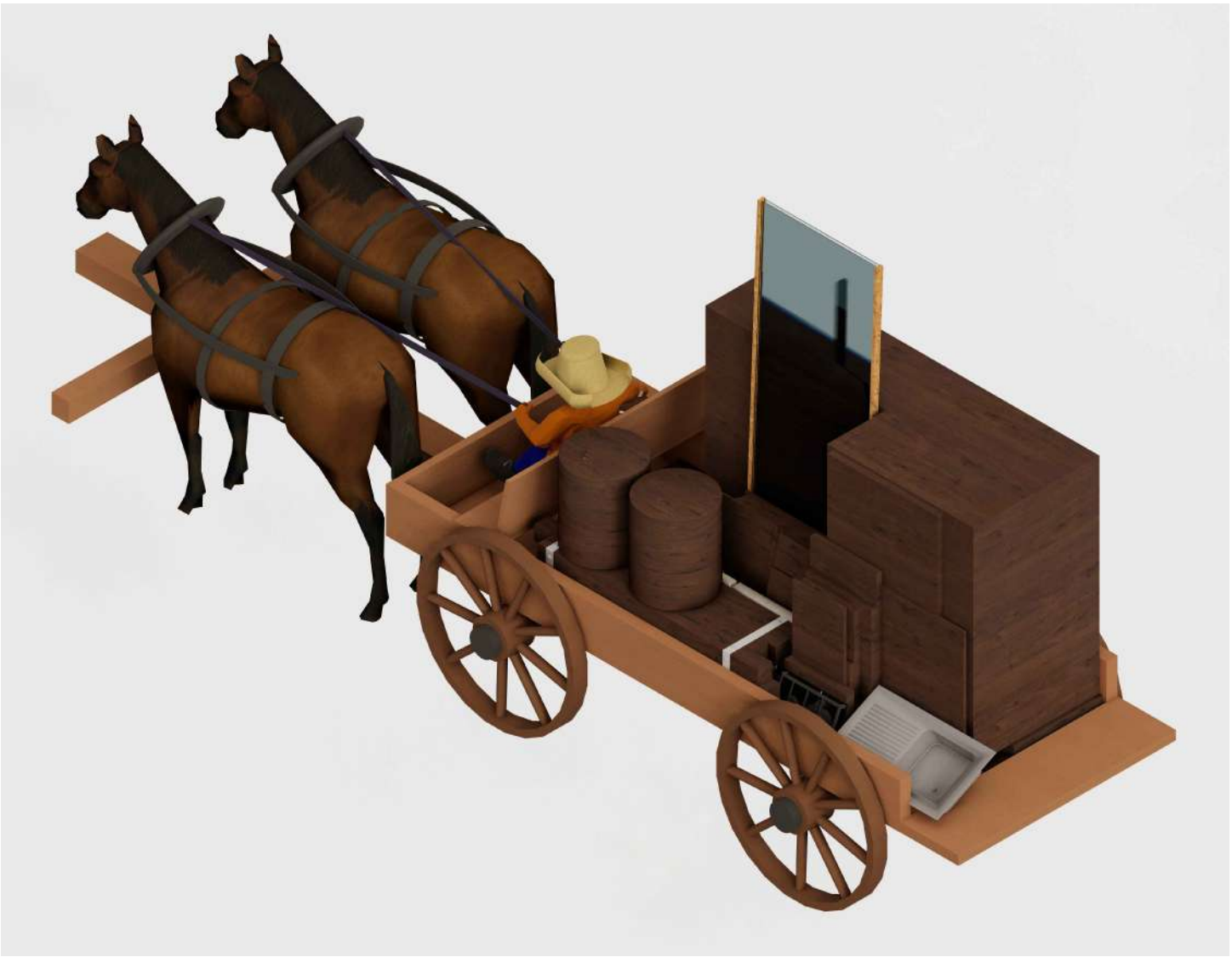
ZONING



GROUND FLOOR PLAN 1:50



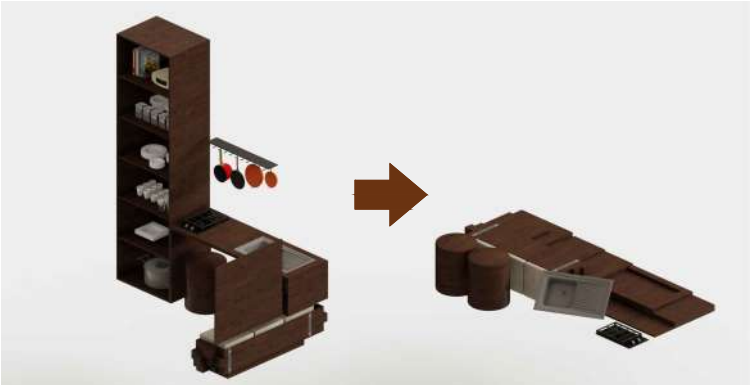
TRANSPORTATION



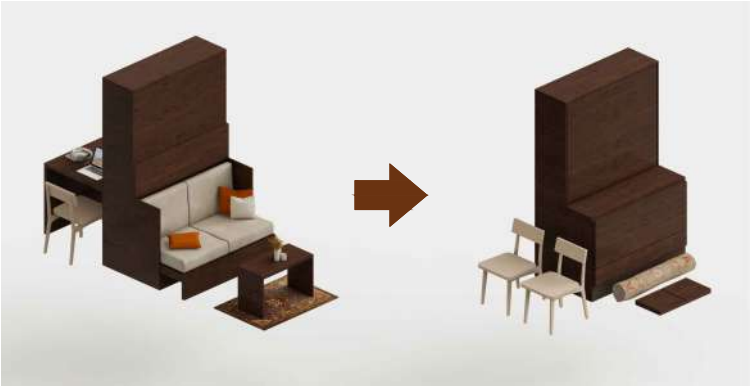
FURNITURE

ASSEMBLED AND DISASSEMBLED

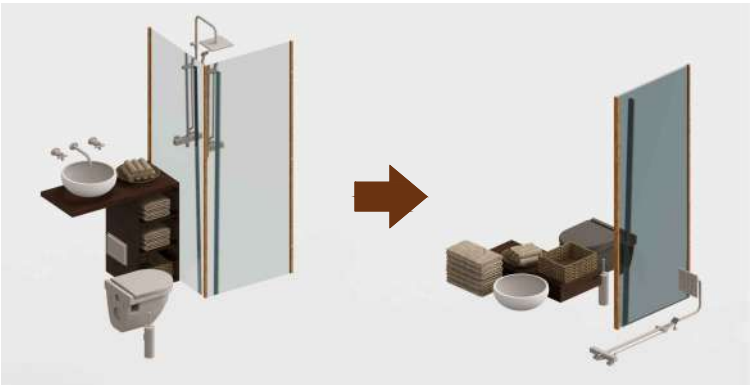
COOKING AREA + SMALL STORAGE



LIVING/WORKING AREA



WC/SHOWER



CONSTRUCTION

1. GROUND PREPARATION:

First the location is determined, and then the ground is prepared. Obstacles are removed, the terrain is leveled and the shape is established with stakes and ropes, followed by the digging of a trench for the foundation pit for strip foundations.

2. FOUNDATION:

The first layer of the base is made of fine stone, which has several important functions: drainage, leveling of the base and formation of a solid and stable base for the rest of the structure.

A stone foundation has been laid, which provides a solid foundation for construction. They are made using the traditional technique as dry stone foundations, where the stones are placed and fitted on top of each other while the joints are filled with finer stones and sand. The stone material used is **Laterite**, available in the Sahel region. The upper surface of the foundation is also leveled with a layer of sand and prepared for further structural elements.

3. WALL CONSTRUCTION:

The walls are constructed using the Superadobe technique, developed by Iranian architect Nader Khalili in the 1980s and 1990s for an affordable, sustainable, and earthquake-resistant building method. This technique involves stacking polypropylene or similar sacks filled with earth. The sacks are layered to form the walls, with wire or twine added between layers for extra strength. Each layer is then compressed with a roller to ensure a solid, stable structure.

4. STABILITY:

Superadobe constructions are known for their resistance to earthquakes, fires and extreme weather conditions, as well as their sustainability and environmental friendliness.

In order for the connection of the first row of sacks with the foundation to be secured and stable, anchors made of bamboo or palm leaves are used, depending on the availability of the material. These anchors are placed in the foundation during construction and pass through the first row of bags. Further, the sacks are placed in a staggered arrangement compared to the previous row.

5. FACADE AND OPENINGS:

The door openings are formed with the help of wooden formwork and have a wooden lintel.

The sack walls are further coated with clay to form a smooth facade, protect the sacks and further strengthen the structure.

6. FLOOR:

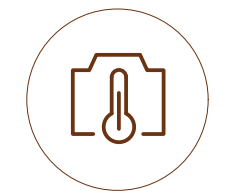
The floor is constructed from a mix of earth, sand, and straw. Once shaped, this mixture is compressed and leveled to create a firm, stable walking surface. Earthen floors are environmentally sustainable, made from readily available materials, and offer excellent thermal mass, helping maintain a stable indoor temperature.

6. ROOF:

Wooden rafters and crossbars are placed on the roof, and the covering of the roof structure is made of reeds. The reeds are placed from the end of the roof to the top on a pre-prepared wooden base, and one end of the reed is overlapped with the next, which is done to prevent water leakage. Reed has natural insulating properties that can help retain temperature and contribute to the building's energy efficiency.



NATURAL
INSULATION OF
WOOD



HIGH THERMAL
MASS OF
STONE



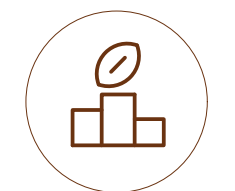
THERMAL
EFFICIENCY OF
SUPERADOBE



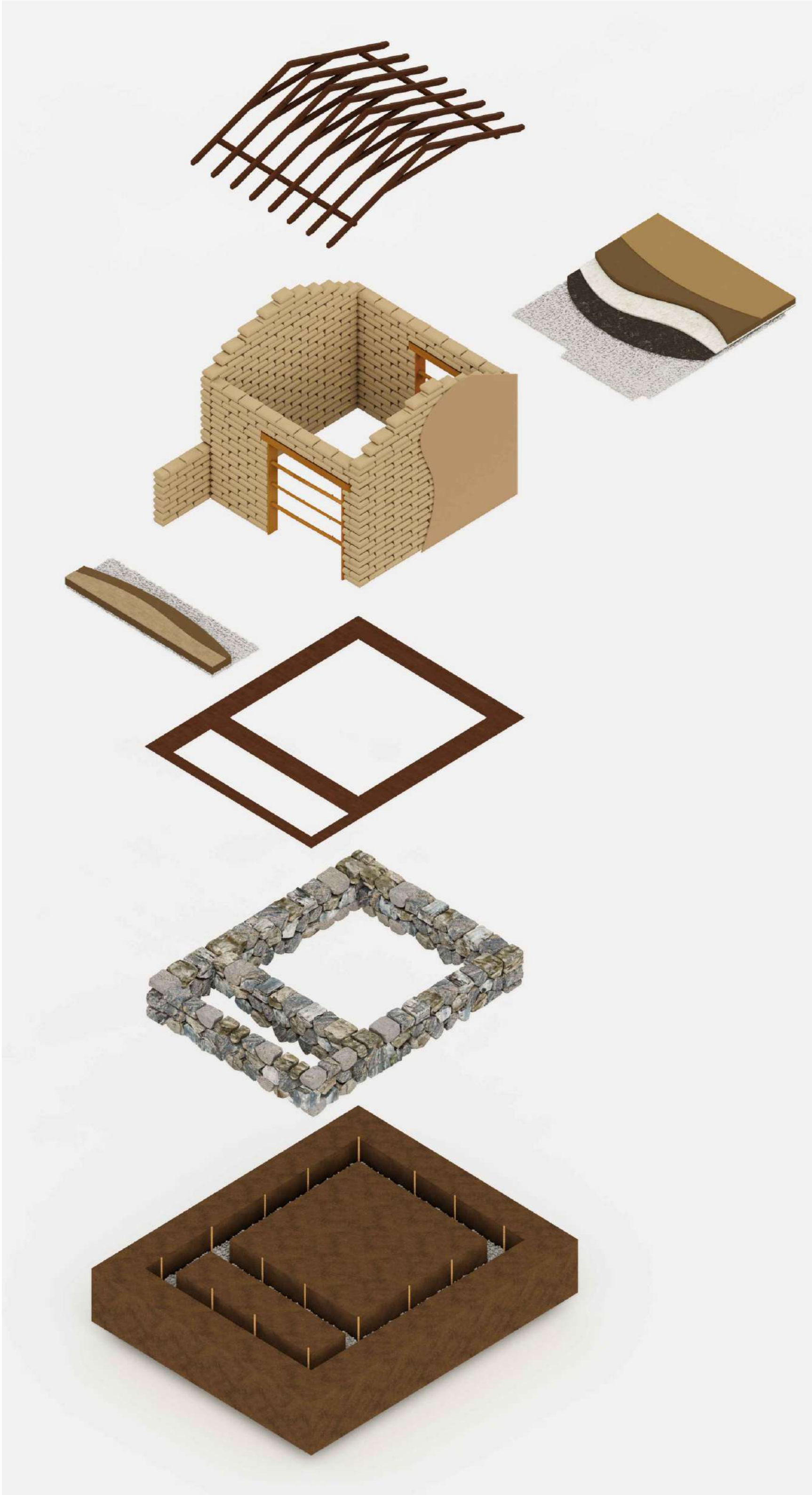
MOISTURE
REGULATION
OF REED



LOCAL
AVAILABILITY
OF SAND



SUSTAINABILITY
OF MUD



LOAD ANALYSIS

Characteristic loads for the Sahel region include extreme temperature fluctuations, high wind speeds, seismic activity, and intense rainfall. Temperature variations between day and night cause expansion and contraction in building materials, requiring flexible construction techniques. High winds demand robust structural design to ensure stability and safety. Intense, short-duration rainfall during the rainy season necessitates efficient roof and drainage systems to prevent water damage.

Self-weight load:

GROUND - $E=0.6\text{GPa}$, $\rho=1800\text{ kg/m}^3$
REED - $E=3\text{GPa}$, $\rho=400\text{ kg/m}^3$

Additional dead load:

ROOF - 1.50 kN/m^2

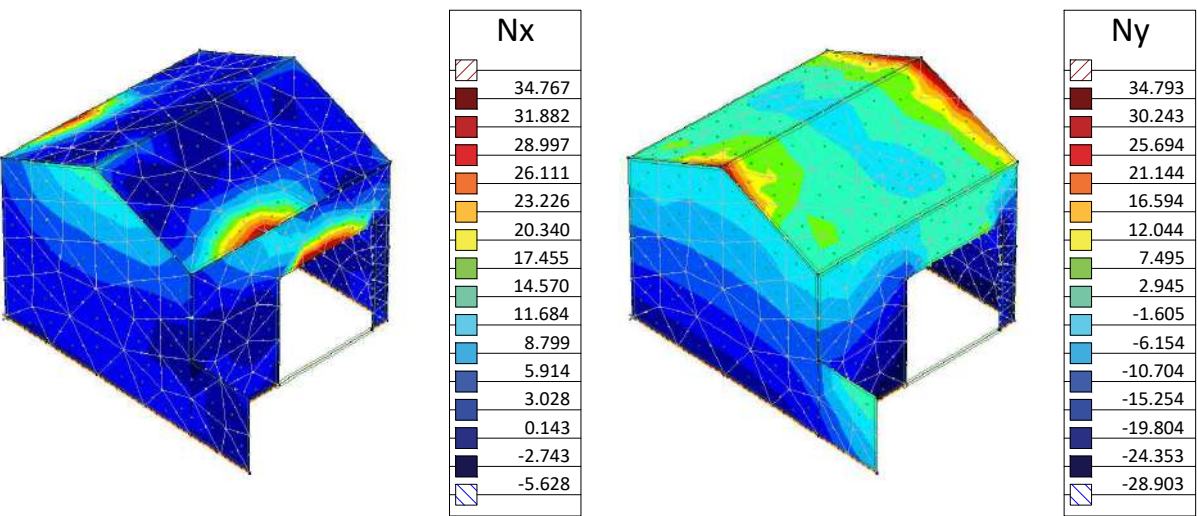
Live load:

ROOF - 1.50 kN/m^2

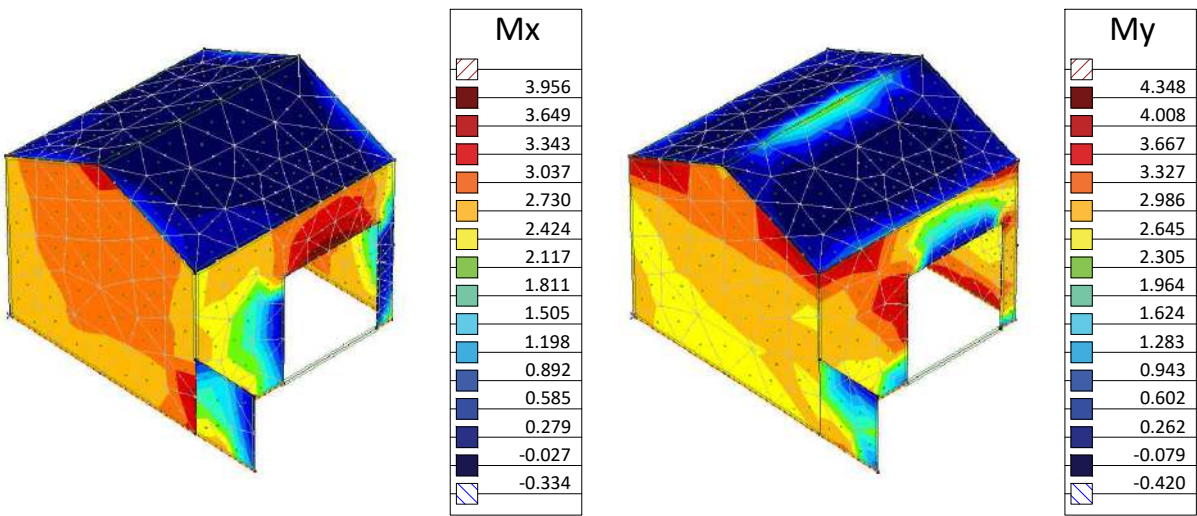
Temperature difference:

$\Delta t=40^\circ\text{C}$

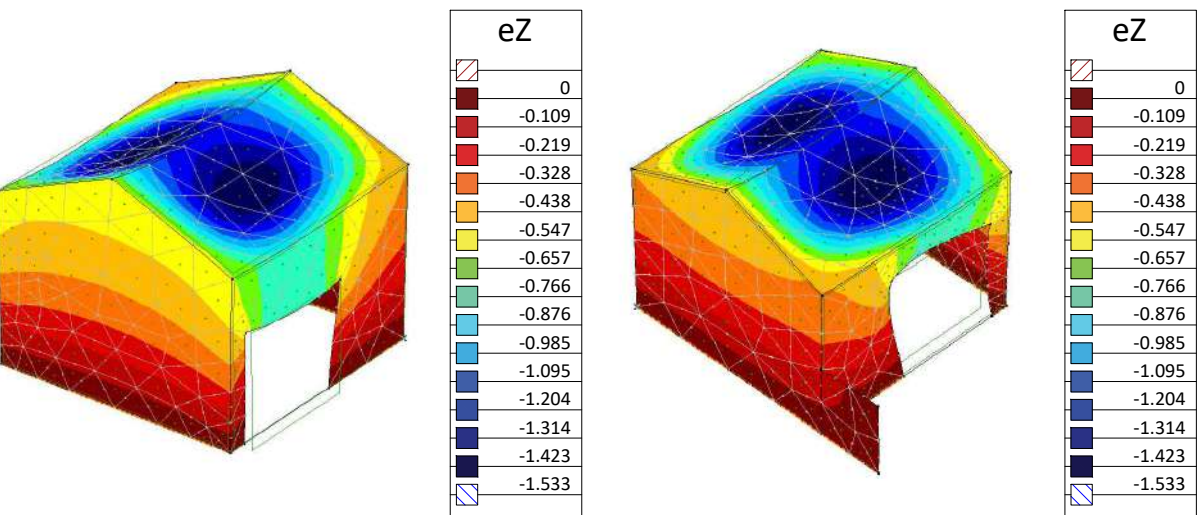
Nx and Ny - AXIAL FORCES FOR X AND Y DIRECTION OF PLATE ELEMENT:



Mx and My - BENDING MOMENTS ABOUT THE X AND Y AXES OF PLATE ELEMENT



Ez - VERTICAL DEFLECTIONS:



KINGSPAN MATERIAL

WATER REUSE

The Sahel region faces severe water challenges due to extreme climatic variations, prolonged dry periods, and brief rainy seasons. This affects agriculture, livestock, and basic drinking and sanitation needs. A rapidly growing population and climate change worsen the situation by reducing rainfall and increasing droughts. Sustainable water management is vital for the region's stability and living conditions. **Therefore, our self-sustaining house recycles all water, from wastewater to rainwater, ensuring efficient use of every drop, conserving resources, and protecting the environment.**

1. RAINWATER HARVESTING:

Permeable surfaces: Finely processed sandstone is a durable, natural choice for paving, offering excellent drainage. Rainwater infiltration is efficiently managed through collectors, directing it to reservoirs situated beneath the floor slab.

Rainwater Harvesting URBAN SLIMLINE WATER TANK: It collects rainwater from rooftops via gutters, storing it for future non-potable use, reducing dependence on mains water and aiding urban water conservation.

2. GROUNDWATER COLLECTION:

Acacia senegal wood: Strategically planted throughout, Acacia senegal wood is the predominant choice for groundwater collection in the Sahel region due to its deep root system, aiding in water retention and aquifer replenishment in arid conditions.

3. WASTEWATER:

Greywater recycling: A reservoir and graywater purification system under the kitchen area provide affordable irrigation water for agriculture in the Sahel, where advanced purification for drinking water is costly, given the region's focus on agriculture.

Blackwater recycling: Due to its high cost, recycling blackwater for reuse is impractical in impoverished areas. Instead, it's repurposed for biogas production, yielding fertilizer for plants as a byproduct, as detailed in the subsequent text.

BIOGAS SYSTEM & PRODUCTION SYSTEM

A biogas system is an advanced technology that converts organic waste, **from blackwater**, into biogas, primarily methane, which can be used for cooking, lighting, and electricity generation. This system has proven especially valuable in poor rural areas because of its sustainability, affordability, and low maintenance needs. By transforming waste into energy, biogas systems offer a reliable power source while also promoting environmental conservation and better sanitation.

1.BLACKWATER COLLECTION AND PREPARATION

- Black water collection tank:** Collects waste black water from toilet salt, kitchen sink and shower.
- Separators and sieves:** They are used to remove large solid particles and inorganic materials from black water before entering the digester.
- Tanks for homogenization:** They ensure waste is thoroughly mixed and homogenized to achieve a consistent input material.

2.ANAEROBIC DIGESTION

- Digesters:** The main reactors in which the process of anaerobic digestion takes place. They have digester heating systems that ensure the optimal temperature for anaerobic bacteria, which is crucial for an efficient digestion process. They may include heat exchangers or heating elements.

"KINGSPAN SLIMLINE WATER TANK: ENHANCING BIOGAS SYSTEMS"

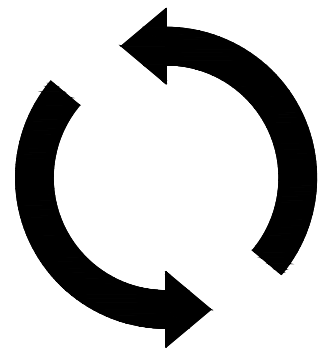
3.BIOGAS STORAGE AND ELECTRICITY PRODUCTION

- Gasometer:** Storage for biogas produced during the digestion process. Gasometers are designed to be hermetically sealed to prevent gas leakage.
- Combined Heat and Power (CHP) unit:** It converts biogas into both electricity and thermal energy, optimizing gas utilization through cogeneration.

URBAN SLIMLINE WATER TANK

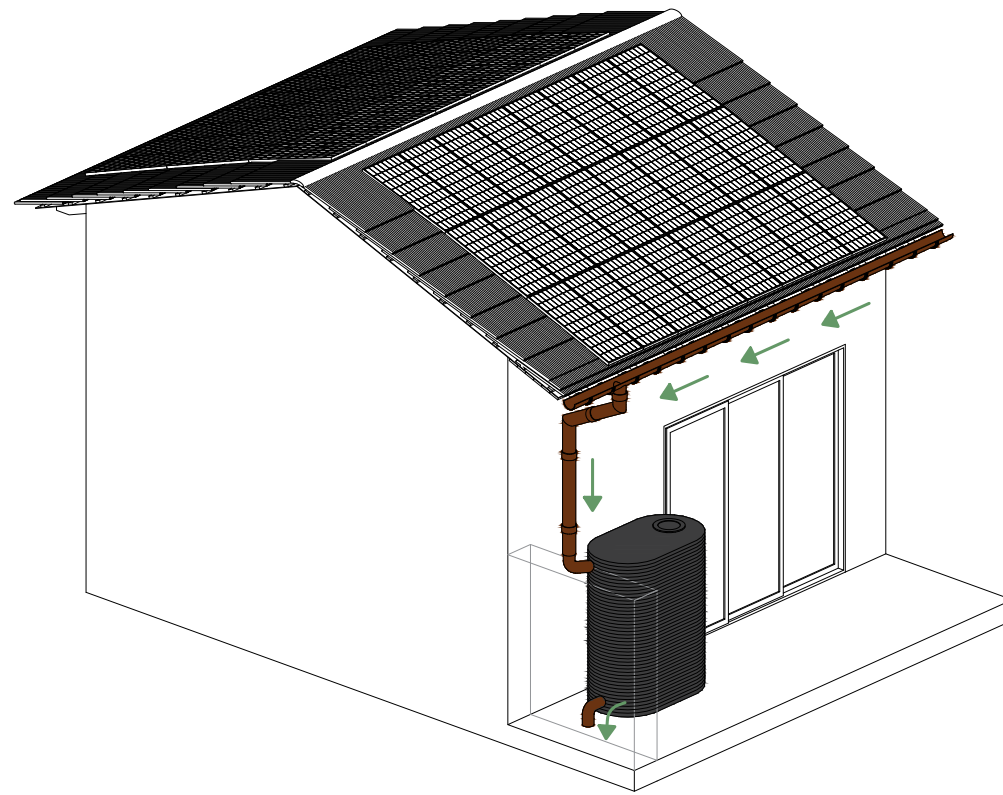


"Fertilizer as a by-product: The digestate, a nutrient-rich residue produced during the anaerobic digestion process, can serve as a high-quality fertilizer. Its use enriches soil fertility, promoting local agriculture and sustainable land management".



CIRCULARITY

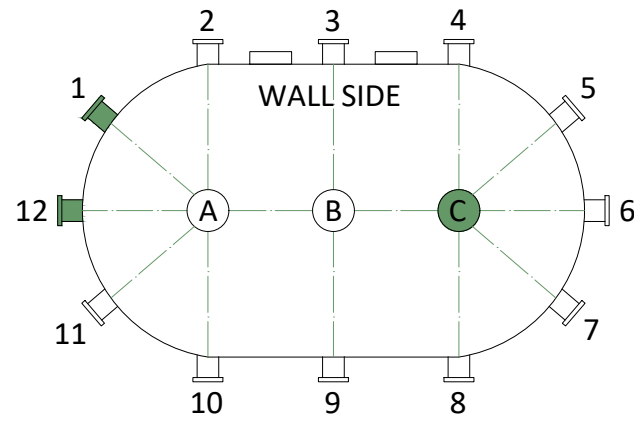
POSITION OF KINGSPAN URBAN SLIMLINE WATER TANK:



SPECIFICATIONS OF KINGSPAN SLIMLINE WATER TANK:

Tank inlet position: 1
Tank outlet position: 12
Tank overflow position: 12
E.g. of second overflow position: 1
E.g. of second inlet position: C

Dimensions: 700W x 148H x 120L
Total capacity: 1088l
Toilet flushes: 181
Hand watering hours: 1



BIOGAS SYSTEM & SLIMLINE WATER TANK

The Kingspan Slimline tank is a valuable addition to biogas production, optimizing water management. Proper connection to the plant enhances resource utilization, efficiency, and cost reduction.

ENHANCING SYSTEM with Kingspan Slimline Water Tank:

Substrate preparation: Water from the tank can be used to dilute the dense organic materials before they enter the digester, facilitating the anaerobic digestion process.

Equipment cleaning: Tank water cleans equipment, piping, and components. After each batch, water from the tank is used to flush the digester and piping. The pump system provides the pressure needed for effective cleaning, reducing the risk of clogging and deposits.

Digester cooling: Tank water regulates the temperature of the digester, which is crucial for optimal microorganism performance.

Dilution of liquid digestate: Water from the tank can be used to dilute the liquid digestate before it is applied as fertilizer to the fields.

