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ETHIOPIAN VERNACULAR BAMBOO ARCHITECTURE AND ITS POTENTIALS FOR ADAPTATION IN MODERN URBAN HOUSING: A CASE STUDY

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ABSTRACT

Ethiopia is not only endowed with a huge bamboo resource but also has a very rich traditional bamboo housing construction techniques, which have been in use arguably for more than thousand years. These construction practices have several benefits including provision of affordable houses for millions living in rural areas of the country, employment creation, reducing burden on natural forests for housing construction, and income generation. Two types of bamboo species are existing in Ethiopia namely, *Oxytentra abyssinica* commonly known as lowland bam-boo and *Yushania alpine* commonly known as highland bamboo. Both species are used for con-struction of residential houses where several vernacular architectural design approaches are ex-hibited including the Sidama house in Southern Ethiopia. This study particularly focuses on exploring how the existing bamboo construction techniques in Sidama region, provide a platform for provision of houses for emerging towns in bamboo growing areas in Ethiopia. Data collection including observation and personal interview was conducted in the region. The data was processed using both qualitative and quantitative methods where construction techniques and the overall process was analyzed technically and areas of improvement were identified. Based on the findings a modified building constriction system and construction process is proposed.

Keywords: Bamboo, Vernacular Architecture, Urban Housing

1 INTRODUCTION

1.1. Housing Shortage in Ethiopia

Ethiopia's population is increasing at a very high rate. The latest population and housing census conducted in 2007 by the Central Statistics Agency shows the country's population at 74 million; 50.5% male and 49.5% female (CSA, 2007). United Nations population projections show this number passing the 100 million mark by 2015 and reaching close to 190 million by 2050 (United Nations Department of Economic and Social Affairs, 2017).

Although the least urbanized nation in Africa, in the past ten years Ethiopia's urban population has been growing rapidly. This growth is mainly attributed to the influx of rural dwellers in search of a better life and employment opportunities in urban center. Currently 17% of the country's total population lives in urban centers, and in a typical growth pattern of least urbanized nations, its urban population is growing at 5% per year making Ethiopian cities some of the fastest growing in the world (Nyamongo, 2017).

The supply of houses in rural and urban areas in Ethiopia has failed to keep up with growing demand in recent decades. Ever increasing cost of conventional construction materials along with the high cost of acquiring a land led to chronic shortages of safe and affordable housing in the country as well as across the east Africa region, with slums emerging as a dominant and distinct type of settlement in many cities (UN-Habitat, 2010). There is now an urgent need to identify sustainable building materials and technologies to meet the region's demand for housing supply by up - gradation of traditional technologies using local resources or applying modern construc-tion materials and techniques with efficient inputs leading to economic solutions. About 85% of Ethiopia's urban population lives in unhygienic and confined housing conditions (Ellis, 2005; UN-Habitat, 2002). With a population growth of 2.8% per year and accelerated migration to urban centers of 6% per year, the demand for affordable and decent housing is set to increase rapidly in the coming years(Haregewoin, 2007).

Recently, the Ethiopian Federal Government is implementing the Integrated Housing Devel-opment Program (IHDP) that is mainly focusing on providing concrete-built condominium houses for low and medium-income families in urban areas (French & Hegab, 2011). However, the reli-ance on masonry and reinforced concrete building systems in this program has made even the most modest housing units too expensive for the majority of urban dwellers.

In contrast; rural housing is more affordable due to the common application of indigenous con-struction material like bamboo. This is especially true in tropical parts of Ethiopia where bamboo can be harvested from the wild in large quantities. The potential adaptation of indigenes and abun-dant building material like bamboo as an alternative construction material for modern structures could alleviate the cost of housing units in urban Ethiopia. In rural areas, especially in extremely marginalized and poor places, most Regional governments are now also implementing the Rural Clustered Village Settlement Program. Under this programs the use of local natural resources, particularly bamboo, is being promoted. This new village policy makes the provision of basic services like education, security, water, electricity and agricultural extension services easy and economical to Regional governments. Due to these developments, the need for a sustainable building material is especially high in Ethiopia; with forest cover accounting for less than 3% of Ethiopia's total area(FAO, 2010), timber is scarce, while other non-renewable building materials, such as concrete, are relatively expensive and often have high environmental impacts.

1.2. Vernacular Architecture

Vernacular architecture is a term used to categorize method of construction using traditional knowledge and ingenious locally available resources to address local needs. This type of archi-tecture provides highly responsive techniques towards addressing climatic constraints and show high amount of adaptability and flexibility (Shanthi Priya, Sundarraja, Radhakrishnan, & Vijayalakshmi, 2012). Vernacular traditions lead a way towards the sustainable built environ-ment. The valuable lessons from vernacular can be integrated with the modern to produce sus-tainable designs. Vernacular traditions can also be used as a design tool for housing programs however the designing of these settlements need understanding users' way of life, social and cul-tural values (Shikha & Brishbhanlali, 2014)

1.3. Potentials of Bamboo Building Materials as Solution to Ethiopian Housing Needs

In Africa, Ethiopia, Kenya and Uganda possess most of the bamboo resources, according to the world bamboo resources assessment report (Zhao et al., 2018). Among the three countries, 86% of the African bamboo resource is distributed in Ethiopia. Two indigenous species of bamboo in East Africa are *Yushania alpina* (highland bamboo) and *Oxytenanthera abyssinica* (lowland bam-boo).

Bamboo, a native, renewable East African forest resource, could be one alternative source of sustainable building material that can help the region meet its housing

needs. Decades of research by bamboo practitioners has validated that, when treated and used properly, bamboo is a sound structural and engineering material (Janssen, 2000), which, due to its strength, flexibility and versatility, is a suitable material for use in housing.
Although bamboo has traditionally played an important role in the rural economies of East Africa, due to indiscriminate clearing of natural forests and the lack of government policies to support development, bamboo resources have diminished rapidly across East Africa, with subsequent erosion in the status of the resource (KEFRI, 2007).

2 METHODOLOGY

Case studies focused on the vernacular bamboo architecture of the Sidama People in southern part of Ethiopia and its adaptability to modern urban housing is investigated. Both primary and secondary data are collected through field observations, literature review and interviews of the local artisans. The steps which were followed during the field study include information gather-ing, on-site observation, interview with local people, photography and visualization of some building elements by means of sketches.

The findings from the study are grouped into seven sub-categories. The sub-categories include: sustainable design culture; sustainable land use; designing for durability; construction materials and techniques; construction waste management; energy efficiency; and indoor air quality; and

2.1 The Sidama People

The Sidama people are found in the Southern Nations Nationalities and Peoples Region (SNNPR) of Ethiopia whose capital city is Hawassa. The district has an area of 7672 km2 and a population of 2,954,136 (CSA, 2007). It is located between 5°45' and 6°45' N latitude and 38° and 39° E longitude. The altitude varies from 1500 to 3500 m asl. The areas above 2000 m asl are generally suitable for growing bamboo. The people in this region have access to natural forest highland bamboo, but majority of them traditionally practice private bamboo farming.

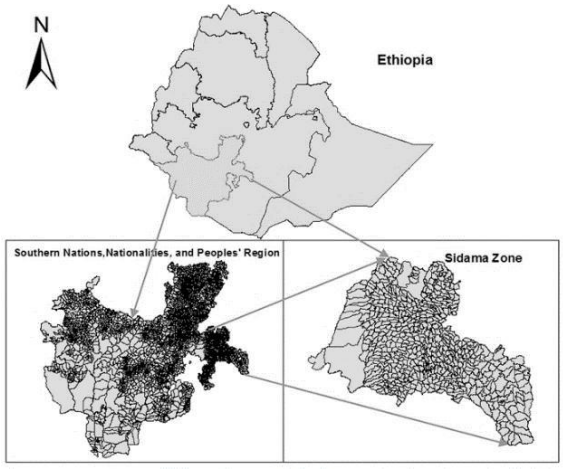
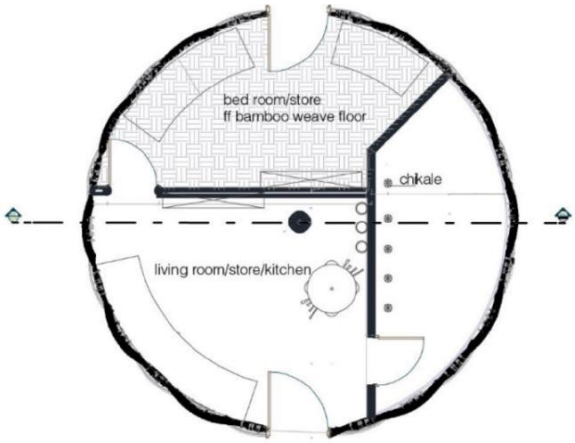


Figure 1. Map of the study area (Sidama Zone)

2.2 House Form, Orientation and Basic Construction Systems

2.2.1 Spatial Layout of Sidama House

The Sidama house is a unique beehive shaped structure that is finished by fixing a layer of undifferentiated woven bamboo onto the structure. Partitions are also made of woven bamboo. Most of the houses have two entrances, a back and front entrance. The back entrance is meant for use by the cattle and sheep while the front entrance by the people.



(a) *(b)*

Figure 2. Sidama House (a). View (b). Spatial layout

Traditionally the house has 3 parts; the residential, the cooking space and the 'Arkata' for a cattle and crop store. The interior is accessed through a porch and it's divided into 'Olico' which is further divided into 'Holge' (parents sleeping area) and 'Bosalo' (sleeping area for children's and guests). The 'Bosalo' is also used for storing production materials and other small items. The central pole 'Helicho' is very important in Sidama culture. The older people 'Chamesa' wouldn't enter the house unless the house has central pole.

2.2.2 Foundation and Structure

Juniper tree poles are used as a component for the foundation. It is applied for the foundation because of its longevity and being proven to protect against pest attack like termites. The poles are imbedded to the ground '*Mokolicho*' is used as reinforcement bars. Thin strands of bamboo are placed around the perimeter of the house. It can be placed up to 100 to 150cm underground. '*Hicho*' are smaller bamboo that are not split and are used for weaving the interior and exterior walls.

Fig 3. Juniper tree poles used for foundation

2.2.3 *Wall*

The construction of the walls is made by splitting the bamboo to smaller strips and uses whole bamboo with smaller diameters. The interior wall of the Sidama hut has two different types of patterns. (‘*Hilo*’ and ‘*Himbiro*’) The ‘Hilo’ pattern follows a linear weaved form, which has a basic parallel appearance. Whereas the ‘*Himbiro*’ pattern has a diagonal weaved pattern.

The interior wall of the hut has a wall finish known as ‘*Lemicho*’. The wall finish can have an extra layer called ‘*Chicha*’. The ‘*Chicha*’ can be applied in different colors, patterns and sizes. The material used for waterproofing the hut ‘*Honche*’ or bamboo sheath (Fig. 4). It is harvested from the skin that the bamboo shoot sheds. It is placed in four layers all around the hut. The exterior wall of the Sidama hut is weaved with a pattern called ‘*Fuko*’; which has an overlaying effect on the façade.

(a) (b)

Fig 4. Wall section, (a). Interior skin of wall, (b). Exterior skin of wall

2.2.4 Roof

A beautiful dome or dome like shape is made for the roof with a triple layer of bamboo splits and ropes for structural support, culm sheaths for insulation and rain protection. A woven basket like cover on the outside ties everything together and protects the house against wind (Fig. 5).

(a)

(b)

(c)

(d)

Fig 5. Dome structure, (a). Weaving of bamboo strips to form dome shape, (b). Erection of the dome, (c). Construction of door shade, (d). False umbrella cover for aesthetics

2.3 Methods of Bamboo Treatment

Smoking of house: dry grasses, paddy stems, dry leaves, dry bamboo leaves, rice husk and some amount of green leaves and branches are used for smoking of house. The smoking is done under the observation for 2-3 days.

3. PROBLEMS AND ISSUES WITH TRADITIONAL BAMBOO HOUSES

Most of the present dwellers of bamboo houses belong to the socially and economically weaker sections in the society. Probably due to their poor economic condition. They opt for low cost bamboo houses and hence are of low quality. Thus economic conditions of the dwellers must be improved to construct quality bamboo houses.

Demand of bamboo for the construction sector is more than the total supply of bamboo. Quality bamboos, at low cost must be made available to people who wish to construct bamboo houses.

Most of the bamboo community is aware of the construction technology and traditional bamboo preservation techniques. If financial help is provided they can build reasonably safe buildings for themselves with little training on latest technology interventions.

Bamboo may be grown in wastelands and mid and lowland areas and homesteads should be encouraged. All this can be included in the plantation programs of the Forest Departments in rural and tribal areas.

Rationing of bamboos in areas where its supply is less or price is more can be thought of. More bamboo depots may be established by the Forest Departments in different parts of the country so that the dwellers can buy bamboo easily.

The government should include bamboo as a construction material in their housing heme thereby upgrading the status of bamboo houses. Economical technology for eservative treatment of bamboo should be popularized for construction. Some model oo houses suitable for local conditions and weather can be constructed to popularize the same among the people.

Table 2. Lessons from vernacular Architecture of Sidama People

Aspects	Parameters	Particulars
Socio-Cultural	Family Structure	Nuclear family structure
	Fairs & Festivals	The festivals are governed by nature, like the festival of 'Fitche Chambalala'
	Community Participation	A group of men from the 'Chinacho' which are a crew of skilled weavers, are called on for the construction of the homes with the help of the other members of the community.
	Belief and rituals	The vernacular buildings reflect the environmental and climatic circumstances, which are well integrated into religious or spiritual convictions, and strongly tied to the ancestors and the social community, ritual and symbolism
Ecological	Building with nature	The form and the structure of the Sidama house is mainly the result of the topography, climate, culture and material used.
	Family Name/Identity	Family names and identities are associated with nature. Therefore they never harm them
Architectural	Site selection	The houses are built on plateau surrounded by the hills, site is usually close to the source of water. The construction is done on non-fertile land.
	Climate responsive	The house form is evolved as per the climatic condition. Less openings are provided due to extreme temperature. The bamboo material gives an optimum indoor thermal qualities in all seasons
	Settlement pattern	It has circular settlement pattern with the community space at the center

	Materials	Almost entirely built from bamboo
	Construction Method	A beautiful dome or dome like shape is made for the roof with a triple layer of bamboo splits and ropes for structural support, culm sheaths for insulation and rain protection. A woven basket like cover on the outside ties everything together and protects the house against wind.
	Aesthetics	The interior of the walls and doors are decorated with bamboo matts
Economic	Livelihood	Contribution to the household income from bamboo harvesting
	Resource management	Judicial use of materials
	Waste management	Building materials provided from the closest environment do not generate waste while in use or after use because they are organic in nature

CONCLUSION

The form and the structure of the Sidama house is mainly the result of the material used. The onion shape and circular plan are created through the flexibility of the bamboo plant. They prefer to do most of the construction work in groups. A group of men from the 'Chinacho' which are a crew of skilled weavers, are called on for the construction of the homes with the help of the other members of the community. The people in the Chinancho select a leader called 'Murcha' to su-pervise the whole construction process which takes 2-8 weeks. Members who do not cooperate are excluded from the group. Currently the highly advanced traditional skill of building is inher-ited and passed down within the family from fathers to sons to grandchildren only. Therefore, it is important that the Ethiopian Government and bamboo sector, should work closely with local builders to improve traditional architecture. This could be targeted through the Rural Clustered Village Settlements program which provides opportunities to improve rural poor housing in Ethi-opia through humanitarian programs.

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REFERENCES

Ellis, F. (2005). ETHIOPIA PARTICIPATORY POVERTY ASSESSMENT 2004-05 by Frank Ellis and Tassew Woldehanna 15 October 2005 (This version of the PPA will be published by MoFED , Addis Ababa in 2005 , and should be cited as ' forthcoming ' until official publication .). *October*.

FAO. (2010). G Lobal F Orest R Esources C Ountry R Eport. *Global Forest Resources Assessment 2010*, 51.

French, M., & Hegab, K. (2011). *Condominium housing in Ethiopia : the integrated housing development programme.*

Haregewoin, Y. M. (2007). Integrated Housing Development Programs for Urban Poverty Alleviation and Sustainable Urbanization (The Case of Addis Ababa). *ENHR International Conference on Sustainable Urban Areas*, 20. Retrieved from http://www.enhr2007rotterdam.nl/documents/W17_paper_Yewoineshet.pdf

Janssen, J. J. A. (2000). *Designing and Building with Bamboo*.

Kigomo, B. (1988). Distribution, Cultivation and Research Status of Bamboo in Eastern Africa. KEFRI, Ecology Series (B) 8(1-2): 5-13.

Shanthi Priya, R., Sundarraja, M. C., Radhakrishnan, S., & Vijayalakshmi, L. (2012). Solar passive techniques in the vernacular buildings of coastal regions in Nagapattinam,

TamilNadu-India - A qualitative and quantitative analysis. *Energy and Buildings*. https://doi.org/10.1016/j.enbuild.2011.09.033

UN-Habitat. (2002). Sustainable Urbanisation: Achieving Agenda 21. *Agenda*, (August).

Zhao, Y., Feng, D., Jayaraman, D., Belay, D., Sebrala, H., Ngugi, J., … Gong, P. (2018). Bamboo mapping of Ethiopia, Kenya and Uganda for the year 2016 using multi-temporal Landsat imagery. *International Journal of Applied Earth Observation and Geoinformation*. https://doi.org/10.1016/j.jag.2017.11.008