Sustainable Architecture in Social Housing: A Response to Population Migration in the City of Mbouda Following the Crisis in the North-West Region

Fopa Jerry Karmel[1]; Bwemba Charles[2]; Seudjo Armand[3]

[2]Civil Engineer, Lecturer, Head of Department of Architecture
[3]Architect DESAU, Matricule 2021/359
[1,2,3]Department of Architecture, National Advanced School of Public Works
[1,2,3]Yaoundé, Cameroon

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Abstract: Cameroon faces a major housing deficit, intensified in Mbouda by the arrival of internally displaced persons fleeing the Anglophone crisis. This study proposes a sustainable architectural response combining local materials and bioclimatic principles to meet the needs of both displaced and resident populations. Based on field surveys and site analysis, the project favors Compressed Earth Blocks, shared spaces, and T3/T4 housing typologies. The resulting model integrates natural ventilation, solar orientation, and water management, offering a replicable solution rooted in the local context. While promising, further experimentation is needed to industrialize materials and scale up implementation.

Keywords: *Sustainable Architecture, Social Housing, CEB, Bioclimatic, Mbouda.*

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I. INTRODUCTION

In a global context marked by climate urgency and geopolitical crises triggering mass population displacements, the housing sector faces an unprecedented challenge: designing dwellings that are affordable, sustainable, and dignified (UN-HABITAT, 2005). In Cameroon, the city of Mbouda, located in the Western Region, exemplifies this issue. Already affected by a structural deficit in adequate housing, it is under increasing pressure due to the arrival of numerous internally displaced persons fleeing violence linked to the Anglophone crisis. This phenomenon compounds an existing shortage, overwhelming infrastructure and worsening residential precarity.

Confronted with this dual constraint, it becomes essential to explore architectural solutions that go beyond a purely quantitative response, fully integrating social, cultural, and environmental dimensions. This article argues that contemporary vernacular architecture, through its ability to mobilize local resources and know-how, offers a viable and resilient approach. Based on a field case study, the research assesses the effectiveness of a design strategy centered on the use of Compressed Earth Blocks (CEB) and bioclimatic principles, with the aim of proposing a social housing model that is environmentally respectful, economically viable, and aligned with the aspirations of displaced communities.

II. PRESENTATION OF SOCIAL HOUSING IN CAMEROON

- *Institutional and Regulatory Context*

Social housing in Cameroon has, since the 2000s, been governed by a strengthened regulatory framework aimed at addressing the shortage of decent housing caused by rapid urbanization. Ministerial Order No. 0009/E/2/MINDUH of August 21, 2008 defines social housing as a dwelling partially financed by the State or a public institution, intended for low-income households, thereby emphasizing national solidarity and equitable access to dignified housing (Social Housing – MINHDU, n.d.). This framework is supported by several legislative and regulatory texts:

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- Law No. 2009/004 on lease-to-own property acquisition: facilitates gradual access to homeownership for low-income households.
- Law No. 2001/020 on the organization of the real estate profession: regulates property transactions and management. • Technical texts from MINHDU: establish eligibility criteria, safety standards, and procedures for managing public projects.
- Civil Code and Recovery of Premises Ordinance: govern lease contracts depending on whether the area is francophone or anglophone.

Key Institutional Actors and Their Roles The current social housing system relies on a plurality of national public actors, decentralized local authorities, and local or foreign technical and financial partners. The main stakeholders include:

- MINHDU : the lead institution responsible for designing and coordinating national social housing policy, overseeing national programs, and supervising the technical implementation of public and private operators.
- The Cameroon Real Estate Corporation (SIC): the operational arm for the construction and management of social housing, also involved in the development of mixed real estate programs. Since 2009, SIC has led the 10,000 social housing units project and has multiplied public-private partnerships to enhance its efficiency and self-financing capacity (Figure 1).

Fig 1 SIC Camp Olembé, Yaoundé

- Crédit Foncier du Cameroun (CFC): As the sole public housing finance bank, CFC plays a central role in granting mortgage loans, structuring housing savings products, and managing refinancing funds for social housing and public or private real estate development.
- Mission for the Development and Equipment of Urban and Rural Land (MAETUR): Specializing in land subdivision, development, and title regularization, MAETUR is responsible for identifying sites, preparing land, and ensuring the viability of plots designated for social housing.
- Mission for the Promotion of Local Materials (MIPROMALO): This institution is tasked with developing, promoting, and integrating innovative local materials into social housing construction, with the aim of reducing costs and ensuring better socio-ecological adaptation. Compressed Earth Blocks (CEB) are one of its main initiatives, as this material offers significant potential to address the challenges facing the housing sector in Cameroon. The following figures present examples of construction using CEB (Bienvenue à la Mipromalo, n.d.).

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Fig 2 Headquarters Building of MIPROMALO


Fig 3 Classroom Construction Project

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- Decentralized Territorial Communities (CTCs): They contribute to site identification, facilitate land mobilization, and manage local social housing programs, notably through agreements with FEICOM (Special Fund for Equipment and Intermunicipal Intervention).

III. METHODOLOGY

To successfully conduct our investigation, we implemented a structured approach to collect and analyze data rigorously, ensuring the reliability and relevance of the results obtained.

➢ *General Site Survey*

The site survey is a crucial step that allows for the analysis and understanding of the environment in which a project will be implemented. It involves studying the physical characteristics to adapt the architectural design to the constraints of the terrain. The goal is to understand its history, location, climate, topography, hydrology, geology, demographics, and socio-economic and cultural activities.

➢ *Data Collection*

- *Field Survey Data*

To support the purpose of this study, primary data collection is essential for obtaining precise and contextualized information. It relies on three complementary techniques: surveys, interviews, and observations. Surveys, conducted using structured questionnaires via the KoboCollect tool. Interviews with experts and local stakeholders enrich this process by providing a detailed understanding of the specific constraints and expectations related to housing. Finally, field observations both participatory and non-participatory allow for direct analysis of social dynamics, the condition of existing infrastructure, housing accessibility, and spatial usage patterns, taking into account the specific needs of vulnerable groups.

- *Secondary Data Collection*

This step aims to gather essential data for understanding the project site. It focuses on geographic boundaries, existing infrastructure, terrain morphology, wind behavior, and solar trajectory. Analyzing physical and administrative boundaries helps clearly define the intervention area. Studying surrounding infrastructure roads, networks, public facilities assists in evaluating site connectivity and connection possibilities, while identifying visual and functional interactions with the neighborhood. These observations also help identify local constraints and opportunities that may influence the architectural integration of the project.

➢ *Design Hypotheses*

The design hypothesis phase marks the transition from analysis to the concrete formulation of the architectural project. It is based on a rigorous site selection process, combining virtual surveys via Google Earth and validation through field visits, according to criteria such as proximity to essential infrastructure, climate, topography, accessibility, and cultural realities. The architectural program defines the required spaces, their organization, and capacity, in response to the specific needs of the population.

The design process uses a range of digital tools to ensure precision, clarity, and coherence. 2D plans were created using AutoCAD, Revit, and Rhino, while 3D modeling enabled visualization of project volumes. Renderings, produced with Corona Render and Chaos Vantage, were enhanced in post-production using Photoshop and Illustrator. Finally, presentation boards were formatted with InDesign for a professional and structured output.

➢ *Sustainable Design Approach*

The design of social housing in this project is based on an integrated bioclimatic approach, aiming to optimize thermal comfort, ventilation, and natural lighting while reducing energy consumption. The east-west orientation of the building limits excessive heat gain, while openings are primarily placed on the north and south façades to promote natural light and cross-ventilation. Narrow floor plans and light shafts improve illumination in deep spaces, and passive devices such as thermal chimneys, windbreaks, and louvered windows ensure good air circulation. Finally, the use of low-carbon local materials, such as CEB and wood, enhances the sustainability of the building envelope while ensuring insulation suited to Mbouda’s climate.

IV. CASE STUDY

A. *General Site Presentation*

➢ *Geographical Context*

Mbouda, the capital of the Bamboutos department, is located in the Western Region of Cameroon, 28 km northwest of Bafoussam. Positioned along National Road No. 6, it plays a strategic role in connecting the Centre, West, and Northwest regions. The municipality spans 437 km², with mountainous terrain at the foot of the Bamboutos Mountains (altitude >2,300 m) and fertile valleys favorable for agriculture (Figure 4). Administratively, the department includes four districts: Mbouda, Batcham, Galim, and Babadjou. Unlike other autonomous municipalities, Mbouda encompasses several villages and neighborhoods under a single administrative entity.

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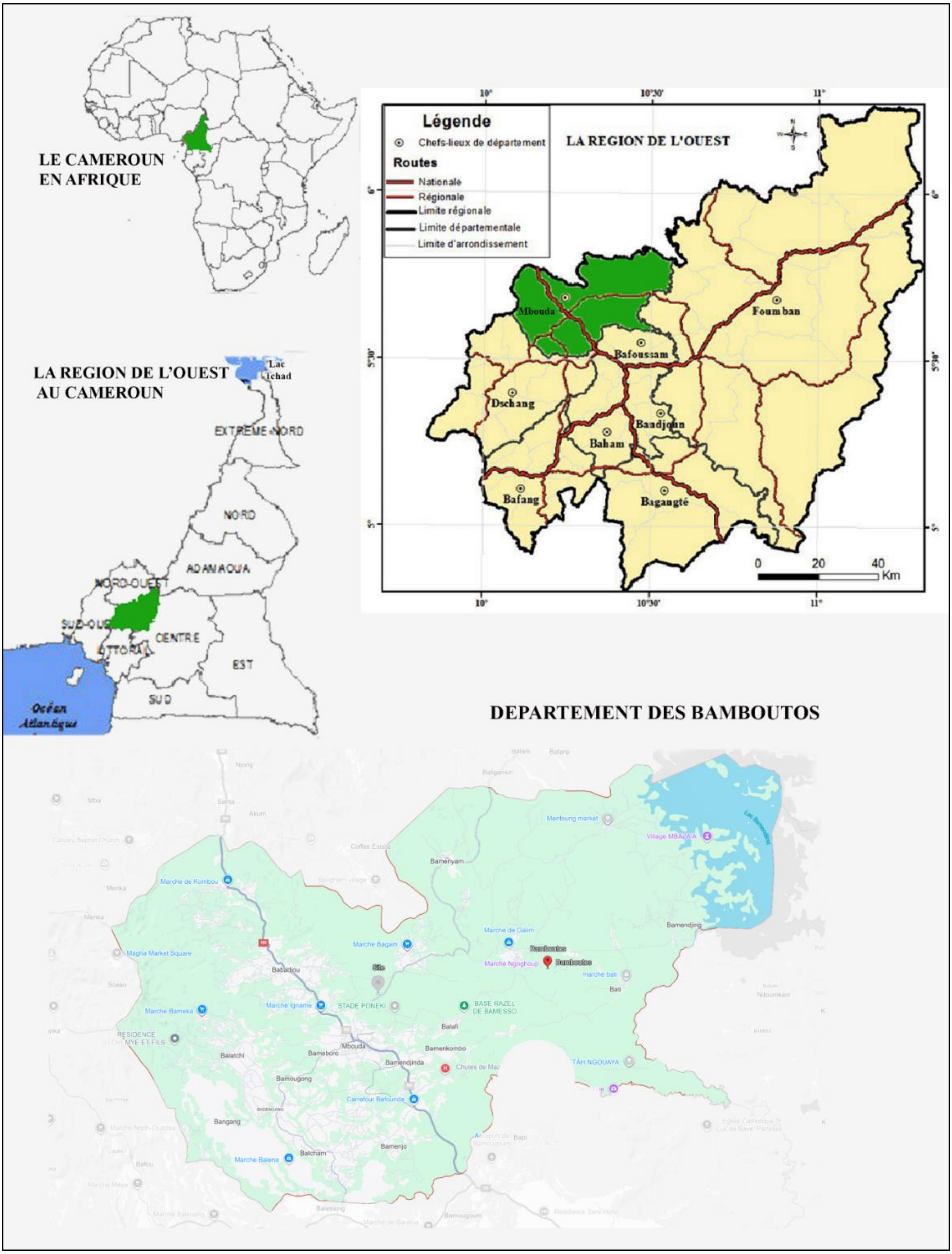

Fig 4 General Overview of the Study Area

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➢ *History of Urban Development*

The city of Mbouda derives its name from the word Mbouda'a, which means "People of Nda'a" in the local language. This people, of Sudanese origin, are believed to have migrated to the area in the 14th century, fleeing conflicts in neighboring kingdoms. Today, the municipality is characterized by a strong Bamileke identity, with a rich culture and dynamic social organization.

➢ *Demographics*

Mbouda has approximately 140,000 inhabitants spread over 437 km², with a population density of 320 inhabitants/km² and an estimated annual growth rate of 2.9%. The population is predominantly female (54.08%) and consists mainly of four ethnic groups, with the Nda'a being the most represented. This group is concentrated in the communities of Babété, Bamendjinda, Bamenkombo, and Bamesso.

➢ *Climate and Temperature*

Mbouda experiences a tropical mountain climate, influenced by its altitude and the Bamboutos Mountains. As shown in Figure 5, the region has a dry season and a rainy season , with annual rainfall ranging from 1,700 to 2,500 mm depending on the terrain. Figure 7 indicates that the average annual temperature is around 20°C, with drops reaching below 10°C in the highest areas.

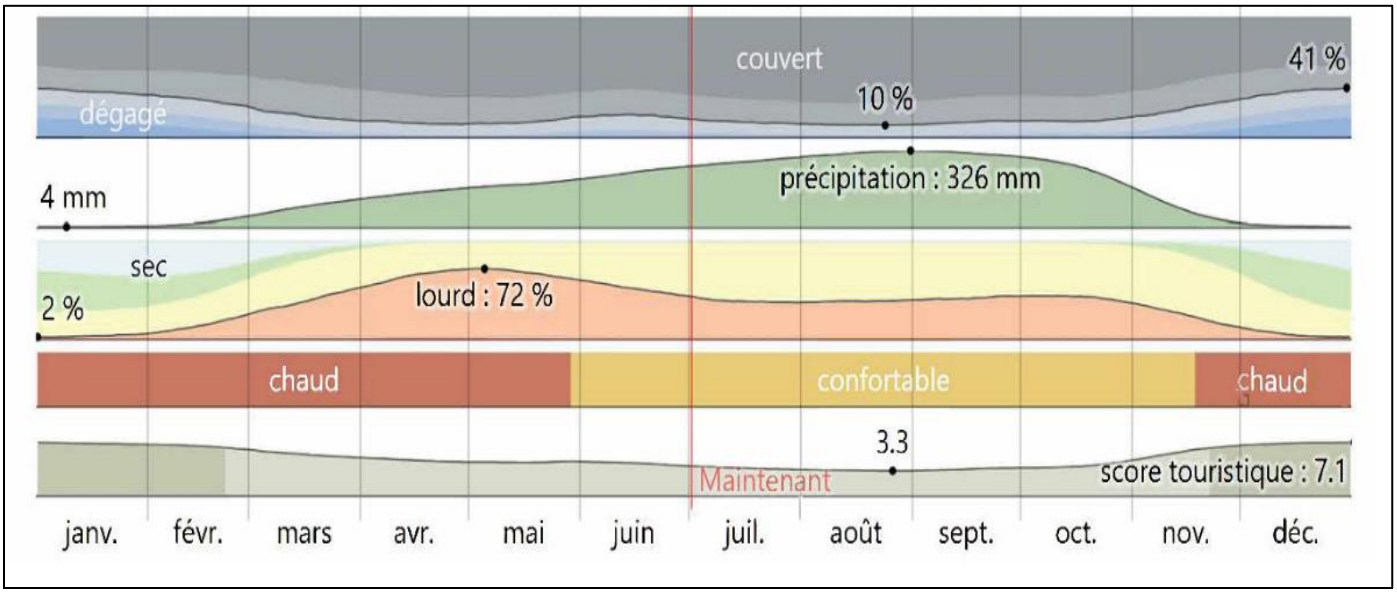

Fig 5 Climate in Mbouda
(Source: https://fr.weatherspark.com)

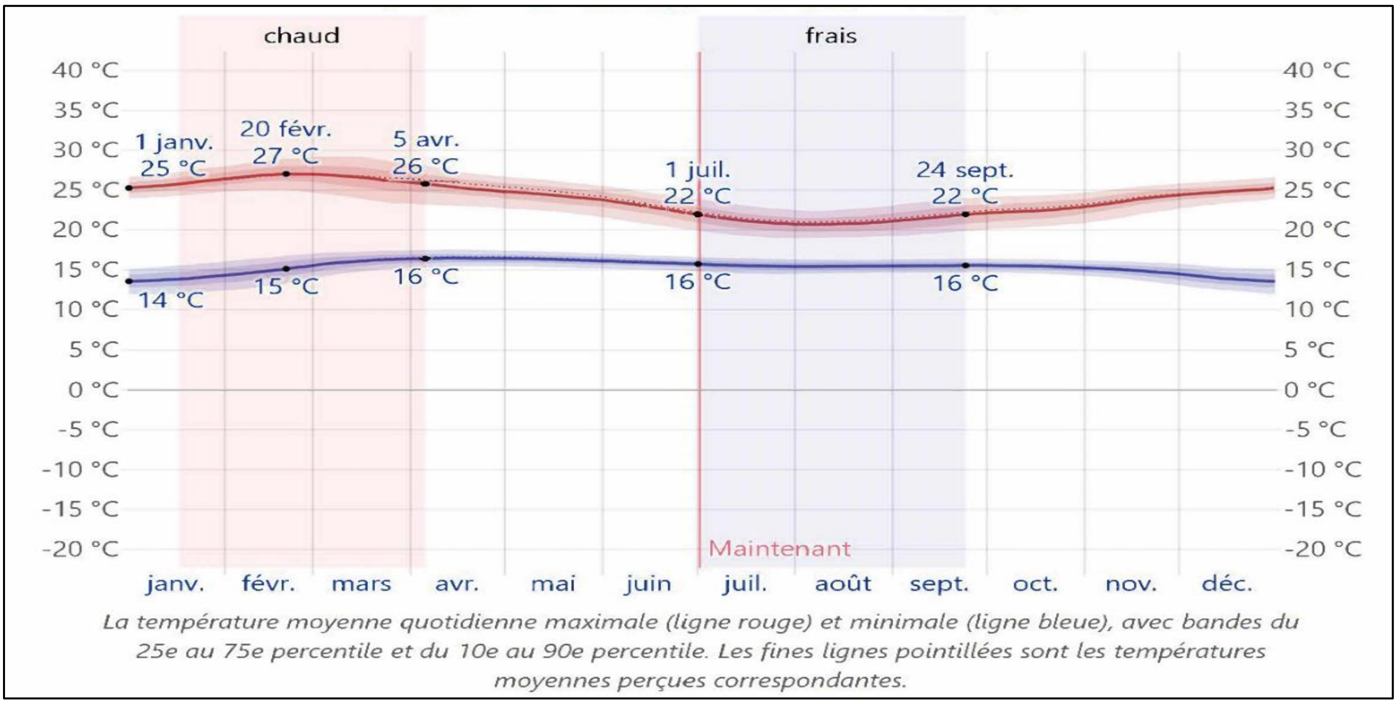

Fig 6 Average Maximum and Minimum Temperature in Mbouda
(Source: https://fr.weatherspark.com)

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➢ *Topography*

Mbouda features a mountainous and irregular terrain, characteristic of the highlands of Western Cameroon. Located at the foot of the Bamboutos Mountains, the city alternates between fertile valleys and agricultural plains. This complex relief strongly influences infrastructure development, requiring adaptations to slopes, erosion risks, and accessibility constraints.

➢ *Wind*

Wind circulation in Mbouda varies by season: dominant winds come from the west between February and May, and again from June to October, peaking at 81% in August. Southern winds appear briefly in May, while eastern winds blow mainly from October to February, reaching a maximum of 52% in January (Figure 7).

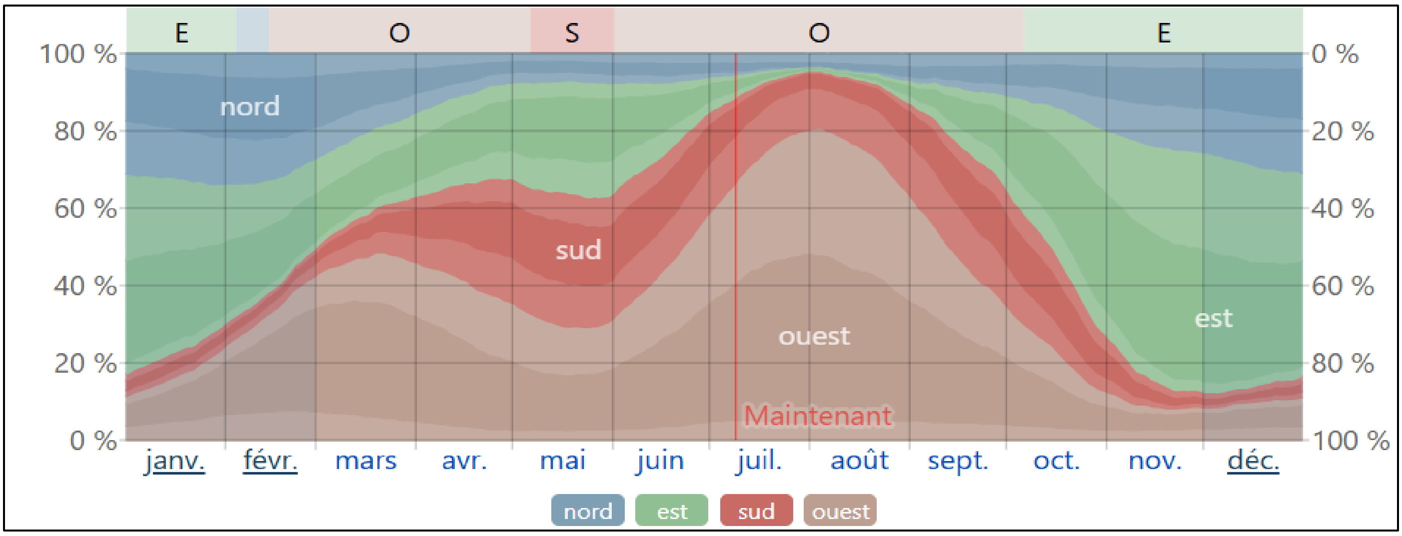

Fig 7 Wind Direction in Mbouda
(Source: weatherspark.com)

À Mbouda, la période la plus venteuse s'étend de début juillet à début septembre, avec des vitesses moyennes supérieures à 6,9 km/h. Le mois d'août est le plus venteux, atteignant une moyenne de 8,3 km/h (Figure 8).

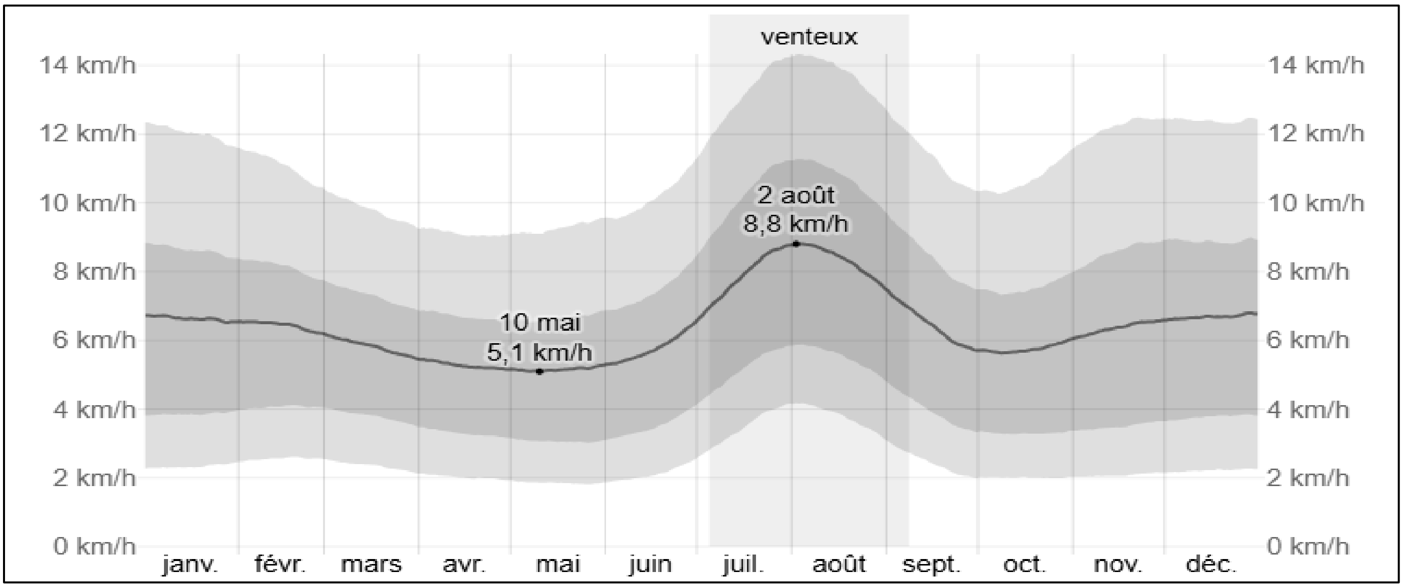

Fig 8 Average Wind Speed in Mbouda
(Source: weatherspark.com)

➢ *Hydrography*

Mbouda's hydrography is based on a network of small streams and creeks originating at the foot of the Bamboutos Mountains. These water sources feed the valleys and support local agriculture, particularly the irrigation of subsistence crops. However, access to potable water remains limited in several villages due to poor maintenance of water points. The city has a distribution network managed by CAMWATER, which partially meets domestic needs, with disparities across neighborhoods.

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➢ *Pedology*

Mbouda benefits from rich volcanic soils, especially in the Ngoaya area, composed of laterites, silty gravels (GM), and plastic silts (MH). These soils support vibrant subsistence farming, particularly in hydromorphic lowlands with raffia. However, their fertility is weakened by slope leaching, intensive use of chemical fertilizers, and the spread of eucalyptus trees, which dry out wetlands. Despite these pressures, raffia remains a valuable local resource, notably used in traditional wine production. This context highlights the importance of sustainable soil management and architecture that respects ecological balance.

➢ *Socio-Economic and Cultural Activities*

The Bamboutos department, located in the highlands of Western Cameroon, is characterized by a dynamic agro-pastoral economy driven by subsistence farming (maize, beans, potatoes, vegetables) and livestock. Periodic markets, women-led trade networks, and diaspora remittances structure local exchanges. Handicrafts (carpentry, blacksmithing, CEB production) and urban services (transport, education, health) complement household incomes.

The department is organized around traditional chiefdoms, which ensure social mediation, land management, and the preservation of cultural rites. Community practices such as tontines, ritual funerals, and traditional festivals reinforce cohesion and collective identity. Housing is often conceived as a multifunctional space, accommodating family life, economic activities, and social interactions. Vernacular architecture, based on earth, wood, and raffia, reflects local craftsmanship (Figure 9). Some buildings are coated with sand plaster to protect and unify façades. The most common roof types are pyramidal or double-pitched, and attics are frequently used as granaries for food storage.

Fig 9 Local Construction

B. Physical Description of the Site

➢ *Location and Physical Characteristics of the Site*

The selected site for the project is located in the Bamessingué neighborhood, within the municipality of Mbouda, the capital of the Bamboutos department in the Western Region of Cameroon. It is precisely situated at the geographic coordinates 5°39'34.17"N and 10°16'20.19"E (Figure 10). The plot designated for the sustainable social housing project covers an area of 3,600 m². The land has a flat topography, which offers a technical advantage for earthworks and foundation stability (Figure 11).

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Fig 10 Site Overview
(Source: Google Earth)

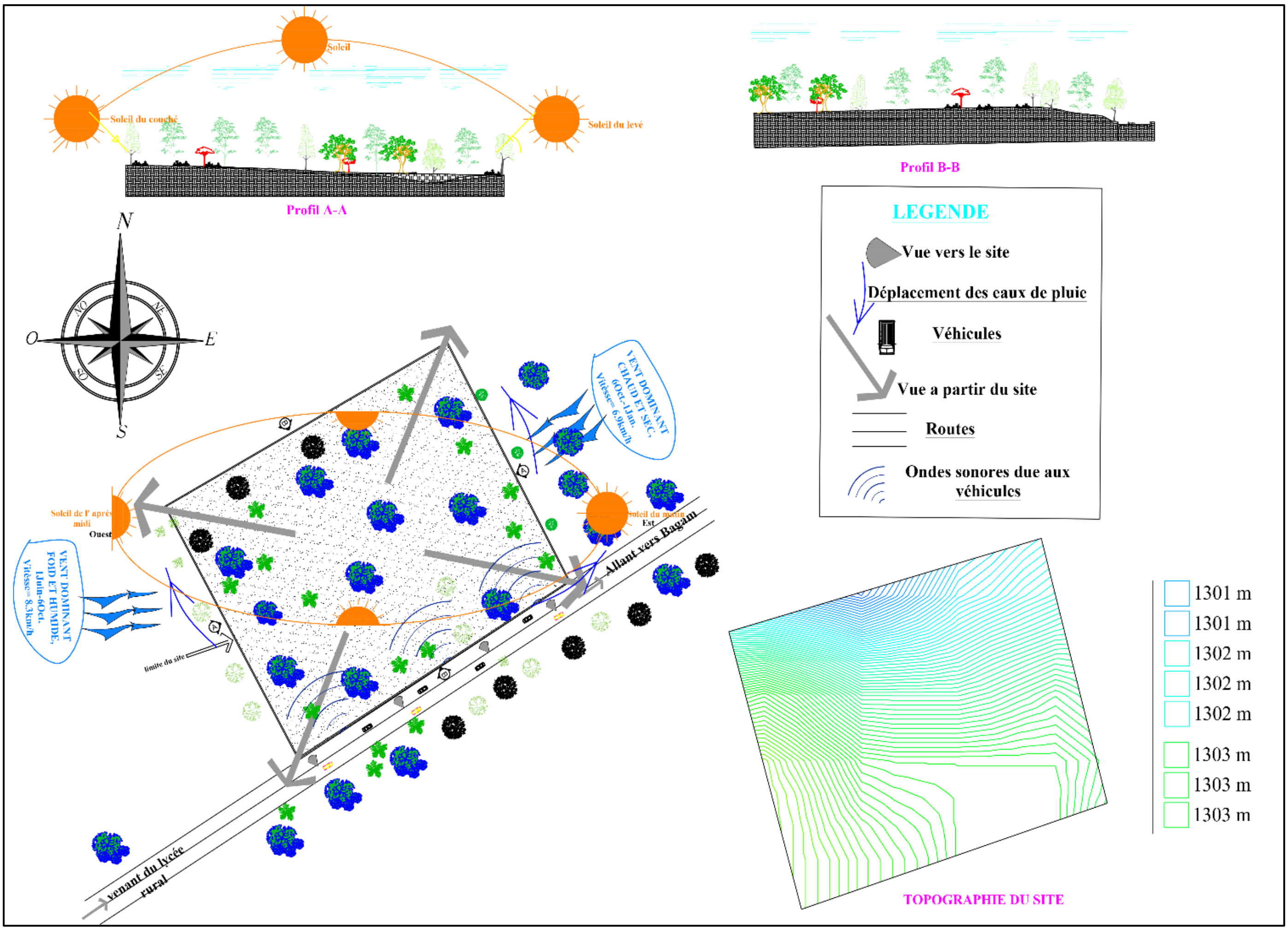

Fig 11 Site Inventory

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➢ *Accessibility and Connectivity*

The chosen site benefits from a strategic geographic location, notably due to its immediate proximity to a 12-meter-wide access road that is usable year-round (Figure 12). This accessibility facilitates construction work and the transportation of materials, while also ensuring smooth mobility for future residents. Located just 10 minutes from downtown Mbouda, the site is well connected to essential services, enhancing its attractiveness. It is directly adjacent to two major public facilities: the Mbouda District Hospital, which provides local healthcare coverage, and the Mbouda Rural Bilingual High School, an important educational hub for local youth. Furthermore, its location in a rapidly developing neighborhood aligns with a coherent urban development dynamic, offering a favorable setting for the harmonious integration of the sustainable social housing project into the existing urban fabric.

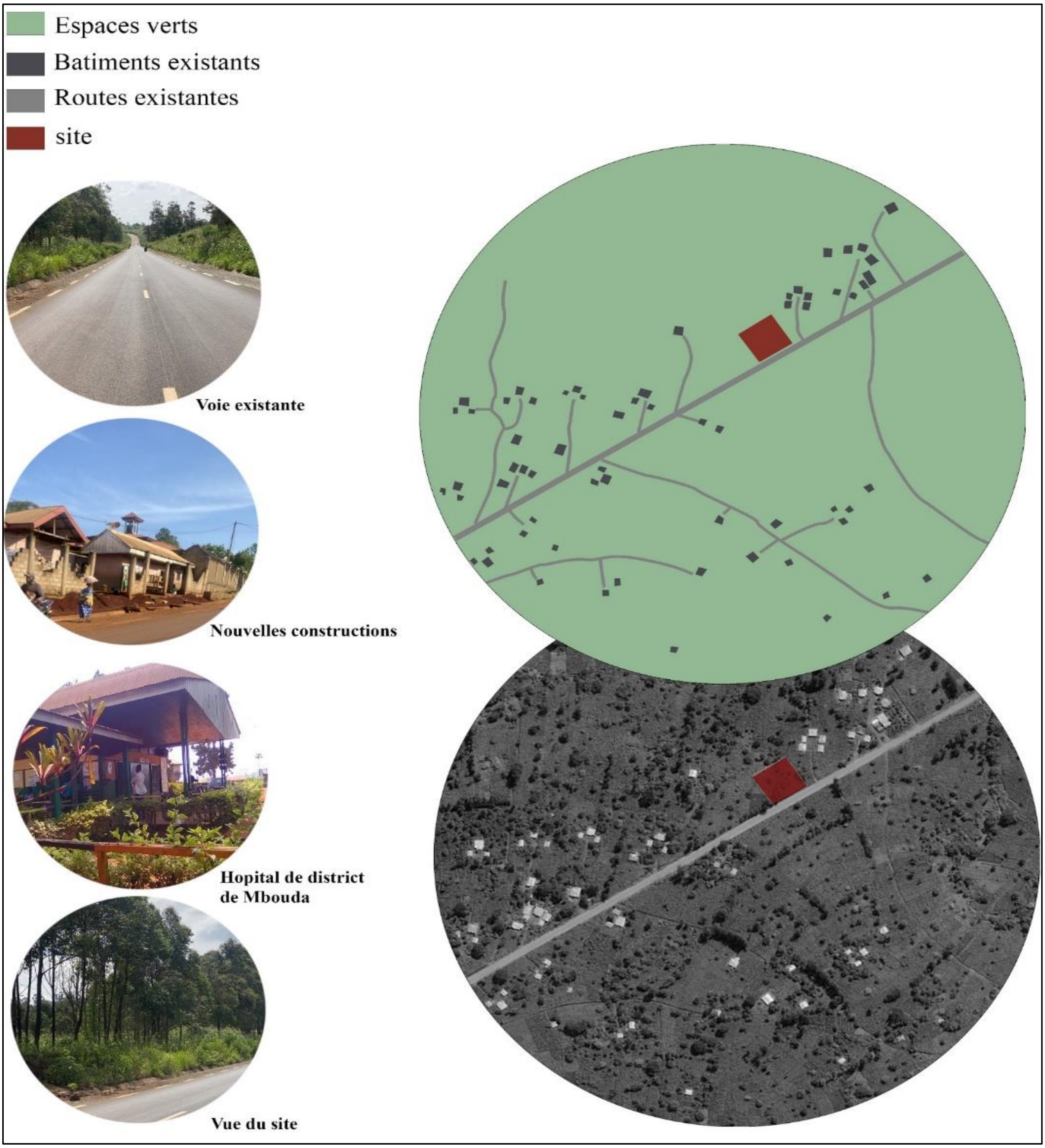

Fig 12 Site Infrastructure and Accessibility

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➢ *Favorable Local Context*

The Bamessingué neighborhood is experiencing sustained demographic growth, accompanied by a proliferation of new constructions gradually aligning along the main axis leading to downtown Mbouda. This dynamic reflects strong urban pressure driven by the growing demand for accessible and decent housing, fueled by a continuously increasing population. At the same time, the site remains bordered by agricultural zones and scattered dwellings, allowing for the harmonious integration of the project into a transforming urban fabric while preserving continuity with the existing landscape.

➢ *Institutional Support and Alignment with Local Policies*

The site has been identified by the Decentralized Territorial Community (CTC) as a priority area for development, ensuring full alignment with local urban development policies. This institutional recognition not only facilitates the acquisition of administrative authorizations and access to secure land tenure, but also opens the door to potential technical or financial partnerships. The direct involvement of the CTC reflects a strong commitment to social housing, thereby reinforcing the project's legitimacy, sustainability, and social acceptance among local stakeholders and beneficiary populations.

➢ *SWOT Analysis of the Site*

Table 2 below presents the strengths, weaknesses, opportunities, and threats related to the site and its environment.

Table 1 SWOT Analysis of Site

S (Strengths)	**W (Weaknesses)**
-Flat terrain, facilitating construction work -Accessibility via a wide road (12 m), usable in all seasons -Proximity to key infrastructure (hospital, rural high school, city center 10 minutes away) -Site recognized by the CTC as a priority development zone Sufficient surface area with room for additional facilities	-Lack of structured urban development on the site -Need for additional technical studies (soil, networks)
O (OPPORTUNITIES)	T (THREATS)
-Developing neighborhood with growing urbanization dynamics -Developing neighborhood with growing urbanization dynamics -Possibility of institutional and financial partnerships thanks to CTC support.	-Potential medium-term land pressure due to growing urbanization - Risk of soil degradation (leaching, intensive agriculture, eucalyptus proliferation)

C. Data Presentation

➢ *Survey Results*

A total of 98 responses were rigorously analyzed. The results, presented in tables and charts, reveal the residents' expectations and the architectural challenges to be addressed in the project design.

- *Household Composition*

Table 2 Household Composition

	Frequency	**Percentage**	**Cumulative percentage**
Other (to be specified)	4	4,1	4,1
Couple without children	3	3,1	7,1
Family with children	59	60,2	67,3
Single person	32	32,7	67,3
Total	98	100,0	

This distribution highlights the predominance of family-based household structures, while also underscoring the significant presence of single-person households an important factor to consider in the diversity of housing typologies to be proposed.

- *Current Housing Typology*

The results indicate that the majority of respondents live in single-family houses or apartments, reflecting a clear preference for autonomous forms of housing (Figure13).

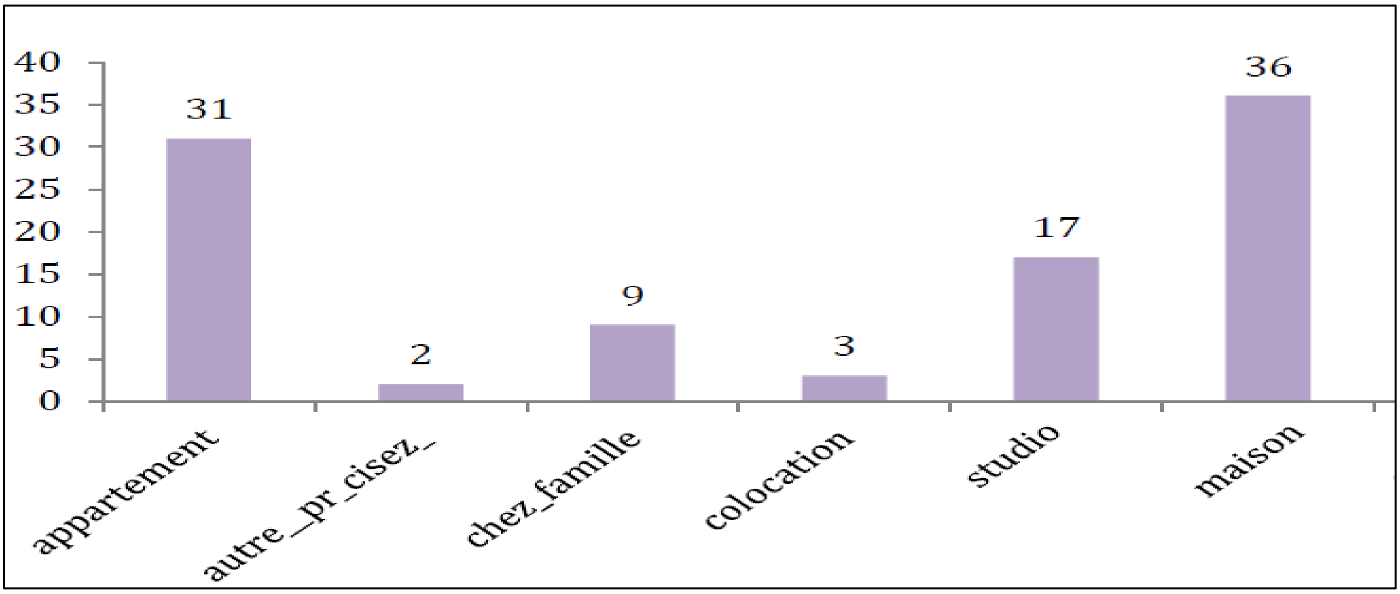

Fig 13 Current Type of Housing

- *Problems Encountered in Current Housing*

Respondents mainly reported two major issues in their current housing conditions: limited access to potable water and electricity, and a lack of living space.

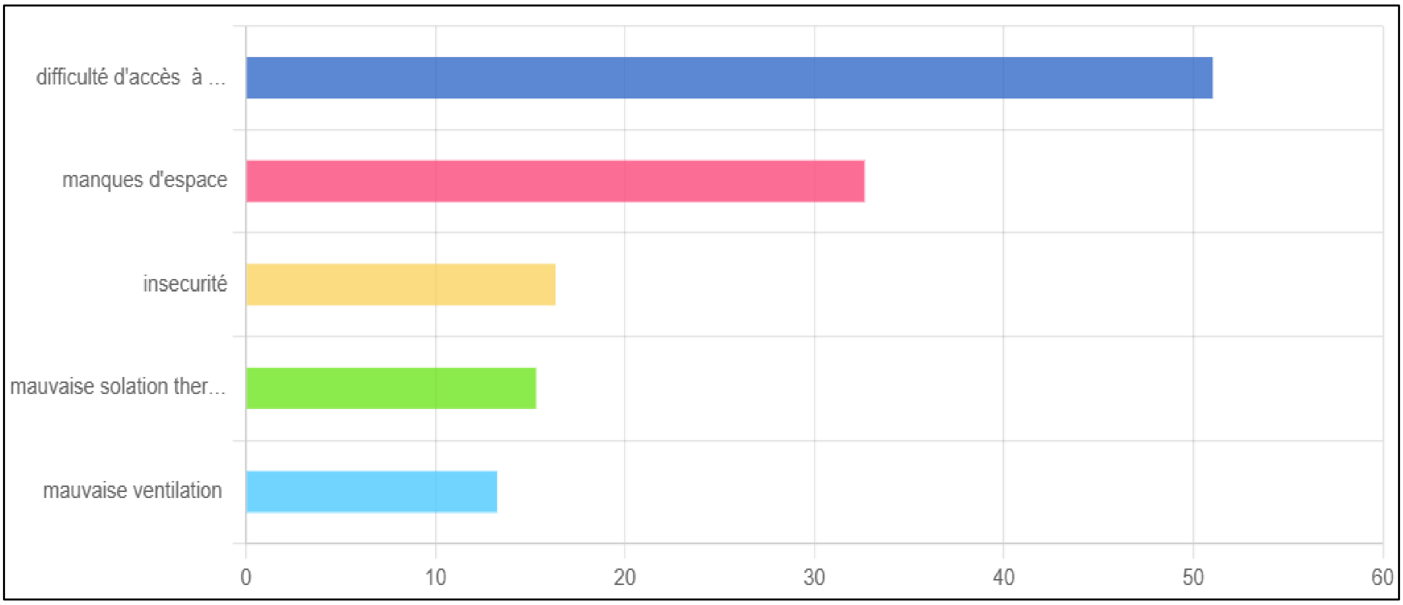

Fig 14 Chart of Current Housing-Related Issues Encountered

- *Surveys on the Desire for Shared Spaces*

A significant majority of respondents expressed support for the inclusion of shared spaces within their living environment, reflecting a strong interest in collective living dynamics and emphasizing the importance of integrating communal areas into the design.

Table 3 Surveys on the Desire to have Shared Spaces

	Frequency	Percentage	Cumulative percentage
Supportive of shared spaces	66	67,3	67,3
Not supportive of shared spaces	32	32,7	100
Total	98	100,0	

- *Specific Constraints to Consider in Housing Design*

These constraints include factors that must be carefully addressed to ensure the housing meets the needs of its users such as accessibility for vulnerable groups, adaptability to local climate and terrain, and cultural preferences in spatial organization.

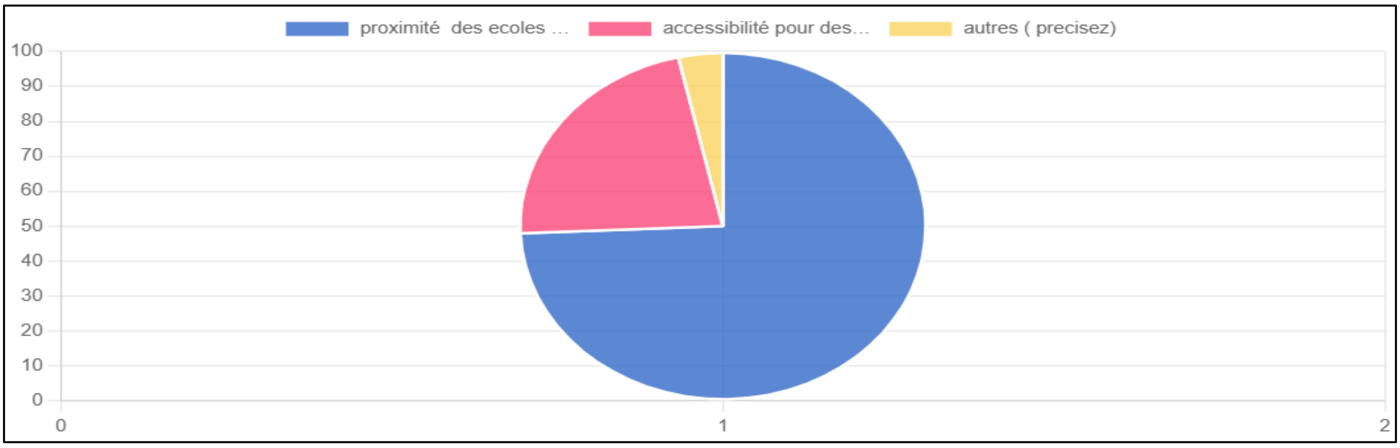

Fig 15 Chart of Specific Constraints

- *Preference for Housing Construction Materials*

Regarding preferred construction materials, a significant portion of respondents expressed a preference for compressed earth blocks (CEB).

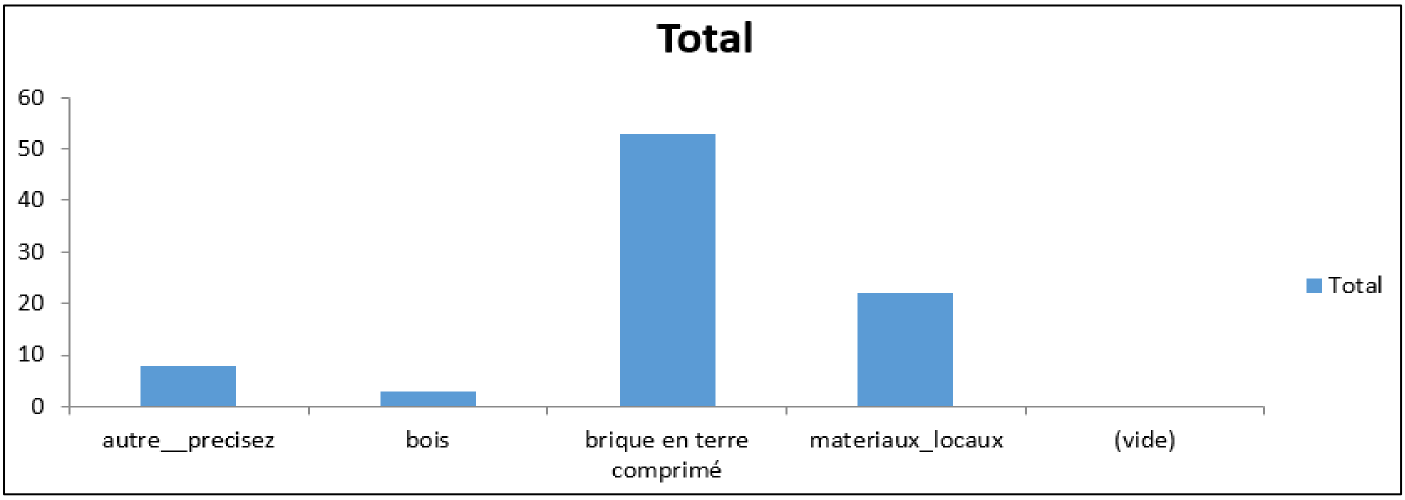

Fig 16 Survey on Preferred Materials for Housing Construction

➢ *Results of the Interview with the Mayor of Mbouda's Decentralized Territorial Municipality (CTD)*

- *Demographic Pressure Linked to the Anglophone Crisis*

The interview with the mayor of Mbouda's CTD highlights the significant impact of the sociopolitical crisis in the North-West and South-West regions on the city's urban dynamics. Mbouda has experienced a massive influx of displaced populations fleeing violence and armed conflict. This internal migration has led to considerable demographic pressure, directly affecting urban infrastructure, particularly housing. The mayor notes that this situation has triggered a surge in rental prices and overwhelmed housing capacity, making access to housing increasingly difficult for both displaced persons and the local population.

- *Unreliable Demographic Data but Real Pressure*
- *The National Census, which would have Provided Reliable Data on Population Trends, is Currently Unavailable.*

The mayor suggested contacting a focal point to obtain more recent information. However, it was clarified that the data remains approximate, as the displaced population is constantly changing. On average, an estimated 8,000 displaced persons are currently residing in Mbouda. To illustrate this dynamic, the mayor cited a locality whose population reportedly doubled in a short period, emphasizing the speed and intensity of demographic pressure. In this context, two major challenges emerge: the shortage of adequate housing and the social integration difficulties faced by displaced populations.

- *A Crisis Worsening an Already Fragile Situation*

The mayor acknowledges that the city was already facing housing tensions before the crisis, though they were relatively contained. The rapid population increase has exacerbated existing problems. In response, the municipality is considering the construction of social housing as a sustainable solution. Although no social housing units have been built yet, a site has already been identified for their development. The mayor emphasizes that these housing units would benefit both displaced persons and the local population, even if the former were to eventually relocate.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25sep657

- *An Optimistic Vision for the Future*

Despite these challenges, the mayor remains optimistic about Mbouda's future. He believes that the implementation of the social housing project could initiate a positive transformation of the city by providing a structural solution to housing issues. He also points out that Mbouda is ranked among the cleanest cities in the country an asset that could be leveraged in a sustainable urban development strategy.

D. Project Design

➢ *Architectural Program*

The sustainable social housing project in Mbouda is organized around two main building types: one dedicated to T3 units and another to T4 units. Each building rises over three levels, with a single dwelling per floor, ensuring optimal privacy and a clear vertical layout. The floors are connected by external walkways, accessible via three staircases positioned on either side of the site, allowing smooth and independent circulation between buildings. This configuration promotes safety, natural ventilation, and a clear spatial reading of the residential area. The entire project includes 6 housing units, distributed as follows: 2 T3 buildings and 4 T4 buildings, totaling 6 T3 units and 12 T4 units.

Beyond its residential function, the project integrates several key components:

- Bioclimatic orientation and climate management: This aspect relies on local climate data (prevailing winds, sunlight) to position the buildings in a way that maximizes passive thermal comfort, reducing the need for mechanical energy. It includes strategic choices in orientation, solar protection, and natural ventilation.
- Social diversity: The project aims to offer a variety of housing typologies suited to different resident profiles and to provide shared spaces that foster community life.
- Environmental sustainability and urban integration: Emphasis is placed on durable materials, ecological resource management (water, waste, energy), and harmonious integration into the existing urban fabric to enhance the project's social and environmental impact.
- Local economic development through CEB production: The establishment of compressed earth block (CEB) production units stimulates the local economy, creates jobs, and promotes ecological architecture based on local resources.
- Community participation in construction: This final component encourages direct involvement of future residents and local artisans in the project's implementation. It fosters ownership, reduces costs, and strengthens social ties around the construction process.

➢ *Project Concept and Architectural*

Approach The project is based on an integrated approach to social housing, placing the real needs of residents, local cultural practices, and environmental concerns at the heart of the design hence the name "Social Housing with a Local Footprint." Community life, a hallmark of the Western Region, especially around a shared courtyard, inspired the inclusion of communal spaces, external walkways, and play areas (Figure 17). These features promote synergy among residents, encourage intergenerational interaction, and reinforce collective ownership of the living environment.

To address urban sprawl, the project adopts controlled vertical densification, with buildings organized around a central access route. This compact layout enables better land management, reduced travel distances, and streamlined infrastructure. Finally, the orientation of buildings, natural ventilation, integration of green spaces, and enhancement of photosynthesis help minimize the project's ecological footprint. Landscaping plays an active role in climate regulation and air quality improvement, while contributing to the creation of a healthy and welcoming environment.

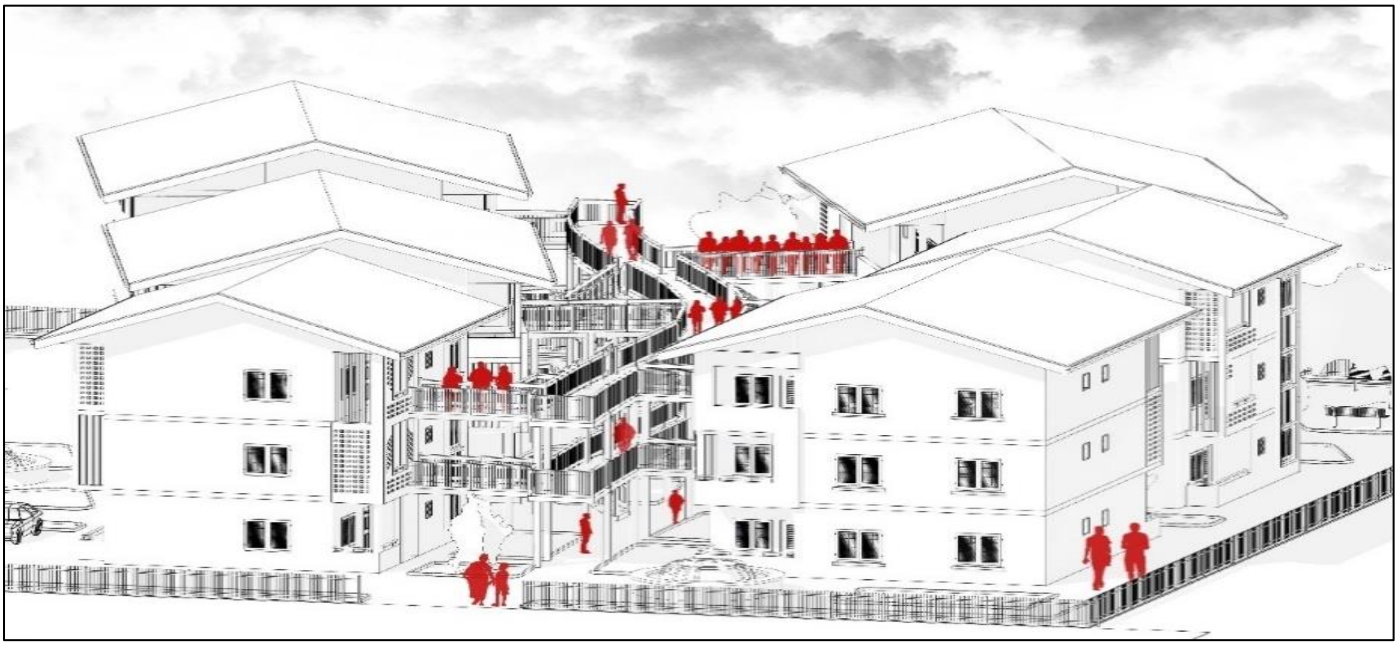

Fig 17 Walkways as Spaces for Social Interaction

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"Africa must not copy the West but work with what it has: land, people, and enthusiasm." It is from this bold vision expressed by Diébédo Francis Kéré that the present project in Mbouda draws its inspiration: an architecture rooted in its territory, conceived with local resources, and driven by a collective human dynamic, aiming to sustainably address the challenges of social housing.

- *Surface Area Distribution of the Housing Units*

Table 4 Table of Housing Model Surface Areas

Typology	Nomber	Room	Surface (m²)
Ground floor			
T3	2	Livingroom	23,9
		Master bedroom	11,5
		bedroom	11,9
		kitchen	7,2
		Terrasse 1	6,2
		Terrasse 2	4,4
		Térrasse 3	5
		Shared toilet	5,3
		WC	2,2
		Corridoor	2,6
		Total	**80,2**
T4	4	Livingroom	33
		Master bedroom	14,5
		bedroom 1	11,6
		bedroom 2	12,6
		kitchen	8,4
		Shared toilet	3,4
		Entrance hall	1,8
		master toilet	4
		WC	2,2
		Terrasse 1	12,3
		Terrasse 2	6,4
		Terrasse 3	4,8
		Corridoor	5,6
		Total	**120,6**
Total ground floor	**6**		**642,8**
Total floor area			**1928,4**
Walkway surface area			**210**

➢ *Functional Layout and Spatial Translation*

The spatial organization of the site is based on a coherent distribution of built and outdoor functions, promoting smooth circulation, user comfort, and landscape integration.

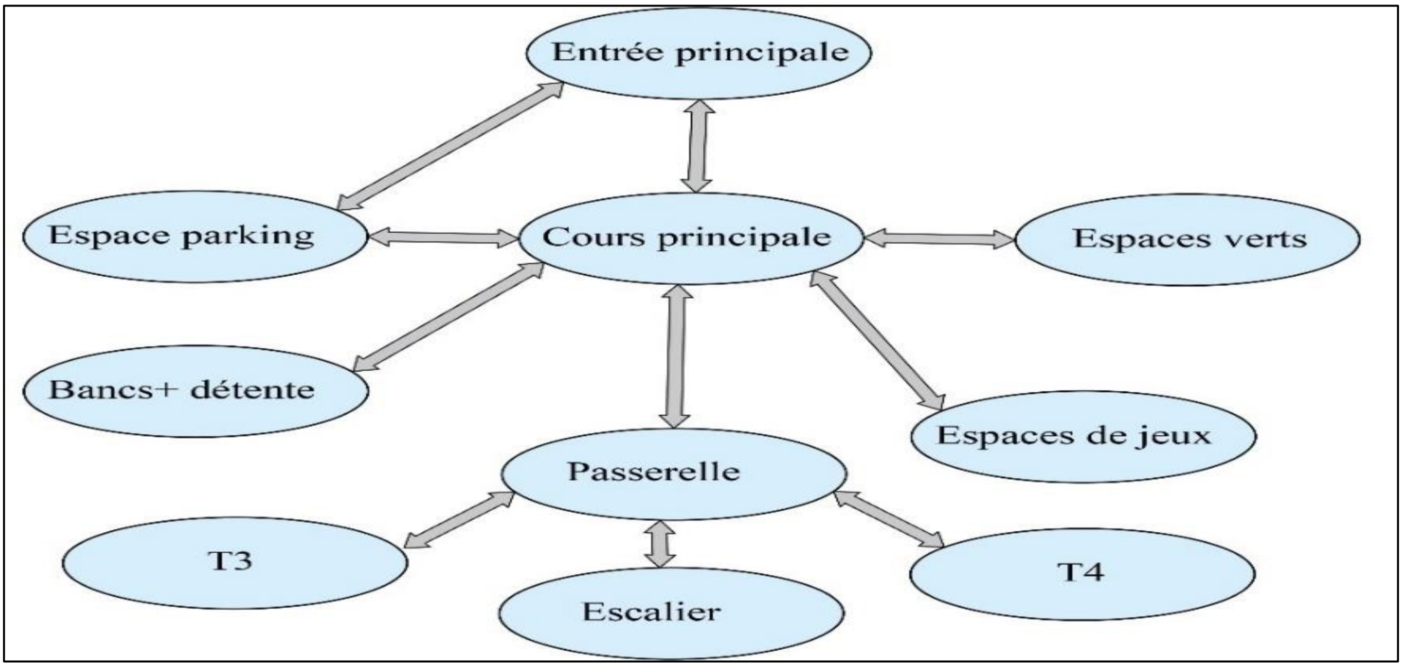

Fig 18 Site Layout Diagram

The following architectural plan translates this organization into a real layout on the site, showing the arrangement of buildings, staircases, and outdoor facilities.

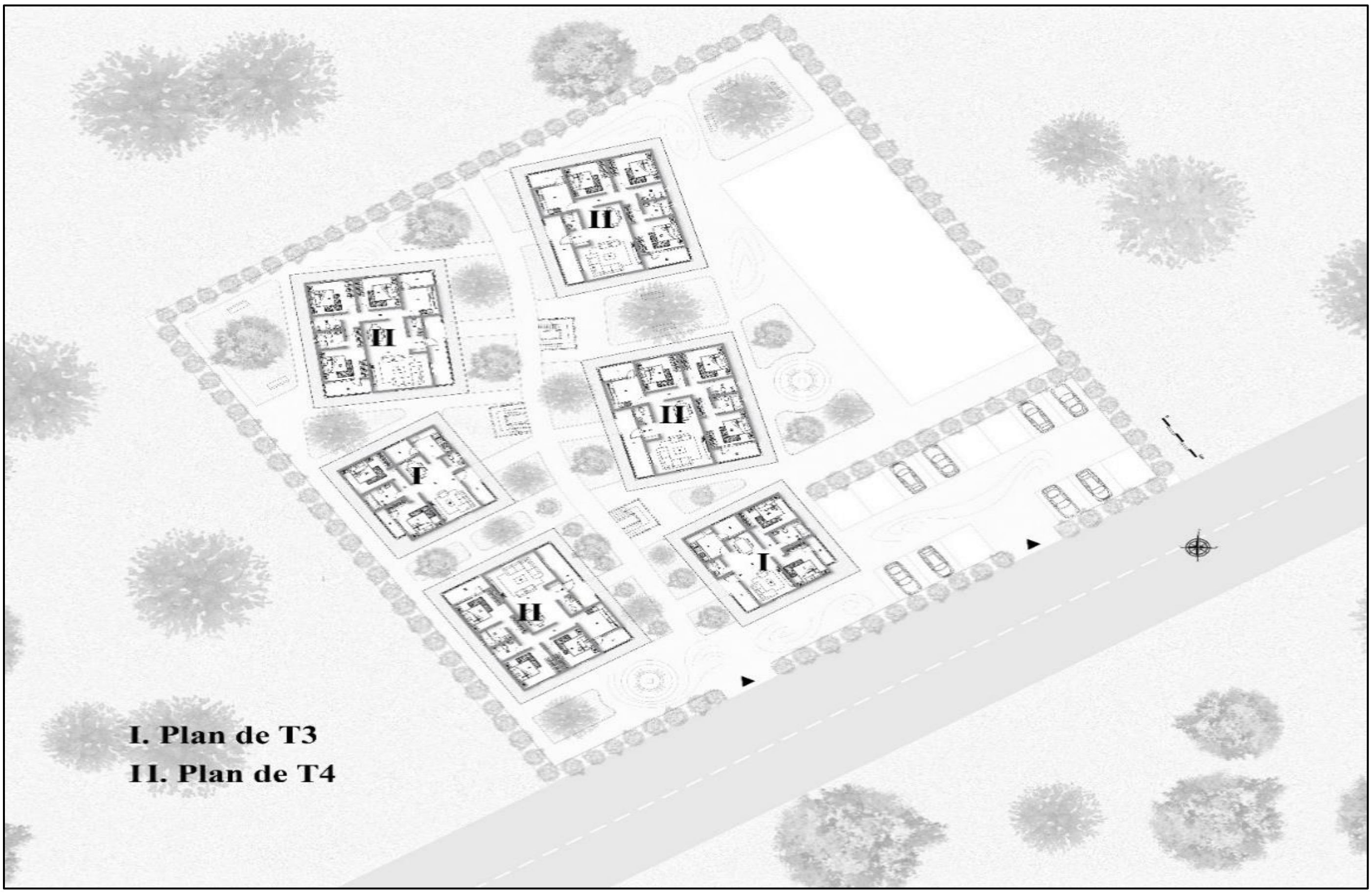

Fig 19 Site Plan

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The functional diagrams shown in Figures 20 to 23 illustrate the distribution of the project's main functions, highlighting the relationships between residential spaces and circulation paths.

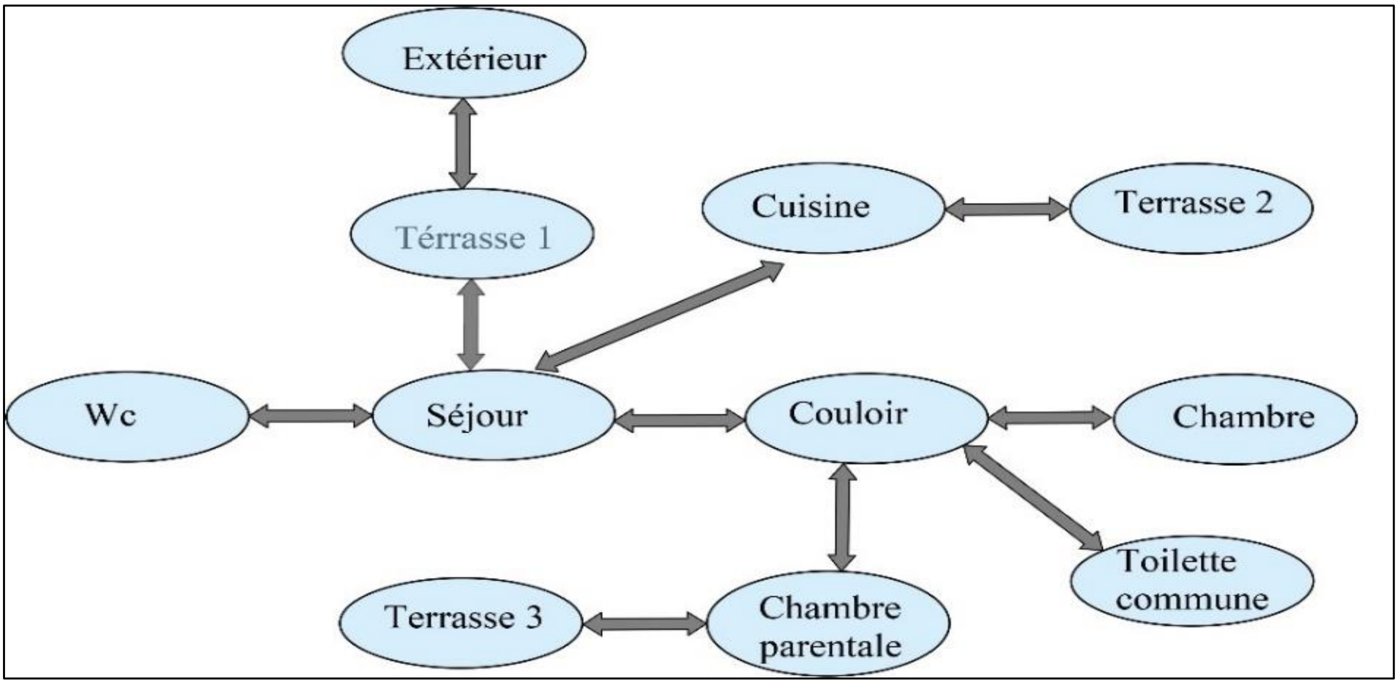

Fig 20 Functional Diagram of T3 Housing Units

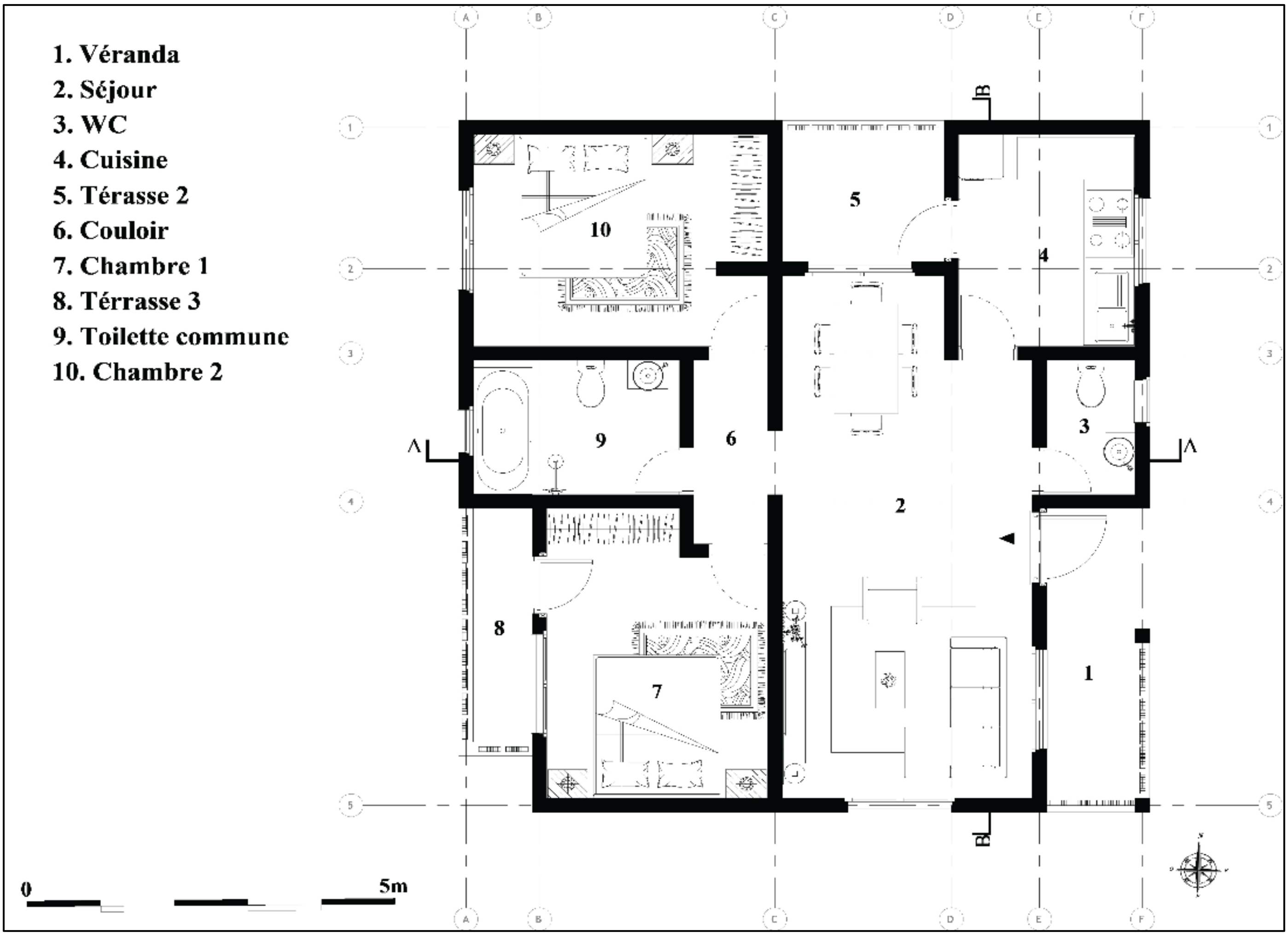

Fig 21 Layout Plan of T3 Housing Unit

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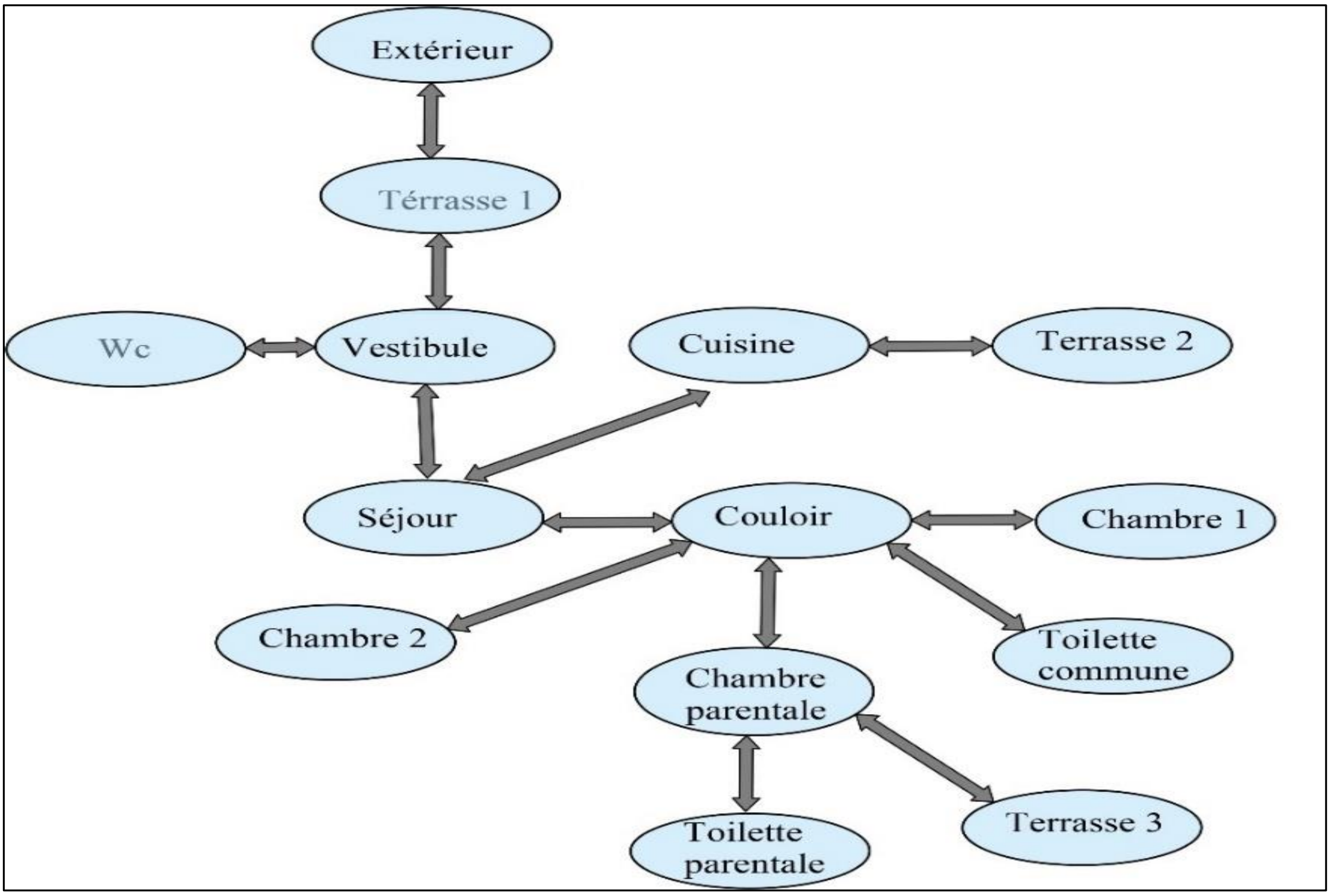

Fig 22 Functional Diagram of T4 Housing Units

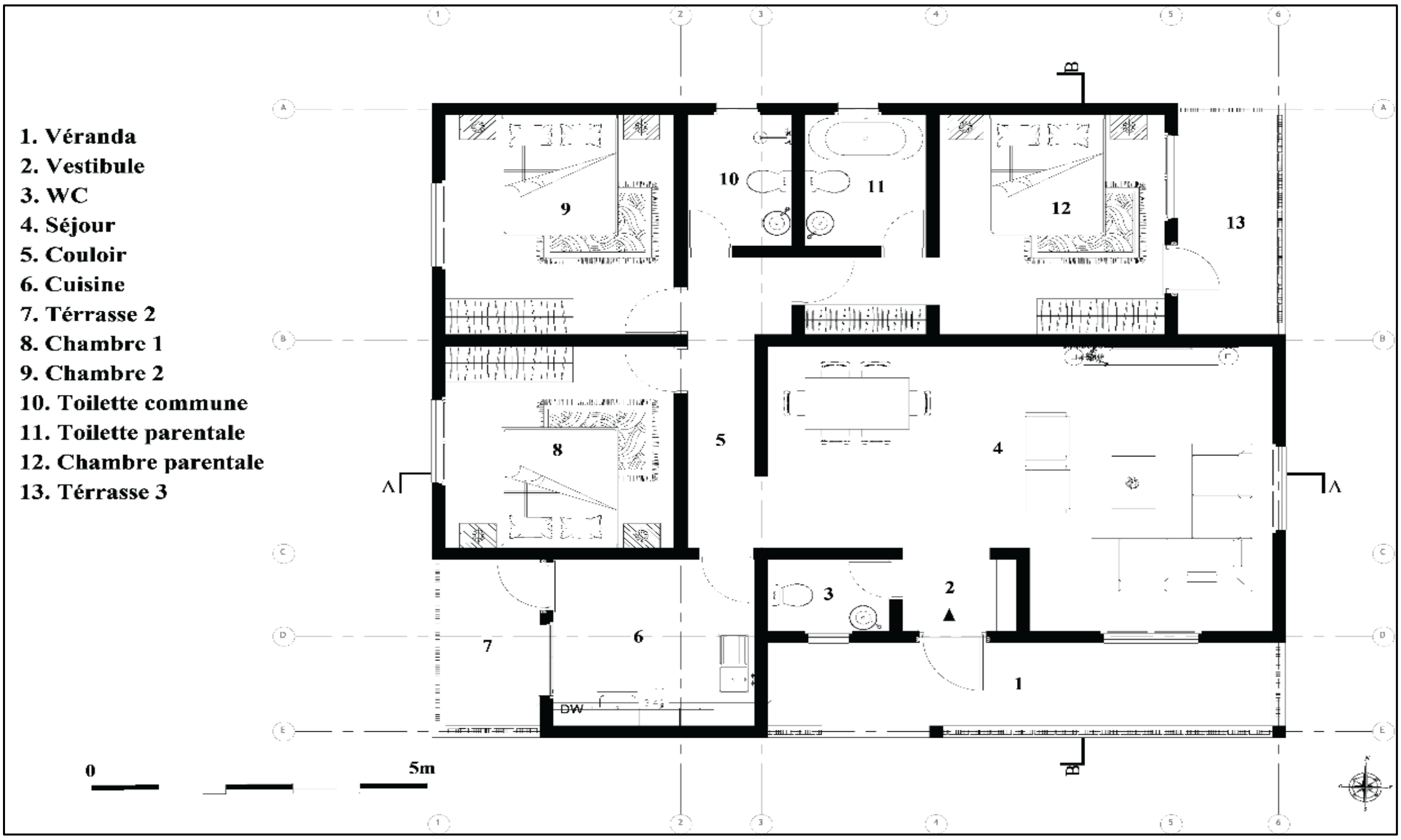

Fig 23 Layout Plan of T4 Housing Unit

➢ *Design Strategy*

- *Building Orientation*

The placement of buildings on the site considers the East–West solar path, with direct morning sunlight from the East and warmer light in the evening from the West. This orientation allows the main façades to benefit from optimal natural sunlight, enhancing interior brightness, reducing reliance on artificial lighting, and improving thermal comfort (Figure 24).

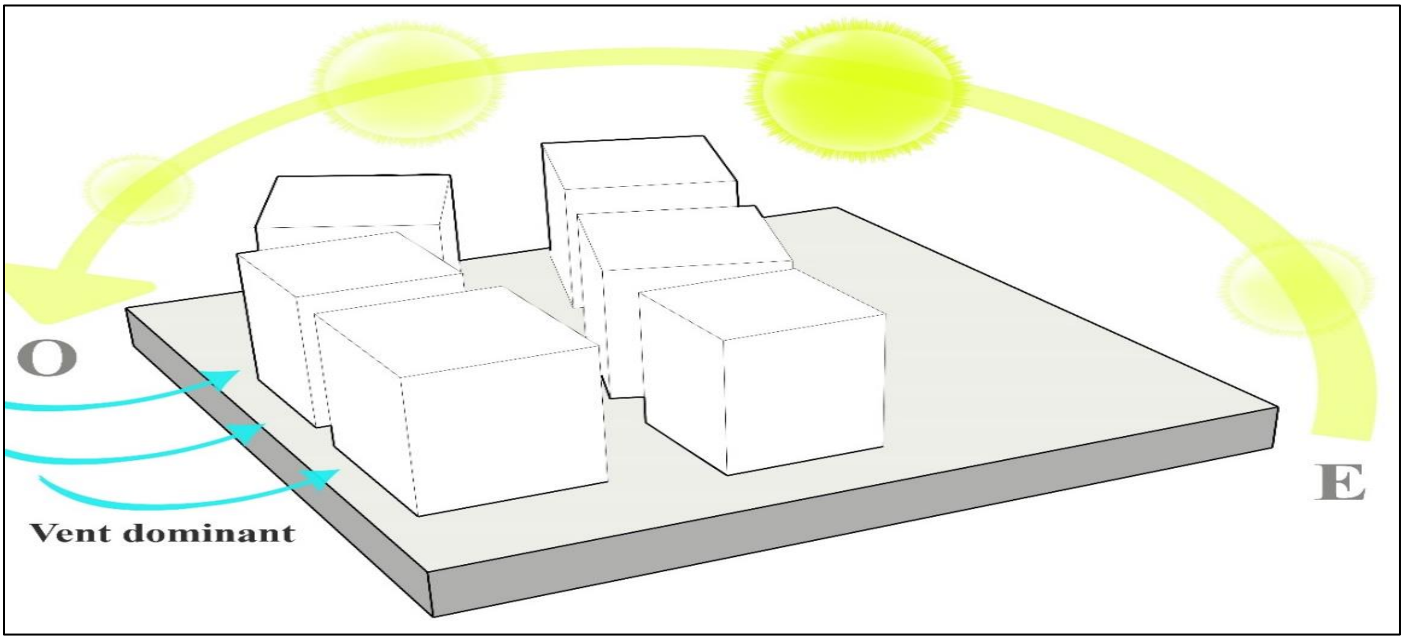

Fig 24 Building Orientation

- *Conceptual Diagram*

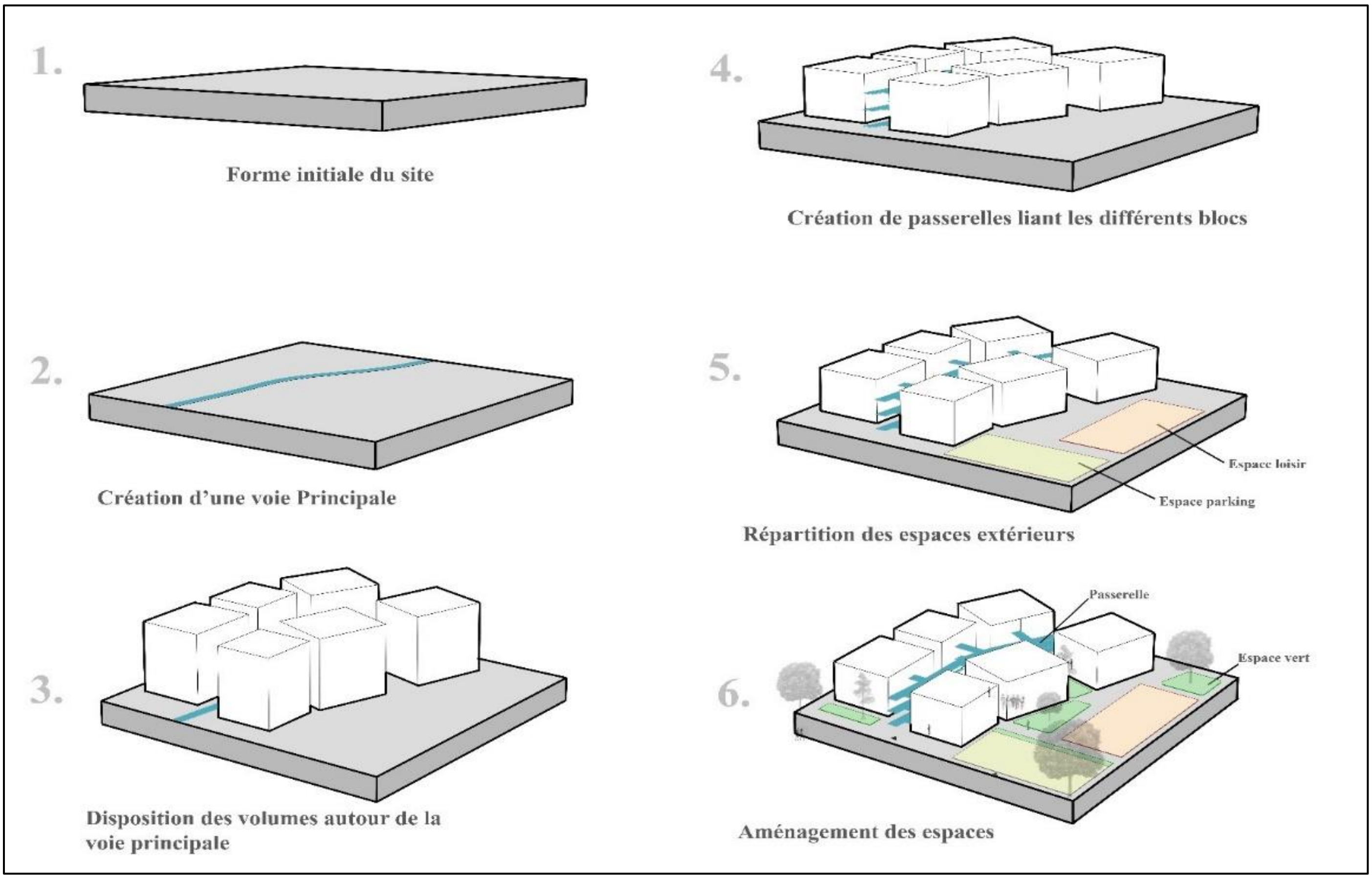

Fig 25 Project Conceptual Diagram

- *Distribution of Outdoor Spaces*

The residential site is organized around several housing blocks coherently distributed across the terrain, with an orientation designed to promote natural ventilation and preserve the privacy of each unit. These buildings are served by staircases and external walkways, ensuring smooth vertical access while structuring internal circulation. A main access road connects pedestrian pathways and parking areas, strategically positioned near the dwellings without compromising spatial clarity (Figures 26 and 27). The layout also includes green spaces and a playground, strategically placed to enhance user comfort, social interaction, and environmental quality. The entire site reflects a functional spatial organization, where each element fits within a logic of use, coherence, and landscape integration.

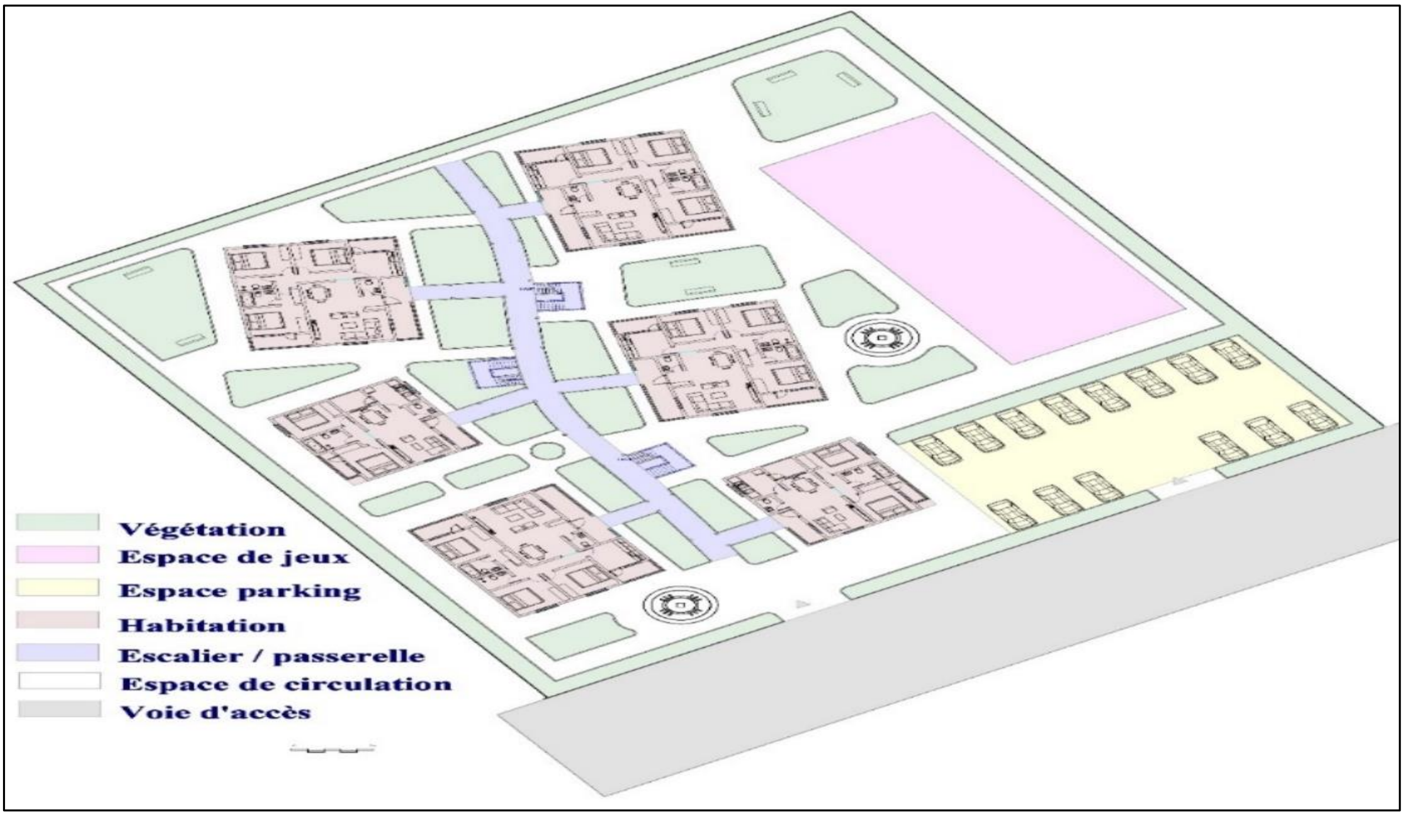

Fig 26 Distribution of Outdoor Spaces on Site

Fig 27 View of the Project's Landscaped Area

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- *Openings*

Louvered casement windows were chosen for their ability to regulate light and airflow while ensuring privacy and security. The same principle applies to terrace doors, ensuring aesthetic and functional continuity (Figure 28). Wood was selected for the joinery due to its local availability and low ecological footprint.

Fig 28 Louvered Window Model

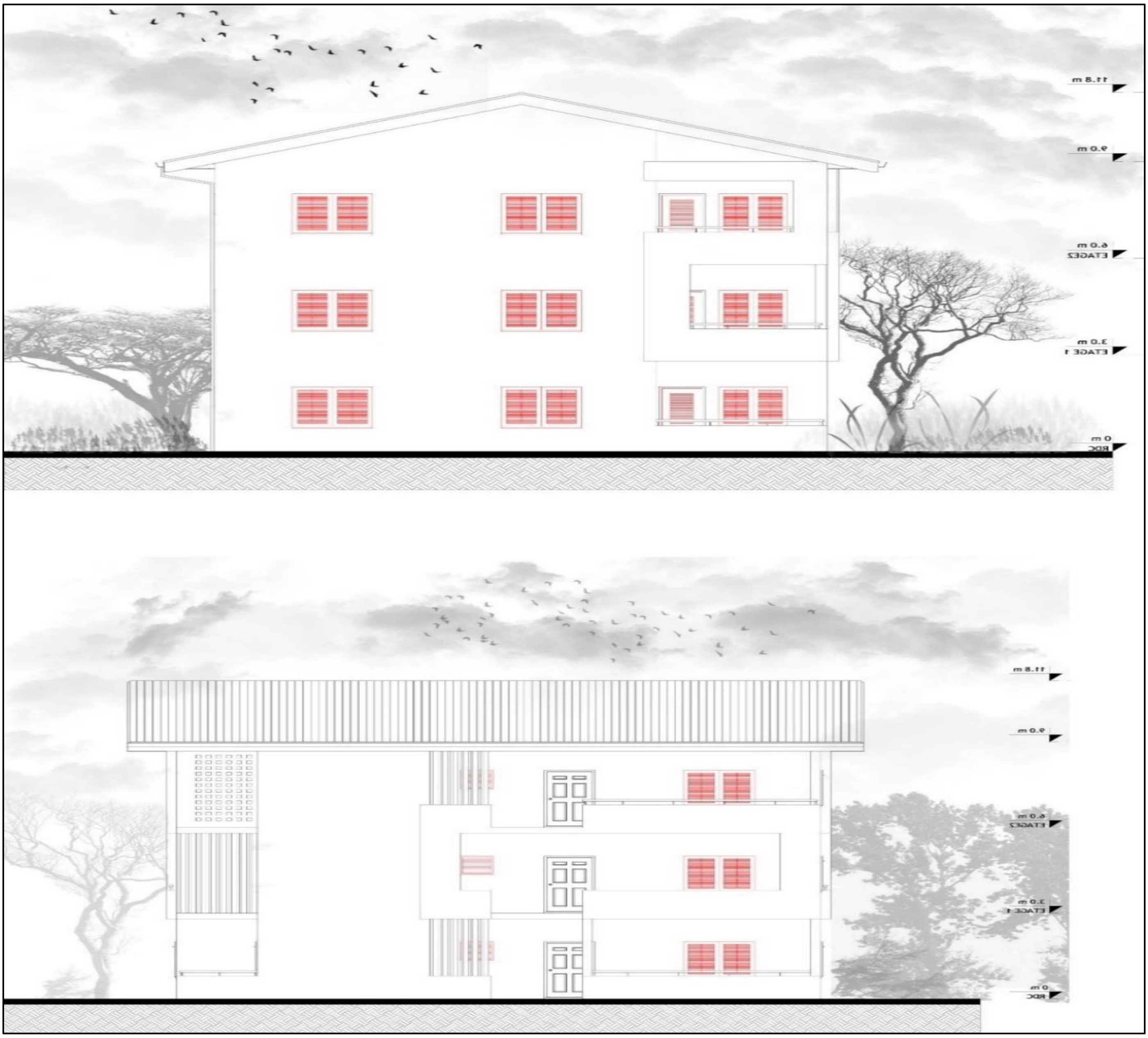

Fig 29 Illustration of Openings on Housing Façades

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- *Sustainable Approach to Ventilation and Lighting*

In this project, the selection and orientation of openings were carefully studied to meet the site's climatic, functional, and ecological requirements. Main openings face southwest and northeast, aligned with prevailing wind directions in the region. This layout promotes cross-ventilation throughout the units while ensuring controlled daylight intake throughout the day.

All rooms benefit from natural ventilation and lighting, helping reduce energy consumption by limiting the need for mechanical ventilation and artificial lighting. The ratio between opening surface area and room surface area is equal to or greater than 1/6, in accordance with current standards, ensuring optimal thermal and lighting comfort.

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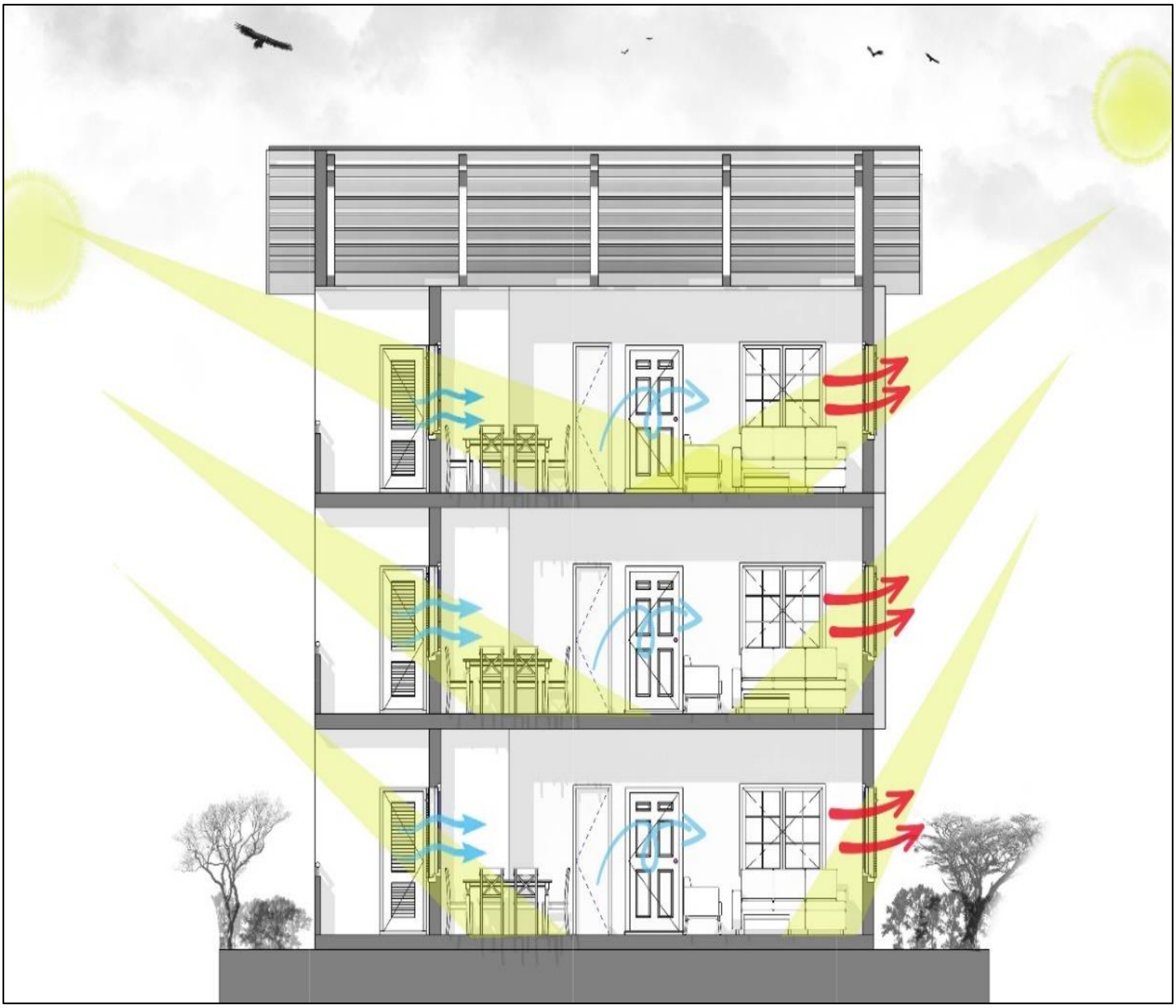

Fig 30 Natural Ventilation System

- *Wastewater Management*

For the plumbing network, a concealed surface-mounted system was chosen. Pipes are grouped within lightweight wooden-frame partitions, clad with locally sourced plywood panels, and routed to a septic tank. This solution offers a clean finish, facilitates maintenance access, and promotes the use of locally available materials.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25sep657

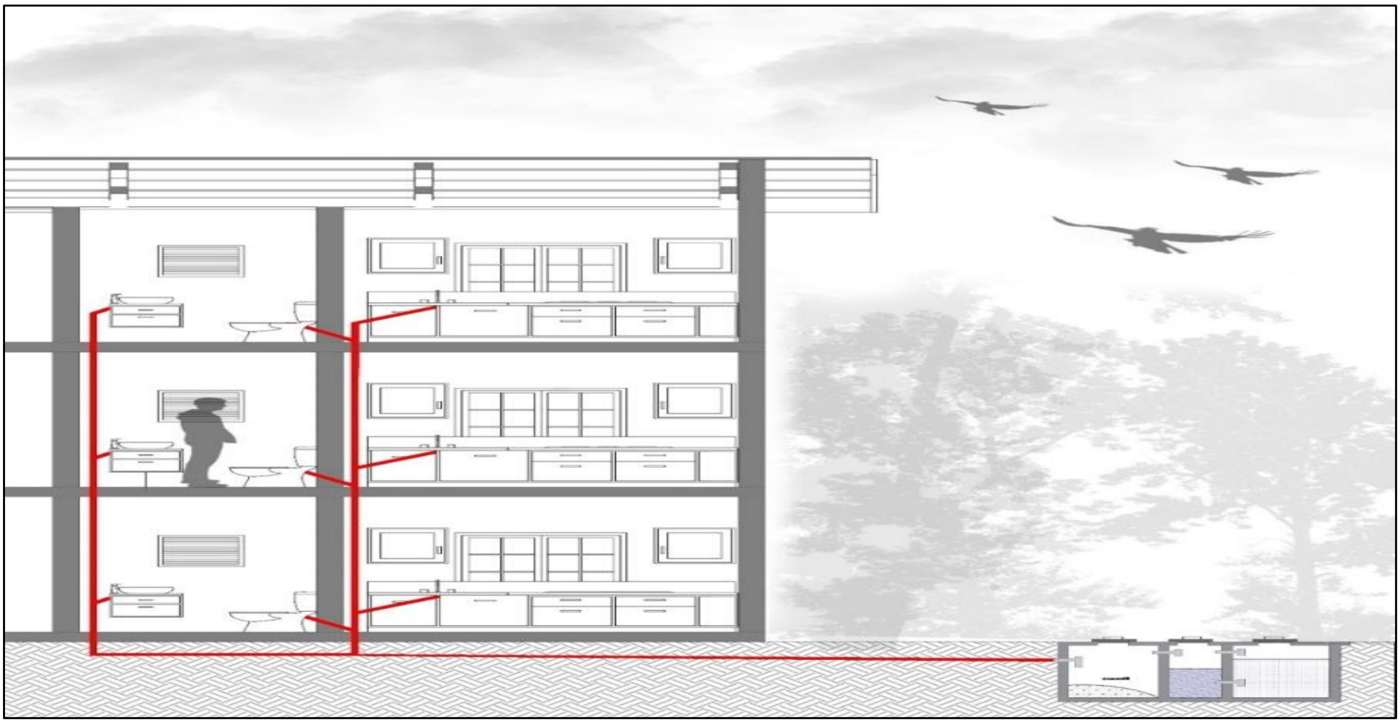

Fig 31 Wastewater Management System

* *Rainwater Management*

The project uses sloped roofs with overhangs to allow rapid water drainage while protecting compressed earth block (CEB) walls from splashes and moisture. The overhangs also provide effective shading, enhancing thermal comfort.

Rainwater is collected via a system of gutters and vertical downpipes, strategically placed to direct water into storage tanks located around the site. These tanks allow secure water storage for reuse in watering green spaces and laundry, reducing dependence on potable water networks.

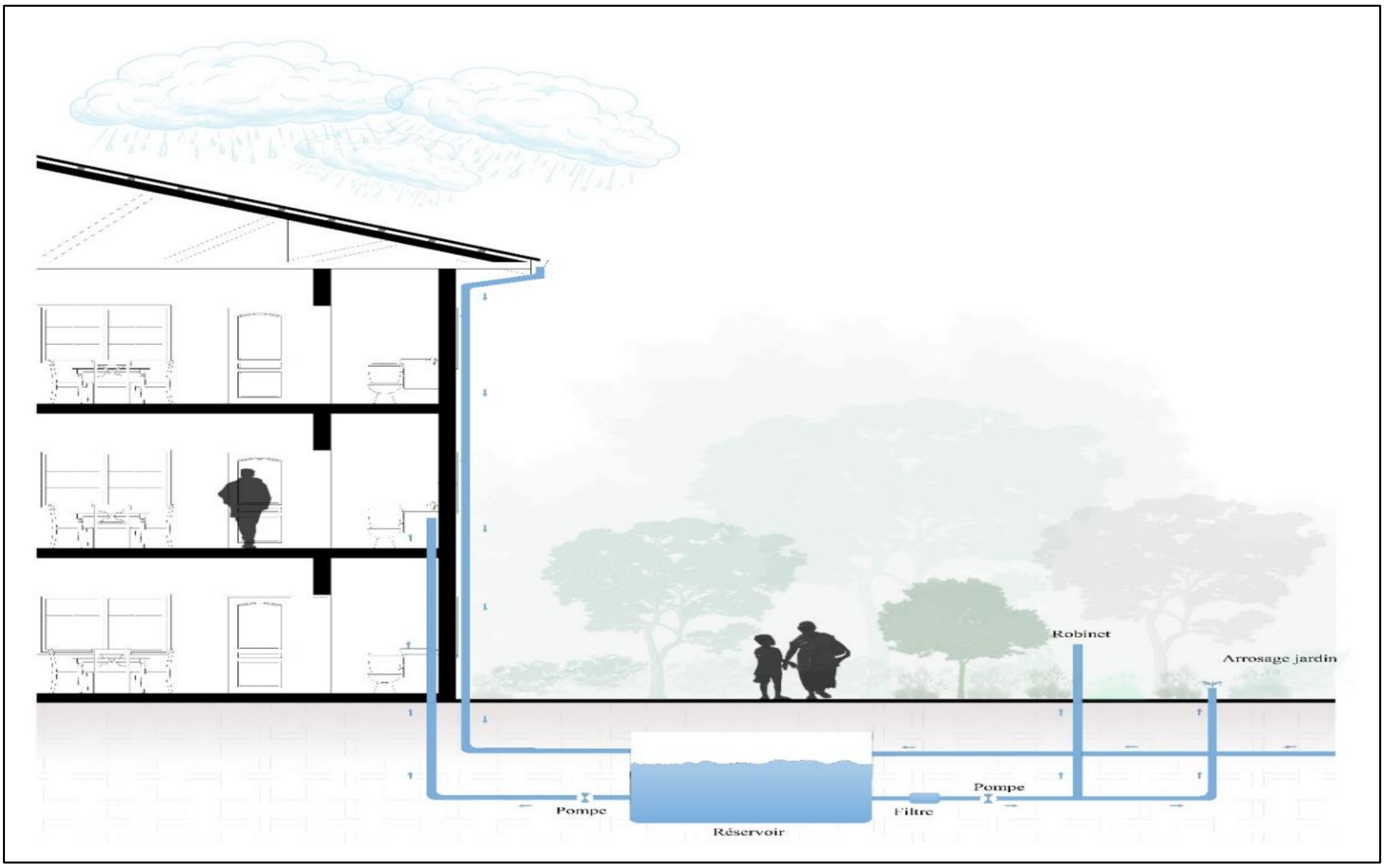

Fig 32 Rainwater Management System

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Integration of Renewable Energy in Design To promote energy autonomy and sustainability, the integration of photovoltaic panels was considered from the design phase. Roofs were designed to accommodate these systems, taking into account orientation, slope, and structural capacity reducing reliance on the electrical grid and improving residents' comfort.

➢ *Materials Used in the Project: Properties and Performance*

- *Characteristics of CEB (Compressed Earth Block), the Primary Material*

✓ *Composition:*

CEBs are produced by compressing a moist mixture of earth and sand, followed by immediate demolding. To improve strength and durability, a hydraulic binder such as cement or lime may be added. Standard dimensions are 315 mm long, 150 mm wide, and 95 mm high.

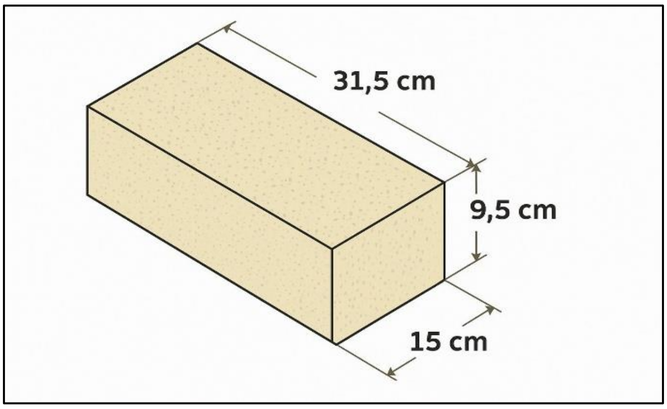

Fig 33 Standard CEB Format

✓ *Ecological Advantages:*

CEB, made from raw earth, offers an eco-friendly alternative to conventional building materials, whose production is energy-intensive and emits significant greenhouse gases. Unlike cement or fired clay, CEB production requires minimal energy, no firing process, and can be done locally reducing transport and resource extraction. The earth used can be sourced directly from the site or from reused excavation material. Throughout the building's life, CEB requires little maintenance and can be easily repaired or reshaped with simple humidification. At end-of-life, it is fully reusable or reintegrated into the soil without environmental impact (Figure 36). These qualities make CEB a low-carbon, durable material perfectly suited for responsible construction.

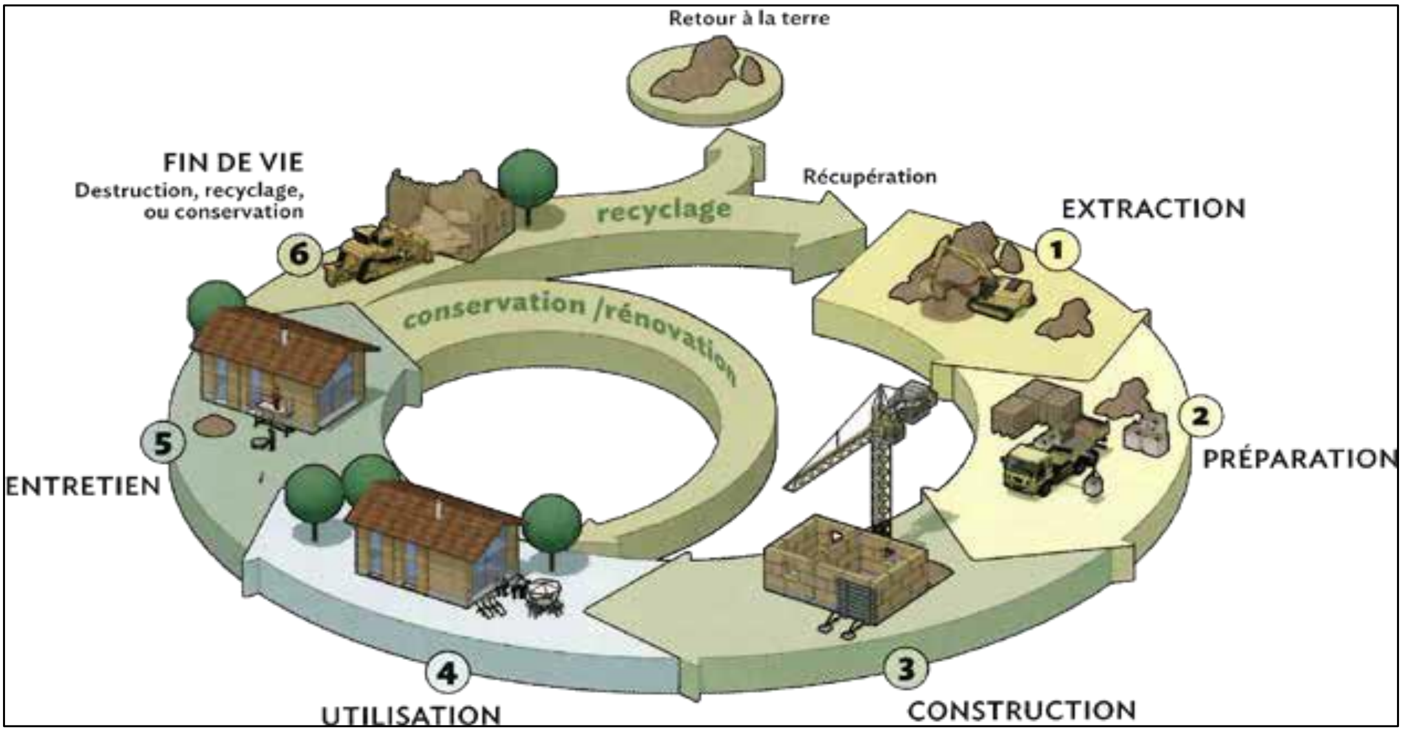

Fig 34 Cycle De Vie Du Matériaux Terre

✓ *Technical Characteristics*

Compressed Earth Blocks (CEB) offer strong acoustic performance due to their open porosity, which promotes sound absorption, and their density, which ensures effective insulation especially for lightweight partitions.

CEB also has excellent hygrothermal properties, thanks to its high thermal inertia that helps regulate indoor temperatures. Its moisture-buffering capacity allows it to absorb excess humidity and release it when the air becomes dry.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25sep657

CEB is highly fire-resistant, being made from earth like stone or concrete which does not burn. Even if it contains small amounts of fiber, it is not easily flammable.

A CEB partition nearly 10 cm thick can withstand fire for about 45 minutes without allowing flames or heat to pass through.

- *Use of Reinforced Concrete as a Structural Material*

In collective housing contexts, where permanent and operational loads are significant, concrete provides long-term structural safety. Its resistance to weathering, thermal variations, and chemical exposure also makes it a suitable choice for tropical regions like Mbouda.

- *Finishing Material*

For this project, we opted for a 25 mm earth plaster as the primary finish for the exterior CEB walls. This choice reflects an ecological, aesthetic, and technical approach. Earth plaster is a natural, eco-friendly, and versatile coating used for centuries to protect and beautify walls. Made mainly of clay, sand, and sometimes plant fibers (straw, hemp, flax), it is easy to apply and suitable for both interior and sheltered exterior surfaces (Figure 35).

✓ *Its Benefits Include:*

- Breathability and natural humidity regulation
- Enhanced thermal and acoustic comfort
- Non-toxic composition
- Warm texture and natural tones that bring authentic aesthetics to spaces

In addition to being repairable and reusable, it contributes to building durability while promoting local resources. Earth plaster also allows for the integration of traditional graphic motifs directly into the surface or in relief, adding a strong decorative and cultural dimension (Figure 36).

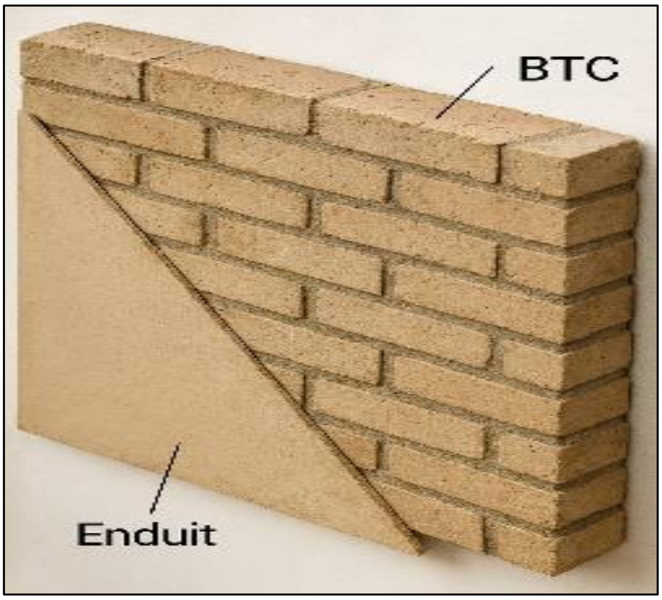

Fig 35 Exterior Wall Finish

Fig 36 Motif Illustration on Project Façades.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25sep657

For interior finishes, the project adopts a coherent and flexible solution using lightweight wooden-frame partitions clad with locally sourced plywood panels. This configuration offers several key advantages:

- High modularity, allowing discreet integration of technical networks (plumbing, electricity) without compromising the structural CEB walls
- Easy maintenance, with access to networks via hatches or removable elements
- A warm, natural finish compatible with various surface treatments such as paint or fine plaster (Figure 37).

Fig 37 Interior Finish with Local Plywood

- *Détails Constructifs*

The maximum height of a wall made with 15 cm thick compressed earth blocks (CEB) is 3 meters, with a maximum length of 4.3 meters. Since the structure is made of reinforced concrete, the columns naturally serve as stiffeners at the ends of the partitions. However, when the distance between two columns exceeds the permissible limit for compressed earth block (CEB) construction, intermediate wooden stiffeners with a cross-section of 150 × 80 mm will be added to ensure wall stability (Figure 38).

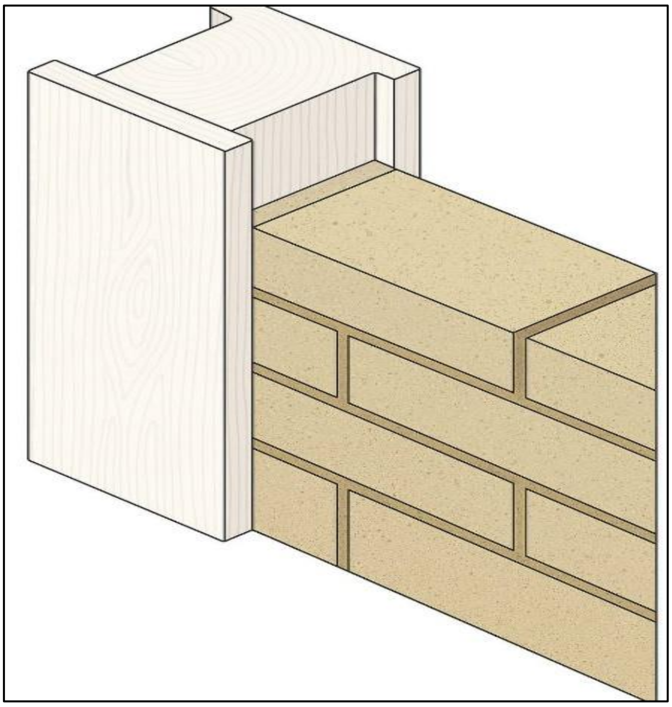

Fig 38 Example of a Wooden Stiffener

Corners must be built by interlocking the rows of blocks to ensure a solid and well-connected assembly from one side to the other, as shown in Figure 39.

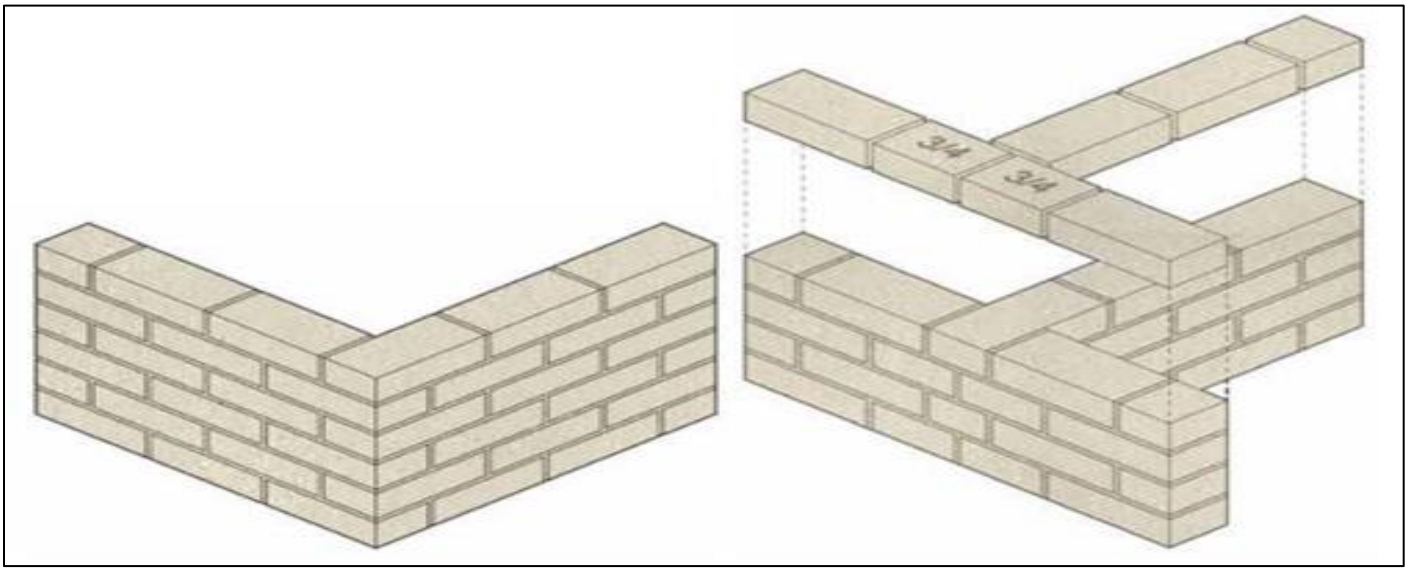

Fig 39 Corner Bonding Principle

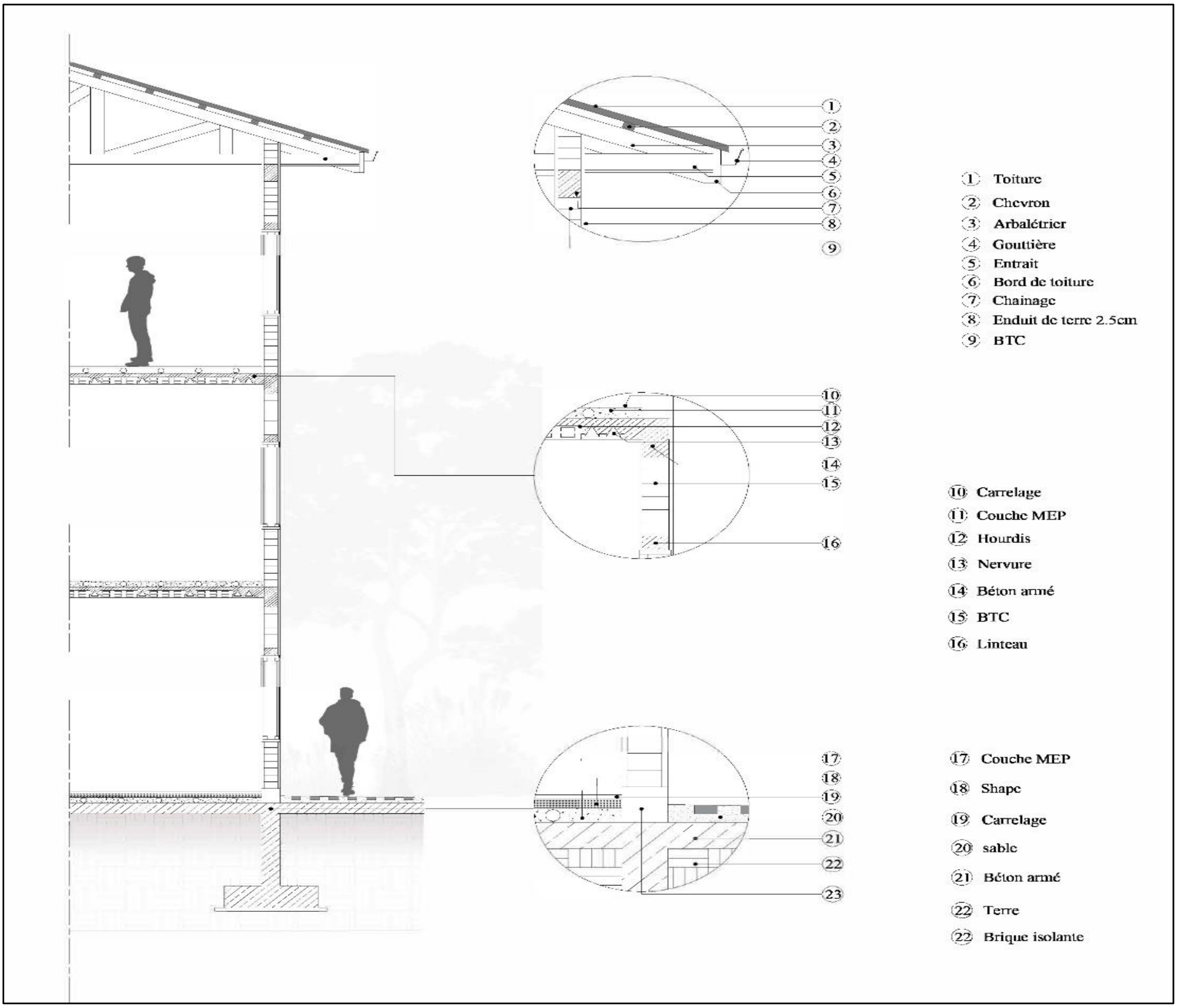

Fig 40 Detail of Framework, Slab, and Roof

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➢ *Building Maintenance*

Earthen plasters require minimal maintenance. Since earth is a relatively soft material, the plaster is sensitive to impact. Any damage can be easily repaired by locally applying a small amount of mortar of the same composition onto the pre-moistened surface. The repair should then be blended using a damp sponge. For shrinkage cracks, moisten the area, fill with adjacent earth mortar, and smooth with a sponge float.

➢ *Project Cost*

The building infrastructure cost was estimated using the guidelines of the National Order of Architects of Cameroon (NOAC). The sustainable social housing project has a total usable area of 1928.4 m² and falls under Category 2, which corresponds to standard projects.

Table 5 Cost Assessment

Designation	Surface (m²)	Cost per m² (FCFA)	Total cost (FCFA)
Infrastructure	1928,4	300 000	578 520 000
Site servicing and external works (30%)			173 556 000
Total			**752 076 000**

➢ *Project Impact*

* *Economic Impact*

✓ Reduced Material Costs: Using locally produced compressed earth blocks (CEB) and earth plaster lowers reliance on expensive industrial materials such as concrete and imported finishes.
✓ Local Resource Valorization: The project boosts the local economy by utilizing available clay soils, plant fibers, and artisanal know-how.
✓ Job Creation: Manual production of CEB, plastering, and cultural motifs generates employment in manufacturing, construction, and maintenance.
✓ Durability and Low Maintenance Costs: The selected materials require minimal upkeep and are easily repairable, reducing long-term expenses for residents and building managers.

* *Social Impact*

✓ Improved Living Comfort: Thanks to the hygrothermal and acoustic properties of CEB and earth plaster, the housing offers a healthy, comfortable environment suited to the local climate.
✓ Community Participation: Incorporating cultural motifs and local materials fosters resident ownership and strengthens the connection between architecture and identity.
✓ Training and Knowledge Transfer: The project promotes the transmission of traditional, sustainable construction techniques while training a new generation of artisans.
✓ Access to Decent Housing: By offering solutions tailored to the financial means of local populations, the project contributes to combating substandard housing.

* *Environmental Impact*

✓ Reduced Carbon Footprint: CEB and earth plaster have low embodied energy compared to concrete and industrial materials, helping limit CO_2 emissions.
✓ Sustainable Water Management: Rainwater harvesting and wastewater treatment systems reduce pressure on natural water resources.
✓ Recyclable and Non-Polluting Materials: The materials used are biodegradable, non-toxic, and reusable at the end of their life cycle.
✓ Bioclimatic Adaptation: The project leverages the thermal properties of earth to minimize the need for heating or cooling, thereby reducing energy consumption.

V. CONCLUSION

This thesis has explored the design and implementation of a sustainable social housing model specifically adapted to the urban, climatic, and socio-economic realities of Mbouda. Based on a detailed analysis of the regulatory and institutional context, it was possible to define architectural and technical guidelines that reconcile functionality, sustainability, and harmonious integration into the existing urban fabric.

The choices made such as the use of optimized local materials like compressed earth blocks (CEB) and wood, spatial organization promoting natural ventilation, rationalization of technical spaces, and the integration of resource-efficient construction solutions demonstrate that it is possible to meet growing housing needs while respecting budgetary and environmental constraints. These solutions, validated through a methodical and rigorous approach, form a technical and conceptual foundation that can serve as a reference for similar projects across Cameroon.

Beyond addressing the initial problem, this work makes a tangible contribution to the broader reflection on the replicability of social housing models. It highlights the importance of a close interplay between architectural design, technical choices, public policy, and the involvement of local stakeholders. However, certain limitations remain, particularly in terms of sustainable financing, standardization of processes, and large-scale dissemination.

The perspectives opened by this research encourage continued experimentation with the responsible industrialization of local materials, energy optimization in buildings, and the integration of modular and adaptable

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solutions. These directions could help establish national standards for sustainable social housing balancing quality of life, environmental respect, and economic viability and thereby contribute to the positive transformation of Cameroon's urban landscape.

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