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Examining change and permanence in traditional earthen construction and preservation in Ghana: A case study of Tamale and Wa

Examining the change and permanence of traditional earthen construction and preservation in Ghana: A case study of Tamale and Wa

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Abstract:

The architectural style found in Wa and Tamale is renowned for its distinctive use of earthen construction, which features square buildings with flat roofs and circular compounds with conical thatch roofs. These structures show how the materials and design in northern Ghana have substantially evolved. However, what forces drive the changes in cob construction in this region? Furthermore, how might these changes impact the preservation of cultural heritage in Ghana? Recently, there has been a growing inclination towards using alternative construction techniques in which nontraditional materials such as cement, bitumen, and used car engine oil are utilized to render wall surfaces. To explore the factors that contribute to the departure from traditional earthen building methods that rely on local materials, this study employs a constructivist research approach. Participants in a survey that informed this study revealed that they struggled to access building materials to construct their houses. While most of the people who responded to the survey have resided in buildings constructed with a mixture of beini and dawadawa, they hesitate to use plant-based biostabilisers in new constructions. Factors that hinder the ongoing construction and preservation of earthen buildings include shifting cultural and social norms, environmental changes, difficulties accessing local building resources, flood risks, regular maintenance requirements, and societal influences. This study concludes that if communities are empowered to take ownership and recognise the value of their cultural heritage, they are likely to be increasingly aware and appreciative of their architectural heritage. Thus, their local heritage will be preserved.

Keywords: Change, Permanence, Preservation, Earthen construction, Transformation, Cultural heritage, Ghana

1 Introduction

After many years of being overlooked by building professionals and policymakers, earthen architecture, also known as vernacular architecture or adobe architecture, has been recognised for its numerous benefits, including creativity, sustainability, and heritage values (Asquith and Vellinga, 2006; Palumbo et al., 2011; Correia, 2018; Moriset et al., 2021). Earthen architecture as a 'cultural heritage encompasses a much wider set of traditions, practices, skills, and features – some tangible and some intangible' (Venture et al. 2021, 396). Although it was previously the most widespread construction type at the peripheries of urban Ghana, earthen architecture is under significant threat. It is often regarded as outmoded and an obstacle to modern living (Asquith and Vellinga, 2006). In terms of technology, people have begun to replace earth with industrialised building materials (Addo, 2016; Appeaning Addo, 2023), which has resulted in building transformations and the gradual loss of tangible and intangible heritage. Moriset et al. (2021) identified several reasons for abandoning vernacular earthen architecture, including people rejecting archaism, wanting to avoid regular maintenance, aspiring to live a modern life, and losing the necessary skills. Moreover, Moriset et al. (2021) posited that the integration of endogenous knowledge into contemporary architecture through hybrid designs may preserve earthen heritage and inspire young people, which may, in turn, revitalise earthen architecture in the 21st century.

The endeavour to formalise earthen structures as a component of Ghana's cultural heritage began in recent years. In 2022, Sébastien Moriset conducted an earthen heritage diagnosis in Ghana, applying the framework of the French Embassy in Ghana Fund for Innovative Projects (FSPI) 'Sankofa project' to identify and document earthen structures in Ghana (Moriset, 2022). Moriset and two other Ghanaians were tasked with diagnosing some of the ancient earthen mosques for preservation by the Ghana Museums and Monuments Board (GMMB) and for the eventual preparation of a World Heritage nomination file. Unfortunately, domestic earthen buildings have not been considered for preservation because of the ongoing transformations in practice and architecture. This paper argues that the ongoing transformation of the materiality and construction techniques of earthen buildings in northern Ghana could lead to the gradual loss of tangible and intangible architectural heritage. This loss could also complicate the recognition of traditional domestic earthen architecture as cultural heritage. Thus, this research examines the factors driving transformations in earthen-building cultures in Tamale and Wa.

Earthen building culture in Wa, specifically the cob construction technique, is characterised by square buildings constructed with earth and timber to support flat earth roofs, which are often used for drying cereals (Owusu, 1994). Traditional Sudanese mud-brick architecture is exemplified by the Wa Naa's Palace, which was listed as a World Monument Site by UNESCO in 2008. In Tamale, the earthen building culture mainly consists of Dagomba compound housing. The north-facing circular buildings in the Dagomba compound have thatch roofs arranged around courtyards that include several buildings for different uses, including sleeping, storage, and cooking (Appeaning Addo, 2023).

Cultural practices such as the construction of earthen buildings are unique to their communities, and since cultures are so dynamic, a generalised approach does not apply; thus, international conventions such as the UNESCO framework on world heritage are the only justification for preserving earthen architecture. Di Giovine (2017) argued that the UNESCO World Heritage Programme should be seen as 'a fundamentally ethical framework aimed at slowly cultivating a new, and ostensibly more peaceful, world system by appealing to communities at a grassroots level to responsibly embrace and act on a particular conception of heritage'. In line with the heritage value of earthen architecture, Moriset et al. (2021) posited that if people understood earthen buildings, they would change their course and rethink their relationships with not only buildings but also various forms of life on earth. However, in this era of urbanisation and globalisation, communities are being exposed to other building materials beyond what they can find in their locality.

An old publication by the Faculty of Architecture, University of Science and Technology, Kumasi, Ghana (1978), established that the bark of dawadua (dawadawa tree) and cow dung were used as floor finishes in northern Ghana. However, these materials are rarely included in contemporary earthen buildings. For example, Appeaning Addo (2023) reported that industrialised materials such as cement and bitumen are now used on external wall surfaces, with the assumption that the use of these materials can prolong the lifespans of buildings and reduce their need for regular maintenance. However, since cement does not bond well with the mud in these buildings, these modern techniques have not been efficient.

Broadly, this study seeks to identify the factors that have contributed to the shift from earthen buildings to cement-based construction in northern Ghana and the implications of this shift in earthen architecture preservation as a cultural heritage. Specifically, this study aims to achieve the following objectives: (1) to examine various building typologies and the evolution of earthen architecture, (2) to determine the factors that contribute to these transformations, and (3) to evaluate the implications of these transformations for earthen building culture and the preservation of heritage. This paper is part of a larger project examining the adaptation and self-recovery solutions for the resilience of earth buildings to flooding in northern Ghana. This study focuses on Tamale and Wa, which are cities in northern Ghana, because of differences in indigenous housing design and construction techniques for earthen buildings between these two cities. Additionally, these two cities frequently experience flooding, which is revealed as a critical factor affecting people's perceptions of the resilience of earthen structures. The following section reviews the literature on earthen architecture traditions in Africa and discusses cultural policy in Ghana.

2 Earthen architecture traditions in Africa: Construction, vulnerability, heritage, and preservation

For millennia, traditional societies on most continents have used locally accessible materials for constructing buildings. In 2015, Varum et al. reported that approximately 30% of the world's population lived in earth-based buildings. This percentage increases to 50% in the rural areas of developing countries but decreases to approximately 20% in urban areas. However, by 2021, with rapid urbanisation and population growth, the number of people living in earthen dwellings had decreased to approximately 10% worldwide, with 20-25% in the rural areas of developing countries (Marsh and Kulshreshtha, 2021). The oldest structures in the tropical savanna zone are earth-based, which has long been the most widespread construction type. The typical construction techniques for these structures are adobe, wattle and daub, rammed earth, and cob.

In Africa, earthen homes are prevalent and are a prominent architectural characteristic. These earthen homes are considered cost-effective and environmentally friendly and have excellent thermal performance owing to their thick walls and high thermal mass. Considering the growing housing shortages in Africa, policymakers and academics have appealed for earth homes to be constructed, as they constitute a promising solution to the low-income housing challenges on the continent (Ugochukwu and Chioma, 2015). For example, Ugochukwu and Chioma argued that locally produced building materials and intermediate technology can reduce construction costs by approximately 60 percent for low-cost housing in Nigeria while asserting that the reinvention of local building materials and technologies 'should not be on the material alone but the methods in which the material and its products are utilised for creating architectural splendour in structures' (Ugochukwu and Chioma 2015, 48). Because of these considerations and the benefits of earthen architecture more generally, it has been proposed that earth construction techniques (ECTs) should be incorporated into the architectural curriculum of tertiary institutions in Nigeria (Ali et al., 2010; Bobbo et al., 2015).

Furthermore, the use of earth as a construction material is associated with several advantages. For example, earth can significantly reduce the environmental impact of current building practices (Pacheco-Torgal and Jalali, 2012; Schroeder, 2016; Costa et al., 2019; Meek et al., 2021), as it is readily available locally and highly recyclable if it is built without chemical stabilisers (Bruno et al., 2017). Moreover, even if it is chemically stabilised, earth can be significantly less expensive than conventional brick and concrete as a building material. Thus, earth may be less environmentally impactful in addressing the demand for affordable housing and remain ecologically benign (Zami and Lee, 2010). As a building material, cement-stabilised rammed earth has been found to have sufficient strength and durability for constructing load-bearing walls exposed to wind and rain with low embodied energy (Kariyawasam and Jayasinghe, 2016). Fabbri et al. (2021) studied the characterisation, hygrothermal nature, resistance to earthquakes, durability, and codes and standards of earthen construction and demonstrated that earth building materials may be better adapted to today's technical and economic constraints. They argue that 'the establishment of comprehensive regulations and codes for earth material is an absolute necessity both to help designers and to develop the field of earthen construction' (Fabbri et al. 2021, 155).

Despite these advantages, there has been a gradual global shift from the use of earth as a construction material to more modern building materials such as cement/concrete, fired brick and tiles, steel panels, and plastics, which are seen as having more benefits (Tomasi and Barada, 2021; Marsh and Kulshreshtha, 2022). Both technical and social factors underpin this shift from earthen building construction. Notably, earth-based buildings are perceived as vulnerable to earthquakes, tropical storms, major windstorms, and flooding because, traditionally, they are not reinforced, and the roof-tie-down anchorage may be weak (Morris, 2012). Moreover, construction techniques may influence the durability of earthen structures. Certainly, construction guidelines for rammed-earth house design in seismically active zones still need to be developed (Thompson et al., 2022).

Ready access to industrialised building technologies and the disdain associated with staying in earth buildings have contributed to the gradual loss of earthen architecture (Bangdome-Dery et al., 2014; Addo, 2016; Widera; Moriset et al., 2021; Appeaning Addo, 2023). Other reasons include the desire for modern buildings, urbanisation, the colluding of cultural values, the colonial experience, and Western education (Appeaning Addo, 2016; Arenibafo, 2017; Oyelami and Rooy, 2018; Moriset et al., 2021). However, this shift from earthen architecture has resulted in a housing deficit, the loss of traditional building skills, the adoption and use of foreign building methods and standards, health challenges (Widera, 2021), hybrid building styles (Alamsyah et al., 2019), and the loss of material cultural heritage (Moriset et al., 2021).

3 Earthen architecture as heritage in Ghana's cultural policy

Traditional earthen architecture is considered one of Ghana's material cultural heritages that needs to be preserved by the GMMB. In Ghana's cultural policy, which was first developed by the Cultural Division of the Ministry of Education and Culture in 1975 as part of the UNESCO convention and reviewed in 2004, earthen architecture was considered a national cultural heritage. The Ministry of Tourism, Arts and Culture reviewed this cultural policy again in 2003, with the goal of encapsulating the cultural tapestry of Ghana vis-à-vis globalisation, the digital revolution, the evolution of the creative arts, and its impact on emerging economies to eventually promote social, economic, and sustainable development in the country. This cultural policy prioritises protecting, conserving, and promoting Ghana's tangible and intangible cultural heritage, including historical sites, artefacts, oral traditions, traditional knowledge systems, and indigenous practices.

Clause 2(4) of Article 39 of the Fourth Republican Constitution (1992) states that 'The State shall endeavour to preserve and protect places of historical interest and artefacts'. One policy objective is to identify and disseminate local knowledge of the environment and support communities in sustaining positive traditional concepts and practices to protect nature and biodiversity for the benefit of the nation. Another objective is to create an institutional framework for collecting, preserving, and conserving tangible and intangible assets.

The GMMB, in accordance with the cultural policy, has embarked upon the preservation of ancient Asante traditional earthen buildings dating from the 17^{th} century to the early 20^{th} century, as well as Mosques in northern Ghana, considering them to have significant material cultural heritage. However, family-owned earthen buildings in northern Ghana have not been listed as national heritage that needs to be preserved, even though research has shown that the occupants of these structures recognise the knowledge and production of earthen architecture as their heritage and material culture, which needs to be preserved and passed on to younger generations (Addo, 2023). Thus, pressure and advocacy for preserving earthen architecture in the new cultural policy has been growing since 2023.

4 Study areas

4.1 Location

The sites examined in this study are Tamale and Wa in northern Ghana (Figure 1). Tamale is the capital of the northern region of Ghana, has a total population of 716,455 and covers a total land area of 922 km^2 (Fuseini, Yaro & Yiran, 2017; GSS, 2021). It is Ghana's third largest urban agglomeration after Accra and Kumasi (Yakubu, 2021). Wa is a fast-growing municipality and the capital of the Upper West region of Ghana (Osumanu and Akombangre, 2020), with a total population of 200,672 (GSS, 2021) and a total land area of approximately 580 km^2 (Ahmed et al., 2020).

<Figure 1>

4.2 Climate and vegetation

Ghana has a tropical climate. Tamale and Wa have mean monthly temperatures ranging between 23°C and 45°C depending on the season. The daily temperatures peak between 40°C and 45°C in March and April. These two cities experience a single rainy season, which starts in April and lasts through September, with rainfall averaging 1100 mm. The dry wind (harmattan) blows from the northeast between December and March, lowering humidity and creating hot days and cool nights.

Tamale and Wa both have guinea savannah woodland vegetation, which consists of short trees and grasses, with shea and dawadawa (African locust bean, *parkia biglobosa*) trees dominating the vegetation cover. These trees are economically crucial to the area, as most women in cities, especially at their peri-urban interface, engage in shea-butter and dawadawa processing as their primary or secondary livelihood activities. As discussed later in this paper, the dawadawa tree also provides valuable agro-based material for housing construction in both cities. Dawadawa is also the name of a spice that is produced from locust beans.

4.3 Temporal change in the use of earth as a building material

Prussin (1969) reported that ethnicity, existing local materials, the technology that is available to builders, and the range and level of economic activity in a community influenced northern Ghana's architectural models and settlement patterns. Furthermore, the social organisation, religious and secular ideology, and migration history of the people from the neighbouring Sudanese regions also contributed to the architectural forms of these areas. In addition to these factors, in a recent study, Addo (2023) highlighted the effects of globalisation, urbanisation, and modernisation on the structure of earthen buildings in Tamale and how they resulted in a hybrid architecture. In 2000, the proportions of dwellings with earth used in constructing the outer walls in the Northern and Upper West Regions were 87.8% and 88.3%, respectively, whereas the national average was 50%. These proportions decreased to 72.9% and 75% in 2010 and even further decreased to 54.8% and 59.1% in 2021 (Table 1).

<Table 1>

The transformations occurring in earthen architecture are varied, whereby different architectural styles are mixed in practice (Alamsyah et al., 2019). Oyelami and Rooy (2018) argued that using compressed earth bricks is frequently regarded as a second-class building resource for poor and underprivileged people in southwestern Nigeria. The limited acceptance of earthen buildings is also ingrained in how the colonial authority in Ghana has perceived earthen construction as unsafe dwellings (MacGaffey, 2006). European quarters were not to be sited near native huts because of health reasons, and stone-built bungalows were promoted as model housing for the native population. Earthen buildings were considered unsafe, as their thatch roofs could easily catch fire. The Ghana building codes, inherited from the colonial era, have not supported the use of earth in building construction for many years. Earth became recognised as a building material only after the Ghana Building Code was revised in 2018.

5 Research methodology

A constructivist research approach was adopted for this study to provide a better understanding of the underlying drivers of the shift in building material preferences in favour of modern cementitious construction techniques. Constructivism is often associated with qualitative research methods and emphasises researchers' reflexivity and interpretations (Shannon-Baker, 2022). Shannon-Baker (2022), citing Tashakkori et al. (2021), explained that the constructivist research paradigm allows researchers to record participants' constructions, descriptions, and narrations of their lived experiences as well as the knowledge to be co-constructed between researcher and participant.

The gradual erosion of traditional housing construction techniques in Wa and Tamale should be understood as a complex process operating at different sociotemporal scales. Hence, participants' views were solicited for this study to develop subjective meanings of the transformation of earthen architecture in the study areas. Together with the community, we constructed their understanding of the observed changes occurring in earthen construction and the reasons for these changes.

The data were collected in three phases between May 2021 and April 2022. The first phase involved a reconnaissance survey of the study sites to observe and understand the study context, indigenous housing construction practices, and the built environment more generally. During this fieldwork phase, we conducted unstructured interviews with local builders, masons, brick moulders, community elders, and local government authorities to understand the local housing construction procedures, the building material requirements and use, and the structural factors influencing the gradual shift away from indigenous housing practices. We also observed onsite construction activities in Tamale to understand the communal character of local house construction activities, the labour demand, the average dry time for buildings and bricks, and other factors.

The data obtained from the reconnaissance survey were used to fine-tune the household survey and plan the remaining phases of the fieldwork. The second phase involved surveying 90 households, 45 each in Tamale and Wa, via a structured questionnaire. The cities of Tamale and Wa were categorised into three zones (Table 2), namely, central, intermediate, and peri-urban zones, based on population and housing census data (GSS, 2021). Fifteen households were randomly selected from the three zones for the interviews. No systematic sampling was needed because the zones have similar building characteristics. For example, Nakore in Wa had mainly cement-based buildings.

< Table 2 >

The largest age group in the survey at both study sites included people between the ages of 21 and 40 years, followed by those from 41 to 60 years old, with few respondents older than 60 (Table 3). Farming is the predominant occupation in both Wa and Tamale, but some of the participants had other occupations, such as teaching, trading, and artisanal work. Approximately 80% of the respondents in Wa owned their houses, whereas 20% stayed in rent-free family houses. In Tamale, approximately 49% owned their buildings, and 47% stayed in family houses. This means that they had control over any building decisions, although these decisions were likely to be made by the household head. Approximately 36% of the respondents in Tamale and 58% of those in Wa were household heads.

<Table 3>

The questionnaire was divided into three sections: Part 1 covered the demographic and socioeconomic data; Part 2 examined the existing building types and construction techniques; and Part 3 focused on the local building materials in the communities. This paper analyses the social dimension of the results while the technical data on soil tests are published in an engineering journal and presented at a conference (Bras et al., 2024; Beckett et al., 2024). The descriptive statistics of the household survey were obtained via cross-tabulations of the Statistical Package for the Social Sciences (SPSS).

The third fieldwork phase involved investigating the participants' appreciation of indigenous housing construction practices in Wa in terms of construction procedures, labour demands and requirements, the nature and source of construction materials, and the average drying time for bricks.

6 Results

6.1 Characterisation of the construction system

In this study, the sampled earthen buildings were categorised into two groups on the basis of their construction typology. The first group comprises buildings constructed before 2000, whereas the second group consists of those built after 2000. It was observed that the form and construction techniques of traditional architectural practices changed over time, influenced by the advent of modernity. As shown in Table 4, the early buildings constructed between the 1970s and 1980s were typically circular shaped with thick cob walls and thatch roofs. These buildings are often sighted in the rural communities of the northern and savannah regions. The respondents recognised such buildings as a representation of the Dagomba architectural tradition, in which the building orientation, planning and materiality are steeped in their culture. The newer buildings, which were built after 2000, reflected their appreciation of modernity, with contemporary building materials included in their traditional architecture.

The architectural forms of the buildings were modified from circular to rectangular, as rectangular bricks were used in construction (see Table 4). Additionally, the roofing system transitioned from traditional conical and pyramidal thatch roofs to gable roofs with purlins, rafters, and metal sheets extending over exterior earthen walls. This change was made to increase the protection and performance of exterior walls against heavy rain. Table 4 (figure e) shows that approximately three courses of cement blocks were laid as the foundation before the walls were filled with sundried earthen bricks. This method was employed to safeguard the base of the earthen wall from dampness, flooding, and erosion. In addition to the changing forms and construction techniques, most buildings constructed in the last five years were single units without courtyards, which were associated with the old buildings. Most of the walls of the old buildings were rendered using earth and plant-based stabilisers (beini and dawadawa) and were later plastered with a thin layer of cement and sometimes painted. The walls of the buildings constructed after 2000 were mostly rendered with cement and sand mixtures, with some experiments involving impervious materials such as bitumen and dirty car engine oil.

However, the cement mixtures used for earthen wall rendering are becoming a norm in Tamale. The participants reported that using a cement–sand mixture to plaster wall surfaces prolonged the life span of buildings. The excuse for those who could not construct their houses using cement was that they could not afford it. However, they stated that they aspire to use cement sand to render the buildings' exterior and interior walls, giving them a very thin coating of cement plastering. Importantly, cement and earth typically do not adhere well to each other, so the cement render peels off. As a result, a new rendering must be applied every year. Additionally, moisture accumulates behind the render because the cement render is less permeable than the underlying earth and likely does not include a damp-proof course. Table 4 (Figure f) shows clear evidence of rising dampness from the ground. Notably, this type of wall surface render has not been included in the national housing census.

<Table 4>

The changing construction methods, building forms and materials, and building planning reflect the impacts of urbanisation and urban migration on the community. As people travel to the city, they borrow construction practices, which they infuse into their traditional building practices. These new buildings deviate from traditional circular buildings with thatch roofing. Even though people have engaged in innovation to prolong the lifespans of earthen buildings, their cultural heritage is being lost.

6.2 Traditional building process

Earthen construction is communal in nature. Local builders are commissioned to undertake the project, but male children, youth, and elders provide support by mixing, moulding, and carrying the cob to the builder. The elders guide the builder and homeowner to ensure that the layout follows the prescribed cultural practices. Women also prepare meals, fetch water for construction, and plaster the finished buildings (Figure 2).

<Figure 2>

A respondent explained,

> *'We build using communal labour. They will dig the soil first, soak it in water for two to three days, and then use the wooden moulds to make some blocks. The blocks are left to dry, and then we use them for building. Using communal labour, the people will arrange the blocks along the walls for the builders'.*

In addition to the work of the builders and masons, the active involvement of the community members is crucial in ensuring that experiential knowledge and earthen construction skills are passed on to the younger generations. However, this construction process is gendered. Men construct the buildings, and women decorate the surfaces of walls and finish the floors. Indigenous knowledge is transferred from the elders to the youth and the children. As the elderly men worked with the young men and boys, they transferred the thought and rationale behind the planning of the spaces to satisfy cultural demands. The women also transferred their experiential knowledge to young women and girls as they decorated the walls. This collective effort ensures that intangible heritage is preserved and passed on to future generations.

This research further examined participants' use of plant-based stabilisers in building construction. The results show that approximately half the respondents who lived in earthen buildings said they used plant biostabilisers derived from dawadawa or beini when constructing their buildings. They reported that rendering walls with plant-based stabilisers increases the resilience of buildings to water ingress. Rendered walls protect earthen structures from losing their strength if they become wet, making the surface of walls water resistant and preventing cracks. However, when they were asked if they would adopt plant biostabilisers to mitigate the risk of flooding and erosion, approximately 70% of participants in Wa and Tamale answered no, giving various reasons related to modernity, prestige, scarcity of local building materials, and the desire for durable and resilient buildings (Table 5). The respondents perceived that the use of plant biostabilisers connotes a primitive way of living. Thus, convincing respondents to accept plant biostabilisers as an alternative to contemporary industrialised building materials is challenging. Moreover, this shift has resulted in the loss of indigenous knowledge of the plants used as stabilisers, the proportions of mixtures, and their application on earthen wall surfaces. The centuries-old use of plant biostabilisers as renders for earthen structures is dying.

<Table 5>

Even so, some other participants in Wa and Tamale, especially in the peri-urban zones, were still interested in using plant-based stabilisers in construction. Some maintained that these materials were part of their cultural heritage and readily available in their vicinities. They also found local materials less expensive than modern materials and felt that the local building materials were durable. Additionally, they stated that constructing a house with earth was less costly and did not require any special knowledge or skills. Moreover, they believed that the plant extracts were suitable and 'worked like cement', making the surface of the earth walls strong and less permeable to rain. These respondents explained that plant-based materials were more conducive to the harsh weather conditions of northern Ghana.

When we asked the respondents if they would be willing to include plant biostabilisers, approximately 60% of them agreed to build with biostabilisers on the condition that they could ensure the durability of their buildings. Nevertheless, 40% of the participants refused to utilize plant biostabilisers in the construction of their buildings for the reasons mentioned in Table 5. The youth were averse to using plant biostabilisers, claiming that they were not fashionable and cumbersome to use and maintain. The responses of the participants indicate that further research is needed to determine the efficacy and benefits of plant biostabilisers in the development of resilient earthen architectures that can be preserved.

6.3 Challenges associated with earthen construction

6.3.1 Accessing local building materials

The survey respondents disclosed that they had trouble accessing building materials to construct their houses. They explained that they sometimes travel more than 10 km to neighbouring communities to cart laterite for construction. The researchers had the opportunity to visit one of the sand pits in Jarigu, approximately 12 km from Wamali, a peri-urban community in Tamale

(Figure 4). A 20-cubic-metre truck of laterite cost approximately GHS 1200 ($100) in 2021. This quantity would be sufficient to construct two rooms using the cob construction method.

<Figure 4>

During the research for this study, it was observed that dawadawa and beini plant solutions were mixed with the soil to a consistency used to plaster the walls of the earthen buildings, and this mixture provided some protection for the building surfaces against water ingress. During the dry season, when construction typically occurs, it becomes difficult to access these plants due to their seasonality; this is an issue, as fresh plant material should be used. The difficulty in accessing these plants has compelled households to use cement for plastering earth walls. As stated above, cement-based materials do not bond with the underlying material (bricks or cob) and easily peel off within one year. The participants expressed dissatisfaction with their lack of access building resources, with approximately 40 out of 45 households in Tamale and 28 out of 45 in Wa claiming that they were dissatisfied with the difficulties they encountered in accessing the plant. This difference in findings could be explained by Tamale being more urbanised than Wa. Therefore, peri-urban development results in the clearing of the beini plant. Even though legislation has been passed to prevent the cutting down of dawadawa and shea trees, the practice is ongoing. Moreover, the rate of urbanisation in Wa is lower than that in Tamale.

6.3.2 Flooding and frequency of maintenance

Approximately 40% of the respondents in Tamale and Wa had experienced flooding in the past year. Flooding occurs almost every rainy season, especially in the central and intermediate zones. The respondents asserted that choked waterways and poor drainage systems in the communities prevented the discharge of floodwater into drains. Others argued that flooding was caused by high-intensity rainfall. When flooding occurs, the base of the unprotected earthen walls becomes damp and weak, which may lead to building collapse. However, an unprotected cob building that had been flooded had not collapsed. The owner explained that the building would have collapsed if it were built with sun-dried earth bricks. Generally, the effects of flooding and erosion on earthen buildings are visible, which explains why households were experimenting with nonpermeable wall renders such as bitumen and 'dirty' oil. Others have decided to use cement blocks to construct the foundation of buildings and continue with sundried bricks, as shown in Figure 4.

Building maintenance is performed at any time of the year when a visible crack in the wall needs to be mended or the roof leaks. In other instances, renovation is performed to improve the aesthetics of the building and to avoid further deterioration of the structure. One respondent mentioned that a strong wind blew off his rusted zinc roof, so he had to undertake significant maintenance of his building. Sometimes, buildings were renovated because a forthcoming marriage ceremony would be performed in the house. The frequency of maintenance varied from regular to occasional to yearly. Compared with cement-based buildings, earth-based buildings require frequent maintenance. The upkeep of cement-based buildings was intended mainly to beautify the buildings and mend leaking roofs. The participants were particularly not pleased that they needed to maintain their earthen buildings more regularly than they would have to do for cement buildings.

6.4 Perception of thermal comfort and building satisfaction

The respondents were asked about their thermal preferences for buildings (Table 6). The findings for Tamale indicate that approximately 66.6% of the people living in earthen buildings were more comfortable than 16% living in cement-based buildings. This meant that approximately 84% of the households staying in cement-based buildings in Tamale felt uncomfortable or very uncomfortable. In comparison, 50% of the respondents staying in earthen buildings in Wa said they were 'comfortable' or 'just okay', whereas the other 50% said they were uncomfortable and very uncomfortable.

<Table 6>

Approximately 64.4% of the respondents in Tamale were either highly satisfied or satisfied with their buildings irrespective of being earth or cement, in contrast to 26.6% of the respondents in Wa. However, many respondents (57.8%) were dissatisfied or highly dissatisfied with their earthen buildings in Wa (Table 6). Numerous factors contributed to this satisfaction or lack thereof. The prevailing belief was that traditional earth-based structures lack the durability and modern aesthetics of cement buildings, as they need regular maintenance. Additionally, earth buildings are prone to developing wall cracks and are susceptible to termite damage, particularly affecting the integrity of thatched roof. Concerns about structural stability during heavy rainfall also led to the perception that earth buildings are less resilient to flooding. According to the respondents, financial constraints prevent them from constructing cement structures, so they cannot choose to build otherwise. Another factor that compounded the dissatisfaction with earthen houses was the impact of flooding on the walls of the buildings. As water percolates through the wall over time, the base of the building becomes weak and eventually collapses. A respondent explained how they could make their earth-based buildings resilient.

> *'We use only the laterite or soil in moulding the bricks, but if we mix it with cement, the building will be strong'.*

Importantly, blending cement with lateritic soil is not very effective, as more cement is needed to achieve the same level of strength. The resulting cemented soil will be sturdy enough to support residential loads but will not be as durable as if the same amount of cement is used with sandy soil. The findings indicate that the processes involved in obtaining building materials and their associated costs have led to household dissatisfaction. This is not to say that cement buildings have no cost. Nevertheless, factors such as the procurement process, construction time, regular maintenance requirements, and the perceptions and associations of poverty linked to residing in earthen housing have collectively made earthen buildings less appealing in Tamale and Wa. Nevertheless, the participants recognised the numerous benefits of earthen buildings in the warm tropics.

7 Discussion: Implications of building transformations for heritage preservation

These findings indicate that both physical and nonphysical alterations have occurred in the earthen structures in Wa and Tamale. Evolving social and cultural norms, environmental shifts, challenges in sourcing local building materials, flooding, the need for regular maintenance, and concerns about the comfort of earthen buildings are among the key factors driving changes in construction methods and the gradual erosion of both the tangible and intangible aspects of this heritage. The loss of this significant cultural heritage would signify the disappearance of the community's traditions, including the knowledge and expertise passed down through generations related to earthen architectural techniques and planning. Since construction is a communal process, the decline of earthen architectural heritage undermines social unity and communal ties.

The architectural traditions in the two study communities are transitioning from traditional earthen construction to modern designs using cementitious and metal sheet components. This shift is driven by the interactions and trade between the city and its peri-urban areas, resulting in a blend of traditional and contemporary influences. Cob construction, the predominant building technique in these communities, allows the construction of thermally insulated buildings that can withstand the harsh climatic conditions in the Savannah region. However, with current technological changes, rectangular sundried bricks with thinner dimensions are used rather than cob walling, which results in rectangular buildings. Koranteng et al. (2021) highlighted the thermal challenges associated with 'copying' buildings from southern Ghana and replicating such designs in the Savannah climatic region. This is because constructions from southern Ghana have thinner walls 150 mm in width and cannot provide enough insulation against thermal heat transfer, which could be detrimental to the health and well-being of occupants. Again, industrialised materials such as bitumen, engine oils, and cement in contemporary construction also raise questions about environmental sustainability. These materials have been proven to be deleterious to the environment. Moreover, authors such as Dabaieh et al. (2021) and Honarvar et al. (2022) have demonstrated how traditional architectural design strategies support a circular economy and regenerative design development that could lead to environmental sustainability.

The development of isolated and nuclearised family homes in rural communities contrasts with existing cultural norms that promote knitted family systems. The traditional family system in northern regions of this country is organised into patrilineages on large compounds that house fathers, mothers, children, and in-laws (spouses of adult male children). Adult women leave the house to join their husbands, whereas men bring their wives to stay on their father's compound. The eldest male in the family is usually designated the head of the household and possesses the authority to permit young members to build on the compound. In studying the Kassena of the Upper East Region of Ghana, Cassiman (2011, 27) reported that the rural family house is the core of one's identity and belonging and 'a place where family ties are defined and where the relationship between private and public space, between men and women, takes shape'. The nuclearisation of families in northern Ghana will likely present new challenges for family life and drive urban sprawl (Tagnan et al., 2022). The nuclearisation of families is also associated with youth migration and education, significantly impacting heritage preservation. Maintaining earthen buildings becomes challenging, as young people leave to form their own housing units while neglecting their family houses. This phenomenon has led to the collapse of some earthen buildings in communities to the detriment of preserving heritage.

Gallo (undated) argued that heritage emerges out of our cultural processes, actions, and knowledge. The tangible and intangible heritage associated with earthen architecture faces the risk of extinction. If the skilful cob construction techniques practised in the study communities are not passed on to the youth and the children, the earthen building techniques will be lost. Given the endangerment of earthen architectural heritage, preservation is urgently needed. According to DeSilvey and Harrison (2020), recognising 'the inevitability of loss; the politics of loss; and the potential in loss' is critical for future preservation, conservation, and heritage management. Modernisation, urbanisation, and climate change are unavoidable phenomena resulting in the loss of earthen architecture.

UNESCO's (2022) definition of culture as a 'set of distinctive spiritual, material, intellectual and emotional features that characterise a society or social group, [which] includes not only arts and letters but also modes of life, the fundamental rights of the human being, value systems, traditions, and beliefs' allows earthen architecture to be regarded as a material culture of a society that could be preserved as a cultural heritage. According to Vecco (2010), if a society or a community recognises the aesthetic, historical, scientific, and social values assigned to its own cultural identity, then that object could be presented as a cultural heritage. The respondents in Wa and Tamale recognised and talked about the earthen buildings embodied in their cultural practices that need preservation. Preserving earthen buildings as cultural heritage objects can inform efforts towards achieving the United Nations Sustainable Development Goals. Hosagrahar (2023) asserts that placing culture at the heart of development policies ensures human-centred, inclusive, and equitable development.

Preserving indigenous knowledge and cultural legacy associated with earthen architecture is crucial for human existence, as it represents the diverse customs, habits, and expertise passed down through generations (Bihari, 2023). Cultural heritage preservation contributes to environmental conservation, social cohesion, and a sense of belonging (Bihari, 2023). Change is inevitable in heritage preservation, particularly for living heritage, which faces the risk of being lost forever or preserved only as a relic of the past (Abdul-Aziz et al., 2023). Furthermore, Mendosa et al. (2022) highlighted the use of three-dimensional (3D) digital technologies, augmented reality, and virtual reality to preserve cultural heritage.

8 Conclusion

Ghana's cultural policy recognises traditional architecture as a tangible and intangible material culture that needs to be preserved under Article 39(4) of the 1992 Constitution of the Republic of Ghana. In the Act, the National Commission on Culture is encouraged to pay special attention to preserving traditional sacred groves, monuments, artistic treasures held chiefly in palaces, mausoleums, private homes, and all objects of high artistic value. Ghana may identify the heritage values associated with earthen architecture and include them in national policy. Such inclusion can slow the loss of cultural heritage, while its absence will distort the documentation of cultural diversity in Ghana. These structures not only are cultural elements but also accommodate several households in rural areas. The loss of these structures will significantly impact affordable housing production, exacerbating the housing challenges faced in cities in northern Ghana. The people may not recognise earthen buildings as national cultural heritage that need to be preserved. However, the desire to have durable and resilient buildings may fuel preservation.

Thus, it is recommended that the heritage value of earthen architecture should warrant its inclusion in world heritage sites beyond Sébastien Moriset’s (2022) research on earthen mosque heritage in Ghana. While heritage listing and recognition may play a role in preserving earthen structures as cultural heritage, other approaches that might be useful in responding to broader societal shifts include education, instituting training programs, and providing financial incentives to maintain buildings. It is critical to involve community members, elders, women, and youth groups in identifying and preserving earthen structures.

By empowering the community to take ownership of their heritage and identify and recognise the value of their cultural heritage, the attitudes, cultural knowledge, and awareness of the importance of the architectural heritage in the local community can be heightened. The different community groups are responsible for defining and protecting their cultural heritage. However, the government needs to be sensitive to the users since the buildings were first constructed to provide accommodations, and the users would like to preserve their property. The earthen buildings could be preserved by changing people's attitudes, perceptions, and behaviours.

Abbreviations

ECT: Earth construction techniques

GSS: Ghana Statistical Service

NDA: Northern Development Authority

SPSS: Statistical Package for the Social Sciences

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Figure Legend

Figure 1. Map showing the locations of Tamale and Wa in northern Ghana.

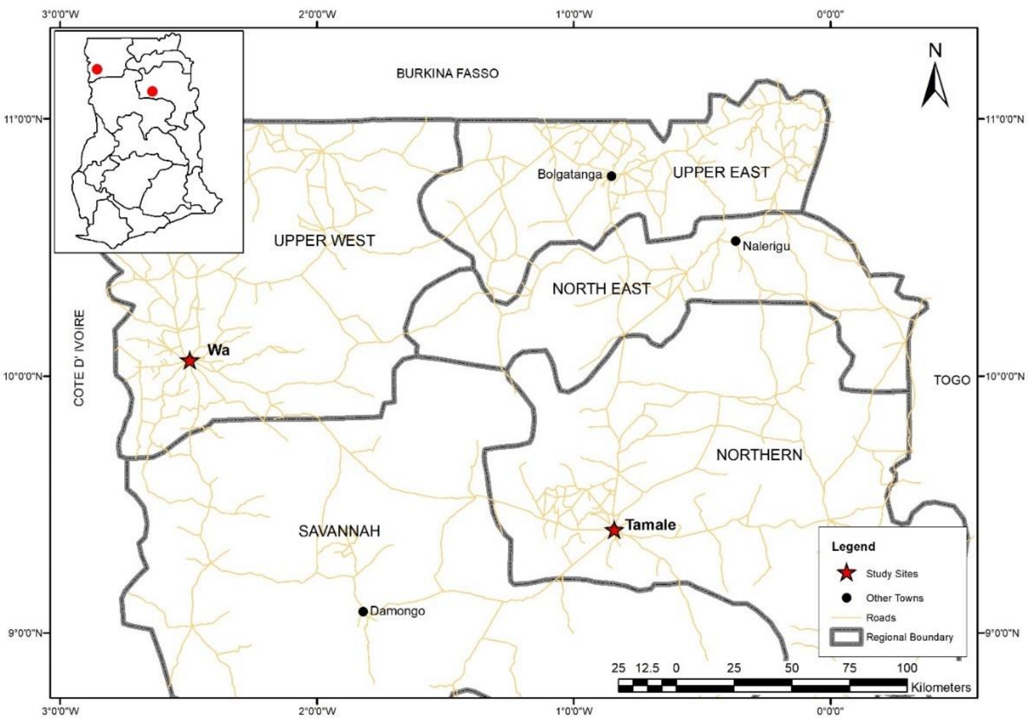

Figure 2: Women plastering a newly constructed earth house in Tamale.

Figure 3: A man demonstrating the construction of a building using sundried earth bricks and earth mortar joints in Wa

Figure 4: Sand mining pit in Jarigu, Tamale.

Table Legend

Table 1: The use of earth as a construction material in dwelling units in Ghana's northern and upper western regions. Source: Compiled from the Ghana Statistical Service (GSS, 2021)

Year	The use of mud or earth	Percentage of earthen houses nationally	Percentage of earthen houses in the northern region	Percentage of earthen houses in the upper west region
2000	outer walls	50.0	87.8	88.3
	roof	1.9	4.9	32.7
	floor	23.8	46.4	57.7
	Total	**3,877,418**	**245,531**	**80,588**
2010	outer walls	34.2	72.9	75.0
	roof	1.4	4.8	12.6
	floor	16.0	28.7	35.9
	Total	**5,817,607**	**339,874**	**118,292**
2021	outer walls	29.6	54.8	59.1
	roof	1.2	3.75	
	floor	-	-	-
	Total	**10,006,420**	**490,157**	**228,779**

Table 2: Study sites and sampling sizes in Tamale and Wa

Study zone and sampling size in Tamale	**Study zone and sampling size in Wa**	**Zone description**
Gumbihini (15)	Kpaguri (15)	These are the indigenous communities located at the centre of town. They constitute the preurban settlements of Tamale and Wa.
Bulpiela (15)	Daanku/Jinkpang (15)	These are the settler communities inhabited by long-term urban migrants and some indigenous populations.
Wamali (15)	Nakore (15)	These are rural settlement nuclei which are being incorporated into the city following rapid urbanisation.

Table 3: Sociodemographic profile of the survey respondents in Tamale and Wa

Description		**Tamale %**	**Wa %**
Age range	21-40 years	44.4	51.1
	41-60 years	40	35.6
	Above 60 years	15.6	13.3
	Total	100% (45)	100% (45)
Occupation	Farming	35.6	57.8
	Trading	15.6	15.5
	Teaching	15.6	0
	Others (artisans, religious leaders, students)	33.3	26.7
	Total	100% (45)	100% (45)
Education	No formal education	48.9	40
	Basic level	24.4	46.7
	Secondary level	11.1	8.9
	Tertiary level (Postsecondary)	15.6	4.4
	Total	100% (45)	100% (45)
Status	Household head	35.6	57.8
	Household member	51.1	42.2
	Other	13.3	0
	Total	100% (45)	100% (45)
Tenure	Owner	48.9	80
	Rent-free (family member)	46.7	20
	Tenant	4.4	0
	Total	100% (45)	100% (45)

Table 4: Building typologies with a description of the materials used in construction at Gbabshe, Tamale.

	Building typology featuring traditional architecture in Gbabshe, Tamale	**Architectural elements**	**Current use**	**Building form**	**Plan**	**Roof configuration**	**Construction techniques**	**Year of Construction**
a		Single-storey courtyard house	Family house	Circular shaped	Circle	Conical Thatch	Cob construction with cement-based rendering and painted	Circa. 1970s or 1980s
b		Single-storey courtyard house	Family house	Combination of circular and cube shapes	Square/rectangle and circle	Conical and pyramidal thatch	Cob construction with cement-based rendering and painted	Circa 1980s
c		Single-storey courtyard house	Family house	Circular	Circle	Conical thatch	Cob construction with plant-based rendering	Circa 1980s
d		Single-storey courtyard house	Family house	Cube	Square/rectangle	Pyramidal thatch with a central support and purlins	Cob construction with cement-based rendering	Circa 2010s. 3 New rooms built in January 2019

						and rafters.		
	Building typology featuring contemporary construction techniques in Gbabshe, Tamale	**Architectural elements**	**Current use**	**Building form**	**Plan**	**Roof configuration**	**Construction techniques**	**Year of construction**
e		Single storey single unit	Family house	Rectangular	Rectangle	Purlins and rafters gable roof with metal sheets	Moulded sundried brick layered walling with cement mortar joints and with cement block foundation.	Circa 2021
f		Single-Storey Single unit	Family house	Rectangular	Rectangle	Purlins and rafters gable roof with metal sheets	Moulded sundried brick layered walling with cement mortar joints and cement,	Circa 2021

							sand and bitumen mixture rendering.	
g		Single-storey single unit	Family house	Rectangular	Rectangle	Purlins and rafters gable roof with metal sheets	Moulded sundried brick layered walling with cement mortar joints and cement, sand, bitumen and 'dirty' car engine oil mixture rendering.	Circa 2022
h		Single storey single unit	Under construction	Rectangular	Rectangle	Purlins and rafters gable roof with metal sheets	Moulded sundried brick layered walling with earth mortar joints.	Circa 2022

Table 5: Summary of participants' reasons for not using plant biostabilisers in construction

Modernity
Because of civilisation, our old methods are no longer fashionable.
Modern materials are more resistant to floods.
Biostabilisers are archaic.
Biostabilisers are not a modern form of building.
They are olden days material we have better alternatives.
No one uses them these days, they are difficult to obtain, they don’t make a house look beautiful.
Prestige
When you build locally, people do not respect you.
Modern materials give prestige.
The local material methods are no longer prestigious.
They said it is for poor people and I am not happy to be poor.
Accessing local building resources
They are difficult to find these days.
This time nobody uses such materials again and they are difficult to obtain here.
Dawadawa is not readily available, and the regulations will not allow us to cut them.
It is difficult accessing these materials.
Dawadawa, shea tree, and sometimes neem trees are not available.
It is difficult getting the materials these days, they are not found in the city or big towns.
It is very difficult to access some of these materials. One would have to travel approximately 20-30 miles to access them.
Achieving durable and resilient buildings
Earth blocks are not as durable as the cement blocks.
The local materials are not strong.
They are not durable.
They do not last long like the modern ones.
They do not last compared to modern materials.
The locally built structures are not strong enough.
They are unable to stand the test of time.
They are less resistant to flooding.
Modern materials like cement blocks are durable.
The building can easily collapse.
What those things [earth, plant, thatch] can do, cement can do better, so I prefer to use cement.

Table 6: Respondents' thermal comfort in cement- and earth-based buildings in Tamale and Wa.

Region	Level of comfort	Building type			Total (%)
		Not stated (%)	Cement (%)	Earth (%)	
Tamale	comfortable	0	0	22.2	8.9
	just okay	0	16	44.4	26.7
	uncomfortable	50	60	11.2	40
	very uncomfortable	50	24	22.2	24.4
	Total	100% (2)	100% (25)	100% (18)	100% (45)
Wa	comfortable		0	7.5	6.7
	just okay		20	42.5	40
	uncomfortable		80	45	48.9
	very uncomfortable		0	5	4.4
	Total		100% (5)	100% (40)	100% (45)

Table 7: Building satisfaction among the respondents in Tamale and Wa

Building satisfaction	Tamale %	Wa %	Total %
Highly satisfied	8.9	4.4	6.7
Satisfied	55.5	22.2	38.9
Just okay	17.8	15.6	16.7
Dissatisfied	8.9	55.6	32.2
Highly dissatisfied	8.9	2.2	5.5
Total	100% (45)	100% (45)	100% (90)