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Building Ethiopia Since 1954

THE VERNACULAR ARCHITECTURE AND THERMAL COMFORT STANDARDS OF THE PASTORAL AFAR IN ETHIOPIA, LESSONS FOR CONTEMPORARY BUILDINGS:

In the case of surrounding areas Dubti and Semera towns, Afar, Ethiopia.

This thesis is submitted to the Ethiopian Institute of Architecture, Building Construction and City Development (EiABC) and School of Graduate Studies of Addis Ababa University for partial fulfilment of all requirements of Master of Science in Architectural Engineering.

By: EMMANUEL BEKELE FULEA

May 2021

This thesis is submitted to the Graduate Programs Director of the Ethiopian Institute of Architecture, Building Construction and City Development (EiABC), Addis Ababa University, in partial fulfilment of the requirements for the Master of Science degree in Architectural Engineering.

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IN THE CASE OF SURROUNDING AREAS DUBTI AND SEMERA TOWNS, AFAR, ETHIOPIA.

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Date: MAY 2021

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Declaration

I, the undersigned, declare that this thesis is my own and original work and has not been presented for a degree in any other university, and that all sources of material used for the thesis have been duly acknowledged, following the scientific guidelines of the Institute.

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Here with, I state that EMMANUEL BEKELE FULEA has carried out this research work on the topic entitled “THE VERNACULAR ARCHITECTURE AND THERMAL COMFORT STANDARDS OF THE PASTORAL AFAR IN ETHIOPIA, LESSONS FOR CONTEMPORARY BUILDINGS” under my supervision and it is sufficient for submission for defence.

Imam Mahmoud Hassen

Signature _____

Date: _____

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ABBREVIATIONS

Abbreviation	Definition
AC	Air conditioning
AMV	Actual Mean Vote
ARP	ARAMIS ADAR PASTORAL
ASHRAE	The American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASP	ASALE PASTORAL
CO	Carbon Monoxide
EBS	Environmental behavioural system
EIA	Environmental Impact Assessment
ELP	ELI-DAAR PASTORAL
ETB	Ethiopian birr
FGD	Focus Group Discussion
FRED	Federal Reserve Economic Data
GJ/ton	Gigajoule
HVAC	Heating, ventilation and air conditioning
LCA	Life Cycle Assessment
NMP	NAMALEFANE BAADU PASTORAL
NRS	Afar National Regional State
PMV	Predicted Mean Vote
TER	TERU PASTORAL
UK	United Kingdom

ACKNOWLEDGEMENT

I want to extend my deepest gratitude to my advisors Imam Mahmoud for his valuable insights and unlimited support throughout the work of this paper, his overall guidance in the discourse of motivation and support along with a friendly approach helped me to push forward even with a difficult time. Further, my gratitude goes to the people of Afar all for co-operating in providing necessary and important data's. I would also like to thank EiABC for providing me with the chance to carry on this course program.

Above all, my greatest appreciation goes to God. Finally, I must express my very profound appreciation for my father, mother, sister, brother and girlfriend for providing me with unfailing support and continuous encouragement throughout the program, and writing this thesis. This would not have been possible without them.

Thank you.
Emmanuel Bekele

EIABC, Addis Ababa
May, 2021

ABSTRACT

This thesis aimed to study and take lessons from sustainable thermal cooling features of the vernacular architecture of the pastoral nomads of Afar, in Ethiopia and extract useful principles that can be applied to the current architectural and construction sector in Afar. Current modern architectural practice in the area has suffered from harsh indoor environments forcing people to use mechanical ventilation which has its drawbacks concerning sustainability. The impact doesn't end there since the architectural styles are adapted from modern practice the cultural and traditional entity that was embedded in their spaces through activities are disconnected from the people.

The thesis focused on studying the socio-cultural structure of the Afar pastoral nomads and its integration with the their vernacular dwellings, their indoor environment, nearby open spaces, and their mobility pattern surrounding the emerging cities of Afar: Semera and Dubti. The urban areas were selected because of the growing inter-relation of the Afar pastoral nomads with the urban zones looking for public facilities as well infrastructure. In addition, it is to assess and evaluate the perception of the public living in urban regions about the pastoral nomad's sustainable way of living, the thermal performance of the dwelling unit and representation of the Afar culture and identity through the nomadic pastoralist lifestyle.

The assessment was conducted using methodologies such as observation, questionnaires, focused group interview and physical measurement. Study samples are taken using the purposive sampling technique. The result showed that the ranking of indoor thermal environmental conditions slightly differed between female and male respondents, between different types of dwelling sizes as well as material specification. Additionally, during outdoor environment analysis, it is observed that outdoor surrounding is used for a lot of activities through simple modifications and shade.

Extracted results from both the survey, questioner and physical measurement results showed that the Afar pastoral nomads were able to provide sustainable thermal cooling features in a space that represent their culture that provides comfortable and productive space. These results were finally discussed and interpreted into guidelines that offer basic considerations during Architectural design in hot and arid climates for people with nomadic pastoral life style. Particularly spatial management, building material selection and adaptation of strategies were considered.

Keywords: *Sustainable Architecture, Passive strategy, Thermal Comfort, Modern architecture, Pastoral Nomad, Nomadic Vernacular architecture, social structure.*

1. INTRODUCTION

This thesis is intended for architect and public sector officials (governmental and non-governmental) who focuses on environmental works, bodies working on building standards and quality controls, particularly those working in architectural design, implementation, and building permit processes.

Accordingly, it aims to outline the elements in the vernacular architecture of the Afar pastoral nomads that made them able to sustain in these harsh climates using sustainable thermal cooling strategies. This is achieved through proper material selection, adequate contextual study, learning, and incorporating cultural factors as an important element of the design decision process and proper integration with contemporary practice and construction advancement. The study is based on literature reviews and a field survey undertaken by the researcher.

This study is organized into six parts:

The first part: Introduce the research paper with the following sections, a background of the study, objective, problem of the statement, research questions, scope and limitation of the study, the significance of the study, and organization of the research. In this subsection brief description of what's known about the topic, the aim of the paper, knowledge gaps, and how the study advances the paper will be presented.

The second: This section outlines theoretical bases for the study and related relevant contextual issues. It composed of a literature review discussing in detail what known about the topics and what has been discovered in the issue of the interest will be presented. Definitions, theories, and methods to study important concepts and meanings will be discussed here.

The third: In this section contextual review will be presented. The presentation will be based on the data collected to describe the study area in detail. Data will be composed of morphological sets of data including population, geographical existence, and specific area maps.

The fourth: Methods and materials present methods employed to tackle the research questions. This section discusses the methods used to collect data and proven methods to study, analyse and present the collected data.

The fifth: Data presentation and discussion. In this section, data will be presented and the results will be discussed according to different parameters. Based on data analysis results will be presented in different formats such as boxes, tables, drawings, figures, and pictures.

The sixth: The conclusion and recommendation. design guidelines will be extracted and summarized from previous sections.

1.2. MOTIVATION, RELEVANCE AND RESEARCH APPROACH

Motivation

I had an opportunity to take Afar as a case study and site to work within my master's first-year design studio focusing on the relationship of climate and architectural design. As well I have visited Afar after I had finished the master's studio in another work-related site excursion. During my visit, I had a chance to look at pastoral Nomads of afar as well their lifestyle and tries to relate to what I had done in the design studio and what was the drawbacks and difficult situations in the design process. One of the difficult cases was to get a compiled study of the area. As a result, I saw a gap in research on the vernacular architecture of the Afar pastoral nomads. From my excursion, I have examined that the design and material choices are very influenced by the material. Both from a material and construction point of view nomadic Afar vernacular houses are built considering multiple pillars of sustainable buildings. Using local and appropriate material as well as incorporating culture and presentation of traditional practices in the architectural design can be mentioned. Studying and documenting these vernacular dwellings from both material and non-material approaches is important. Then extract a principle that can be introduced to the new contemporary buildings in Afar to propose a sustainable way of living in the hot and arid climate of afar plus addressing the deteriorating identity and cultural crisis is crucial.

Relevance

Documenting original Afar vernacular houses is useful to conserve the ideas of experimental builders which could easily vanish because of the current transformation to a contemporary standardized architectural practice. This documentation can be used later for further study, academics research and policy makers this makes this paper useful for professionals. Also, as the study identifies the strategies used in these vernacular architectures in providing sustainable thermal cooling features for indoor environments making such a study could help us to extract principles on how to conserve certain core elements from this vernacular architecture and incorporate them into modern design concepts this makes the paper beneficial for the people of Afar.

Research approach

It could be understood that the vernacular dwellings of the Afar pastoral nomads are aged and tied to the culture of the society. The people have their cultural meanings and functions. They are also built with locally available materials. To Transformation the core principles a well-integrated study and documentation are important. The study is therefore ***exploratory*** (to understand the systems and strategies that are used to bring thermal comfort) ***and descriptive*** (regarding documentation of the vernacular dwellings).

1.3. BACKGROUND TO THE STUDY

According to the world bank, (World Bank, 2016) Ethiopia population is more than 112 million people in 2019, occupying different regions of the country with a range of climate, which varies with altitude, ranks the country as the second-most populated nation in Africa after Nigeria, and the fastest growing economy in the region. (World Bank, 2016). According to the 2015 Ethiopia Urbanization Review by the world bank, urbanization in Ethiopia is increasing at **about 5.4% annually**. That would mean 30% of the country's population would live in urban areas in 2028. This clearly shows the need for building housing and infrastructure matching the population. Designing and constructing these needs considering sustainability would be crucial in achieving a healthy and prosperous community.

In the case of Ethiopia, though only 20% of the total population lives in cities, the current urbanization rate is much higher than the current national average population growth (Yonas Soressa, Imam Mahmoud, Alemayehu, et al., 2018). As the number of people living in cities has increased, the need for housing facilities has also increased. Ethiopia's urban population more than doubled from 4.87 to 11.86 million between 1984 and 2007 and, is expected to triple by 2037 (World Bank, 2016). Urbanization and population growth demand housing as a result the construction industry is expected to boom hence, the construction of contemporary buildings is promoted through growth and urbanization. Planning and understanding sustainable construction are important in this phase, fast-unmonitored construction will have an impact on our cities. For the hot and arid climate conditions like Afar, the effect will be even more.

Afar Region, formerly known as region 2, is a regional state in north-eastern Ethiopia and the homeland of the Afar people. Its capital is the planned city of Semera. In north-eastern Ethiopia, Afar Region, the climate is hot and arid throughout the year. The temperature varies from 25^0C during the wet season to 48^0C during the dry season. Afar can be classified as one of the places with extreme climatic conditions. Afar is home to a considerable number of people with nomadic pastoralist lifestyle. Climate was approached as a starting point in the design of the dwellings of the pastoral nomads of Afar. The pastoral nomads of Afar move from place to place in search of water and food for their cattle. Their temporary dwelling is designed considering their mobility culture and social values. The temporary dwelling is considered as the vernacular architecture and identity of the Afar people.

Centuries worth of experiments on dwelling units made it possible the practice and realization of vernacular architecture which is a proper solution for the climate with the integration of the respective cultural and aesthetic values (Emmanuel, 2012). An architectural practice that integrates and address the environmental, economic and social factor of which its existing fabric can be referred as Vernacular architecture (Asquith and Vellinga, 2006) and it provides a good examination and adaptation to the climatic constraints as well as culture and customs fusion with the dwelling are addressed through the design decision.

The range of strategies is as broad as the variety of climates, popular customs, and cultures. The designs of vernacular dwellings are based on sustainability concepts considering the environment and their cultural identity throughout their existence. Vernacular designs and construction techniques are shaped by the local culture and tradition, climate, and regional location. Findings and guidance from vernacular architectural principles caused considerable improvement in being sustainable specifically in power consumption of contemporary buildings, like heating, cooling, and lighting demands.

Contemporary buildings consume a significant amount of primary energy comparing to a vernacular one. Standard building materials like steel reinforcement, cement consumes a considerable amount of embedded energy when they are manufactured. In addition, maintaining indoor thermal comfort using active cooling strategies, whereby major sources for greenhouse gas emissions are from active cooling resulting in global warming. On the other hand, because it redefines the cultural values embedded in the architectural practice it will lead to loss of identity and cultural crisis. Due to the harsh weather conditions in Afar, it can be very uncomfortable to stay in a modern building without mechanical ventilation, especially in summer times. Building materials, techniques, and cooling strategies have to be adapted to adapt to the local conditions in contemporary buildings.

The concept of sustainable architecture has brought significant changes in the profession. It has become an integral part of the design process. Good architecture has become more concerned with the protection of the environment. This concept has shifted to encompass the idea of a building that is sensitive enough to its environment to ensure its longevity. This paper aims to extract useful principles out of the vernacular architecture of the Afar pastoral nomads and apply them to contemporary construction. The pastoral nomads of Afar have practiced this life for a many years. Similarly, there are still pastoral nomads practicing this lifestyle even near to the capital of the region Semera. Considering the area has a very hot and arid climate, living in these

areas without any mechanical assistance makes the vernacular architecture special and well-fitting to its context.

1.4. PROBLEM STATEMENT

Buildings contribute directly and substantially to manufactured risk because of the number of raw materials, energy, and capital they devour as well as the pollutants that they emit. Architects, therefore, have a specific and significant professional role in reducing this risk. Considering this importance of embedding already proven solutions from vernacular architectural principles into modern building design is important. This problem even magnified following rapid urbanization and design standardization. This growth in urbanization will increase the demands for housing and infrastructure in cities. These enormous demands in all sectors followed by these vast constructions in our cities. Afar as a region is no different it's one of the most growing cities in Ethiopia with a harsh climate and unique cultural values that demands proper adaptation of modern design and construction.

Ethiopia is a country with a rich history in using vernacular solutions to maintain adequate indoor air conditions, through allowing natural ventilation, using locally available building material that is sensitive to the immediate climate and proper building orientation referring to the sun path. Despite this successful history, current contemporary Afar architecture suffers from harsh indoor environments because the current trend did not consider the context including climate conditions, materials, and the socio-cultural structure of the community.

The quest to achieving thermal comfort in modern buildings with improper materials strategies and solutions won't only harm the environment and socio-cultural structure, additionally, a Cheap air conditioning system will create a sound that is disturbing and unevenly distributed it also presents a health risk for the inhabitants. Developing countries like Ethiopia should take advantage of the rich vernacular knowledge to decrease contemporary construction environmental impact. Capitalization on its proven solutions embedded in the vernacular dwellings not only provide sustainability, in addition but also stabilizes indoor environment comfort that is not dependent on mechanical ventilation. Nomadic afar architecture can be an example of providing a comfortable environment for centuries.

1.5. GENERAL OBJECTIVE

The general objective of this research paper is to document the vernacular architecture of the Afar pastoral nomads, analyse its relation to the culture, life style and family structure of the people, as well as its strategies for thermal comfort in such a hot and arid zone. It aims to extract lessons and useful design principles from this nomadic vernacular architecture that can be applied to modern/contemporary design of buildings in the area.

1.6. THE SPECIFIC OBJECTIVE OF THE STUDY

- Documentation of vernacular architecture of the pastoral nomads of Afar near Semera and Dubti in relation to the socio-cultural structure of the community
- Examining the socio-economic interaction of afar pastoral communities with sedentarized communities living in inner urban zones of the Afar region.
- Measuring and documentation of the thermal comfort of vernacular architecture of the Afar pastoral nomads near Semera and Dubti.
- Identifying the sustainable thermal cooling features and strategies employed in the vernacular architecture of the pastoral nomads of Afar near Semera and Dubti.

1.7. RESEARCH QUESTIONS

- How do Afar pastoralist communities around Semera and Dubti interact and relate with the other inner urbanized zones of the Afar region?
- What are the features of the existing vernacular dwelling units of the pastoral nomads of Afar near Semera and Dubti and how do they relate to the socio-cultural structure of the community?
- What level of thermal comfort and thermal sensation Afar vernacular dwellings around Semera and Dubti provide without out mechanical ventilation?
- What are the passive thermal cooling strategies embedded in the dwelling units to provide sustainable thermal cooling for indoor environments in vernacular architecture of the Afar nomadic pastoralists near Semera and Dubti?
- What design principles can be extracted from vernacular Architecture of the Afar nomadic pastoralists that can be adapted to the modern architectural practice?

1.8. SCOPE AND LIMITATION

Thematic scope

The focus of the research paper is understanding and examining vernacular architecture of the pastoral nomads of Afar. In the process, the existing vernacular architecture will be documented, sustainable features and their passive thermal cooling features will be studied. The topics in the research focus on the assessment of sustainable features of vernacular dwellings, Thermal comfort standards and the impact of achieving thermal comfort jeopardizing the environment.

Spatial scope

The sample size for the study will be limited to the nomadic pastoralists living in 10 Km proximity to the capital Semera and a nearby city called Dubti. It focuses on pastoral community living in 10 Km proximity to understand and study the relation and variable factors between the urban settlement and the pastoral nomads.

Limitation

Access: Geographical location of Afar is difficult to reach and conduct the research specially where the pastorals locate themselves.

Language and cultural gap also a limitation to collect the data and understand their social interaction without local assistance.

Even though the above-listed limitation exists using secondary credible sources the gaps have been filled.

1.9. SIGNIFICANCE OF THE STUDY

A study of the thermal cooling system of Afar nomadic vernacular architecture near the capital Semera and Dubti areas assists for the deep understanding of the nomadic socio-cultural structure and physical structure of the existing nomadic dwellings. Lessons from this vernacular architecture can effectively improve energy efficiency in contemporary buildings as well as contribute to a sustainable approach through the reduction of emission and carbon footprint. At the time of fast urbanization adaptation of sustainable approaches is an important action to protect our environment and health. This can be achieved through applying the strategies and methods that

are captured from nomadic Afar vernacular architecture. This research can also help other architects to guide on how to adapt local techniques and strategies into contemporary buildings.

From this research, the following specific audience will benefit.

Inhabitants,

- Cost, deduction of energy cost through energy-efficient design using local materials and strategies.
- Keeping cultural identity, cultural identity integration through proper studies of the social structure of the area.
- Protection of the environment, the environment will be protected from the green gas effect resulting from energy and building material production using fossil fuel.
- Creating comfortable indoor spaces motivates productivity and health by providing naturally ventilated spaces.

Professionals,

- Through the creation of awareness and information
- Presentation of the problems and compiled methodologies to solve the problems.
- Inspirations and opens doors for future researches.

Promotion of heritage and culture also a platform for integration of our identity

- Documentation and study
-

Revision of our building standards using our parameters.

- Those parameters can be extracted from our vernacular principles and our existing climatic conditions.
    - Material standards
    - Impacts on health will be analysed well.

Opens for future research and studies.

1.10. RESEARCH OUTLINE

This dissertation paper is composed of six chapters following the structure of the study. Chapter one contains the background of the study, statement of the problem, research objectives and questions, scope and limitation of the study, location of the study area and research outline.

Chapter two deals with fundamental concepts and a review of the literature. Chapter three discusses research methodology. Chapter four focuses on contextual review. Chapter five analyse and interpret data as well discussing findings and results which could be used as an input for the guideline. Finally, Chapter six will deal with a conclusion and design guidelines.

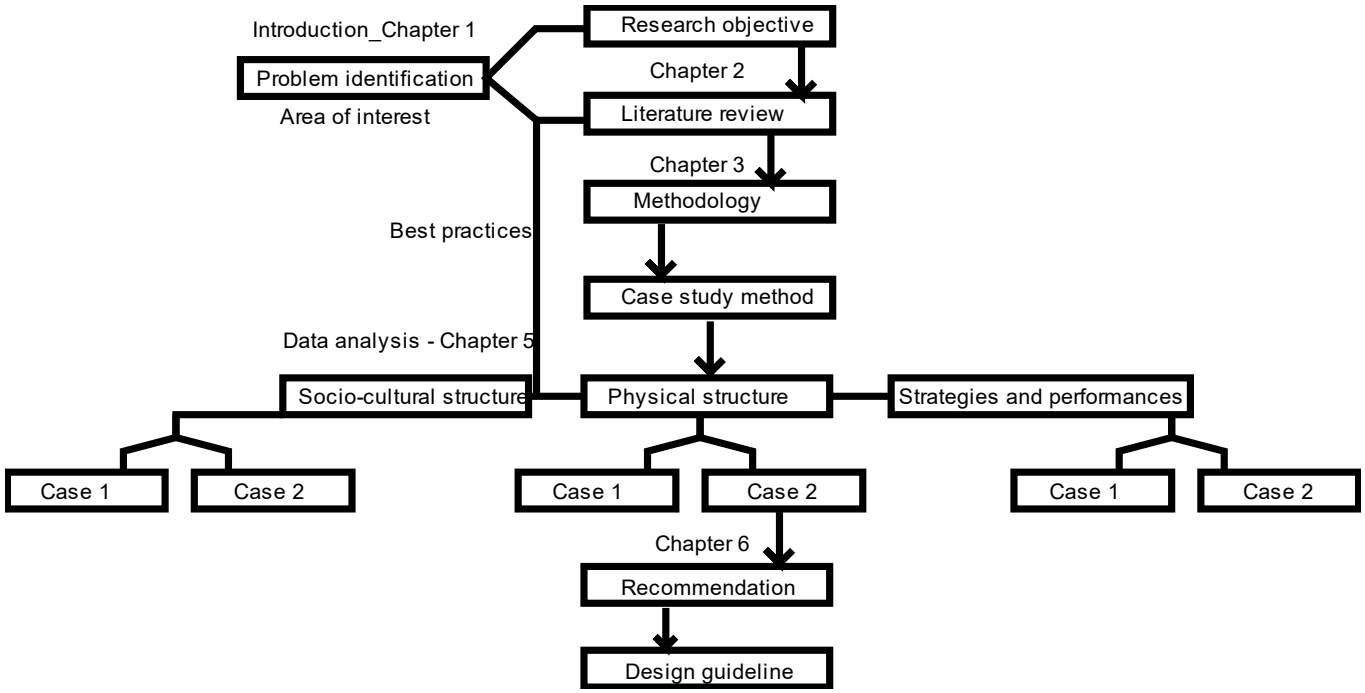


Figure 1. 1: Research outline and hierarchy of study

2. LITERATURE REVIEW

2.1. INTRODUCTION

The purpose of this section is to provide a literature background of the study and identify the variables of concern about the study of sustainable thermal cooling strategies of Afar nomadic architecture.

Different part of the section will elaborate on the impact of development and fast urbanization in the construction sector on climate change, unmonitored resource and power utilization and threaten cultural diversity including identity crisis. Furthermore, the research paper also explores the concept, theory and meaning of vernacular architecture as a solution through studying and extracting principles that can be adapted to contemporary design and construction practices.

The importance of studying vernacular architecture on how they provide acceptable indoor environments sustainably regarding thermal comfort as well as addressing and keeping the social and cultural structure in the process of making and utilizing it. To achieve full integration of principles from vernacular architecture to a contemporary one it's important to understand broad concepts in detail that are embedded in vernacular architecture.

In the following literature review, broader concepts are discussed and redefined in detail accordingly with the title and context of the paper. The paper explores the following three main concepts that will guide it in providing the right methodologies, definitions, standards, importance, parameters, theories and tools and strategies for studying the concepts subsequently. In different sections sustainability and sustainable architecture, thermal comfort, vernacular architecture and Nomadic vernacular architecture are discussed. Interrelations among topics are also explored since one form on the other.

Generally, there are some challenges in adapting principles from vernacular architecture appropriately (Meir & Roaf, 2005) . These challenges are seen immensely in developing countries like Ethiopia because of the lack of an integrated research approach in the above discourse. This paper will provide a reference document for further research on the topics that are raised in the literature review. This paper will advance the study of vernacular architecture of nomadic vernacular architecture of afar furthermore, extract principles for adaptation to the contemporary context. In addition, it will provide all in one research documents for reference for further research and studies regarding vernacular architecture in Ethiopia.

2.1.1. SUSTAINABILITY AND SUSTAINABLE ARCHITECTURE

Sustainability has been characterized in numerous contexts. As a presentation to the subject, we'll investigate the definitions of the term below. World Commission on Environment and Development report in 1987, as reported by to the Brundtland Report:

> *"Humanity can make development sustainable – to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs . . . Sustainable development is not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs."*
>
> (Marien, 1992)

The definition is clarified in terms of keeping up and moving forward the quality of human life within the carrying capacity of the existing supporting environment. In advanced terms, this clarifies the imaginative approach both in design and constructions while keeping up the quality and thriving of the inhabitants. In this way, it favours that sustainable advancement is progressing (and not simply keeping up) the quality of life inside the limits of the carrying capacity of supporting biological systems (Meir & Roaf, 2005).

The relationship of human creatures with their environments gives a distinctive philosophical point of view in understanding existing issues. Hence, Environment can be considered as a direct plinth for addressing the supportability framework or characteristic framework. Ecology gives bits of knowledge almost how common frameworks work, counting frameworks centres to human impedances. Without a doubt, the natural system of ecology can be taken as a scientific avocation for sustainability.

2.1.2. SUSTAINABLE ARCHITECTURE

Taken specifically from the term both 'sustainability' and 'sustainable architecture' it centres on the sustainability of design, both as a field and a product of the field. Sustainable design, at that point, can be re-imagined as a reaction to modern concerns of design to a ceaseless impact of human action (Williamson et al., 2003).

The lack of sustainability in natural structure can be seen by two perceptions; resource utilization over absolute limits or varieties forced on the system whose rate of alter is beyond the possibilities of adjustment consequently, this may be characterized as fabricated dangers. Fabricated dangers are dangers that are created by our impact of an activity on the environment. The foremost common ones are populace development and wanted a higher standard of living (Redclift, 2009).

Charles Jenks,(Jencks, 1977) best known as a critic composing on present-day and postmodern design, states unequivocally: the belief system of nonstop human development – both numerical and financial – is unreasonable. It'll proceed to make unused issues, reciprocals of the greenhouse impact and the gap within the ozone layer (Haddad, 2009).

The manufactured risk could be a concern that should be managed. In no time, this infers commitment to either: diminishing the human population, or less affecting lives for numerous individuals, or creating innovation to play down the in general impacts. For the human race to continue its environmental effects indefinitely, it must not be more than the amount that the planet can support indefinitely (Malavisi, 2018).

The arrangement of these concepts can be followed to the early 1970s. Portrayed as ‘green’, ‘ecological’, and ‘environmental’ names that the plan of buildings ought to in a general sense take account of their relationship with and affect the natural environment. Rising from the same period, names such as ‘low energy, ‘solar’ and ‘passive’ are utilized to represent approaches to planning concerned with the concept of reducing reliance on fossil powers to function a building (Sassi, 2006).

In 1987, the World Commission on Environment and Advancement report was created. Afterwards, the Earth Summit held in June 1992 in Rio de Janeiro, Brazil, was a characterizing occasion within the sustainable advancement development. From the earth submit a few agreements rose. A few of them are broad some of them are specifically related to sustainable design. Agenda 21 is one of the understandings that has set a point by point approach and execution rules to create beyond any doubt that the improvement is in line with the concepts of sustainability (Williamson et al., 2003).

Agenda 21 sets out point by point recommendations for communities all through the world to embrace and actualize measures cantered on eight key destinations pointed at progressing the social, financial and natural quality of human settlements and the living and working situations of

all individuals. The guidelines and key points mentioned have considered buildings as a contributing factor for climate change in producing carbon and greenhouse gases.

2.1.3. PILLARS OF SUSTAINABLE ARCHITECTURE

Whether we examine an already built building or considering planning and develop one the building must address at slightest the essential three structures or sustainability pictures or rationales. (Williamson et al., 2003)

These images are:

- Natural image (Environmental)
- The social or cultural image
- Technical image (Economical)

The natural image

The primary step to an understanding of sustainable architecture is accepting nature as the base of life and considering the method is basic. This is when we can start finding a solution for the problems regarding sustainability in general. (Yang & Li, 2016)

In his enormously influential book Design with Nature, published in 1969, Ian McHarg argues that:

> *"In case one acknowledges the basic suggestion that nature is the field of life which a smidgen of information of her forms is vital for survival and or maybe more for presence, wellbeing and delight, it is astonishing how numerous troublesome issues show a ready solution."*
>
> (McHarg, 1969)

Understanding to work with nature not to work against it is the key meaning of plan with nature. So, what design with nature cruel? From the book design with nature, we will get it that the concepts begin from examining the quick setting of nature refereeing the sun path, wind breath, shades or tress etc. So, by studying these features and applying the results integrated with the architectural design we can say we have designed with nature.

Material

Normal materials can be recognized as materials with a really small human adjustment: e.g., straw parcel, slammed earth, and squeezed mud bricks, or rough-hewn stone can be expressed as common materials. Sustainable architectural principles can also express through materials. An impression of shelter may be raised as a case, it is built of local materials with negligible impact on its environment and will rot back into the same environment. Indeed the reality that we can see

that to possess this ‘building’ giving up much of our desires of individual consolation may be a part of the natural image. (Akadiri & Olomolaiye, 2012)

The cultural image /the social and human interaction

The meaning of existence is clarified as the association of human being with their immediate setting counting other occupants of the same kind. Sustainability can be characterized as securing this image and proceeding with the human and social structure of the community.

The social image depicts a particular and important virtuoso locus of which design could be a part. It mirrors an anthropological look that advances keeping individuals socially input, combined with a conviction that ‘the local culture knows best’. In Architecture: Meaning and Place, Christian Norberg-Schulz contends the carelessness of a present-day man Due to a need for social interaction is clarified. (Keitsch, 2012)

Present-day buildings are anticipated to revamp the vernacular does not duplicate them. Replicating vernacular architecture may as it were negligible progression within the persistently advancing structural design and construction industry. (Alexander et al., 1987). Moreover, considering culture could be a dynamic process and the information of its changing process is basic.

Example

Hassan Fathy (Fathy, 1976) designed a mosque to recognize conventional Nubian vernacular shapes. Fathy set out to form buildings in a fashion that he accepted consolidated the pith of his claim culture’ (Steele, 1997: 6), educated by and regarding convention but not simply reproducing it. For instance, the most façade of the mosque ‘uses a modern and ponder kind of iconography’ combining elements with complex authentic implications that are territorial but moreover ‘transcend local tradition to form an association with the arrangement of Islamic personality itself’.

To address the social image, he utilized the following standards: Suitable building innovation, socially situated development strategy, tradition and through this making the national pride and act of a building for the existing nearby setting can be accomplished (Sassi, 2006).

Sustaining architecture means in the glasses of cultural images is accommodated in terms of new activities into the community. The accommodation of the activities will be detected and influence the architectural design vernacular design can be seen as an example.

The technical image

The technical image of sustainability depicts specialized development within the arrangement of social, financial, and natural issues. In this image, sustainability could be a matter of creating specialized gadgets and frameworks that neutralize or make benefits out of what may incidentally show up to be issued. The technical image is composed of:

- Hard facts
- Measurable environmental facts of external factors that affect the architecture of a building. Along with measurable economics.

The Technical image leads to hard 'facts', and especially the quantifiable 'environmental facts' of the constituents of discussing, lighting and noise levels, resource utilization, etc., besides similarly quantifiable financial matters. Success can, moreover, be measured by measuring factors like energy and operating cost. Within the technical picture fabric and energy advancement concerning lighting and thermal comfort will take the most elevated share. (Studies et al., 2013)

2.1.4. SUSTAINABILITY AS A SYSTEM

The above explanation of approaching sustainability as a system can be used for a general purpose but it lacks a basic subsystem in the explanation regarding the analysis of a specific building these elements are the building and the user.

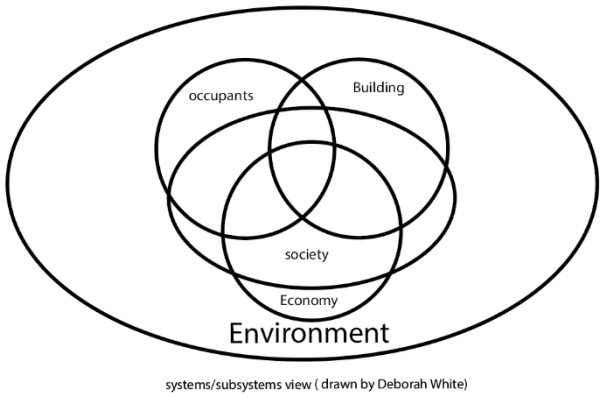


Figure 2. 1: system/subsystem view (Williamson et al., 2003)

The Environment subsystem extraordinarily contains the subsystem Society, Subsystems of Economics, Occupants and Building overlap both the Environment and Society subsystems, the subsystems Financial matters, occupants and Building have positive interrelations. (Williamson et al., 2003)

For illustration, the unfavourable impact of emanations delivered by a building, such as the off-gassing of materials, may influence the wellbeing of the tenants, the financial subsystem in terms of efficiency, as well as the encompassing natural framework. Additionally, the social significance of a building is integrals bound to how it meets partner needs and its financial reasonability.

The environment

Keeping up the environment is vital perspectives of feasible architecture Emission and utilization of raw materials are both inputs and yields of a given framework. These are the two major angles of natural impact. (Williamson et al., 2003)

Emissions

Chemical or physical operators (substances, noise, etc.) may be discharged into the environment as the result of human exercises related to buildings. Emission concerning the environment-related with either fabricating of building materials or the operation of a building. The impacts can be seen on the greenhouse impact, exhaustion of the ozone layer, smog, poisons (human and natural), waste disposal, and radioactivity.

Extractions

The anticipated depletion of the earth's stocks of fossil fuels and certain mineral and mineral assets may be a specific concern in most writing around sustainable building.

Keeping up this social varying quality must be seen as a vital component of sustainable architecture since history would show up to seem that grouping among human social orders is the source of adjustment and advancement. It may be a myth to think of traditions as impenetrable to alter. Traditions advance, but moreover can be quite suddenly modified or changed (Giddens, 1999).

The social and cultural relevance exists in changing environment of society and culture itself. Social Image isn't tended to through geographical implies or following regional architectural styles. The social measurement is indeed harder to handle. Anybody who travels will have taken note that buildings in cold climates are warmed to higher temperatures than those in which buildings in hot climates are cooled. This must do with culture, not comfort. And one cannot exchange suspicions almost building utilize between times and societies, and individuals don't continuously react as one would anticipate (Baird, 2013).

The occupants

The well-being, health and security of a building's inhabitants and all those possibly affected by a building could be an essential objective of feasible architecture. For illustration, a sensible level of safety factor against structural collapse is a self-evident need for maintainable design. Satisfaction concerning the comfort of the occupants in each space is also vital. By addressing this we can minimize the discomfort level of the occupant (Baird, 2013).

Economic performance (Technical issue)

Issues of the assignment of resources in time and space are central to realizing a sustainable design (Redclift, 2009). Individual factors of financial activities that impact choice-making are listed as follows.

- Output
    - Goods, Services, Asset, Production
- Inputs
    - Materials, Labour, Capital

The root cause of the mess lies in an overpowering accentuation on utilization and the course to human bliss and financial development as the implies of accomplishing it. Financial development within the ordinary sense is the issue. its interest harms the environment leads to social bad form, and is hindering to genuine financial improvement, 'it is by and large as it were those environmental activities that don't undermine the interface and schedules of mechanical capitalism that succeed'. (Othman, 2007)

The building

This subsystem is concerned with the human possession needs that relate to the benefits life of a building and its components, and questions around the life span execution of the built facility. 'optimizing the esteem of a built resource all through its programming, design, development, support, repair, renewal, and transfer phases' (Vanier & Lacasse, n.d.).

The life cycle of a building is considered as one of the factors that have to be considered when a given building is analysed. This could ordinarily be broken down into four particular stages: The generation of the building, The use of the building, demolition of the building, with the reuse or waste of materials and components. Understanding the production of the building in maintaining

sustainable architecture is crucial. The generation of buildings incorporates the plan and development forms, with the beginning and preparing of materials, transport, and operations in plan workplaces and on-site. Sites affected, Processing impacts, Product impacts. Could be listed as impacts. In addition, following the listed points while using and maintaining a building: the effect of the building and its interaction with its environment is external and internal the energy to run the house and waste products from the house. (Wind interference, formation of shade etc.), Energy to run the household (gas, electricity, water) running infrastructures, Waste products from the house.

Furthermore, to maintain sustainable architecture both in design and construction knowledge of demolition and recycling of buildings and their materials furthermore, traditional materials, as a rule, perform way better in this respect than modified ones and may perform well in other ways. David Lea comments: on materials that are acquired naturally without health and energy factors and could crumble into the environment without affecting it.

2.1.5. ASSESSMENT OF SUSTAINABILITY

The basis for Sustainability assessment is the environment. The analysis for the assessment is carried out by examining the impact a building or a system has on the immediate existing environment. (Williamson et al., 2003)

Two essential methodological frameworks have been made for natural appraisal:

- Environmental Impact Assessment (EIA)
- Life Cycle Assessment (LCA)

These two assessments have different approaches sharing the same aim and objective. The EIA handle points to survey the actual natural impacts of a building (or proposed building) found on a given location and in a given setting. The LCA procedure, on the other hand, is defined to evaluate the non-site-specific potential natural impacts of an item notwithstanding where, when or who utilizes it. Conducting sustainability assessment requires processing tons of data thus, tools that are supported digitally is important. At the starting of the computer transformation within the early 1970s, Odum saw ‘the building of electronic frameworks models’ as a conceivable way of bringing supporting the investigation (Odum, 2007).

Numbers of computer models of shifting multifaceted nature have been created with the point of mimicking the complex natural behaviour of buildings. This strengthens and evaluation of a building and supports the study and assessment of a building.

Different steps in the analysis of sustainability assessment are described below. The primary step in either strategy is stock investigation. In this step, the life cycle inputs and yields of the product, process or activity are catalogued and measured. This incorporates, for case, fossil fuel utilization, airborne outflows (greenhouse gasses – GHGs), waterborne emanations, strong emanations and raw materials.

The second step is effect examination. Actual information for each recognized impact ought to be collected and evaluated – but here lies an issue. Ideally, genuine information for particular items, created in particular manufacturing plants, ought to be utilized, but for the most part at the design stage not one or the other the real item is known (Sherwin, 2004) for case, when looking at cement fabricate plants, found a wide variety in vitality productivity, greenhouse output and other natural impacts. Depending on the plant, the epitomized vitality shifted between 3.3 and 8 GJ/ton.

The third step is impact evaluation, measuring the potential contribution of an item or prepare for antagonistic natural impacts. The US Environment Security Agency's System for Dependable Natural Decision-Making (FRED) presented 'a decision-making system for accomplishing an adjustment among cost, specialized execution, and natural preferability' (EPA 2000, n.d.).

In this system stock streams are related to ten natural impacts:

- global warming potential,
- acidification potential,
- eutrophication potential,
- natural resource depletion,
- indoor air quality,
- solid waste,
- smog,
- ecological toxicity,
- Human harmfulness and ozone exhaustion.

2.2. THERMAL COMFORT

2.2.1. DEFINITION OF THERMAL COMFORT

Thermal Comfort can be characterized as the ideal condition in which the slightest additional effort is required to preserve the human body's warmth adjust. Different natural variables (discuss temperature, encompassing surface temperatures, discuss mugginess and discuss speed) and psychosocial components (clothing, exercises, age and sex) influence human consolation. (Callejon-Ferre et al., 2011)

This zone is bound by temperature values between 21^0C and 26^0C and relative humidity values between 20% and 70%. No techniques got to be implemented in this zone. The satisfactory consolation zone may be a bigger consolation zone in which an individual does not have zero consumption but can adjust with a satisfactory least consumption. This zone is comfortable for 80% of the populace. (Manzano-Agugliaro et al., 2015).

Thermal comfort is achieved either by heating or cooling the indoor space of a building warming and cooling are the factors utilized to preserve the warm consolation of indoor spaces. Human wellbeing and consolation have been seen as the foremost imperative parameters amid evaluations of warm conditions of indoor environments. The warming and cooling of a space to preserve warm comfort are an energy-intensive handle that speaks to up to 60–70% of the overall energy utilization in non-industrial buildings. (Omer, 2008).

The energy efficiency of buildings in today's innovative and developed design and construction era has to be re-evaluated. The time has come to re-evaluate the 20th-century approach to comfort guidelines, to recognize their shortcomings which providing thermal comfort in universal guidelines advances mechanically cooled situations. On the other hand, construct on their qualities to empower passive buildings to rise. It is passive buildings that will empower us to live comfortably with the climate alter and fossil fuel exigencies of the 21st century. This paper will be utilized to investigate one of the vernacular designs existing in a harsh environment. The over articulation illustrates clearly the significance of the amendment of our warm standards regarding our residences. We are able only that through profound think about our vernacular architecture and the standards they are built on. (F. Nicol & Roaf, 2012)

The concept of energy effectiveness in buildings alludes to keep up the warm consolation whereas minimizing vitality utilization (Omer, 2008). Heating, ventilation, and air conditioning (HVAC) are the biggest energy consumers in a building.

The mission of architecture has continuously been the security of man from the outside environment and in this case, bioclimatic architecture endeavours to realize human thermal comfort by connecting enthusiastically with the outside climate. As individuals spend more than 80% of their lives inside buildings, the environmental consolation in a working environment is unequivocally related to the fulfilment and efficiency of its tenants. Thermal comfort can be accomplished by utilizing conventional materials and inactive methodologies which can decrease vitality to cool and warm the space, automation in energy examination to bring mindfulness in our choices, understanding of bioclimatic engineering in all communities and genuine clients of the building to play down cooling and warming gadgets.(Manzano-Agugliaro et al., 2015).

Sustainable Thermal cooling features of indoor environments have to be understood to properly adapt and integrate with an architectural design. Sustainable architecture (Bioclimatic) alterations fundamentally contain three headings: energy, human health/wellbeing and sustainability (Metallinou, 2006). The air condition of a building does not only have a crucial impact on the comfort of the building's tenants but too significantly impacts its sustainability. (Shrestha et al., 2021). Buildings should allow the residents to control their indoor environments. A great example of this will be afar nomadic architecture hence it's built completely by the residents.

2.2.2. THERMAL ENERGY REQUIREMENT OF A BUILDING

Physical and material factors affecting the energy requirement of a building. They can be defined in two categories one natural factor and the other is human interference related factor. Ekici and Aksoy (Bektas Ekici & Aksoy, 2011) listed the parameters that affect building's energy requirements as follows:

Physical–environmental parameters

- daily exterior temperature, solar radiation, wind speed and direction

Design parameters

- shape factors, surface transparency, orientation, thermal– physical construction material properties and distances between buildings, Structure and construction method

Socio-cultural studies are very important in structuring architectural design practices. Occupants thermal comfort isn't chosen by indoor microclimatic conditions alone Past investigate recommended that their thermal comfort is inside and out related to social parameters such as socio-economic foundation, culture, and what they encounter at family. The warm environment is affected by the variables listed below. (Shrestha et al., 2021)

- age, mode of buildings operation, Activity level and lifestyle, Clothing, Gender, Race and nationality, drink more or less water, are among the socio-cultural adjustments, to adapt to the indoor thermal environment. The clothing is worn by the inhabitants differed by age as well as by gender.

Example

A one-year think about in college campuses in Portugal appeared that clothing conduct and clothing cover are key issues within the estimation of consolation temperature. Found a gender distinction in clothing separator in Korea, which is related to culture and climate dress (Badescu & Staicovici, 2006). The comfort temperature increases as the outdoor air temperature increases. This opens up a probability to adaptation meaning the resistance ability of the residents and individuals living in that area will develop and change through time. (Shrestha et al., 2021)

Understanding the parameters affecting thermal comfort is difficult because 'comfort temperature' is a theoretical temperature at which it is calculated a particular individual or group will be most comfortable (or most likely will be comfortable). In a continually changing environment, it is subject to gradual change. It also takes no direct account of differences between individual people. The following variables are considered general parameters impacting the thermal comfort of an individual or a given group.

- Design and material used in buildings,
- climate and culture and can have a reasonably definite value at any particular time.
- The individual response to temperature is influenced by the person's thermal history, and the same is true of groups of people. Hence, it is important to understand not only the short-term thermal history of the person or group but also their seasonal experience in terms of the drift in their comfort conditions over the year.

The contrast between people within any sub-group is for the most part far greater than the distinction between groups. Group contrasts are related more to climate and culture than to physiological variety. (F. Nicol & Roaf, 2012)

An adaptive approach to achieve thermal comfort in a building is essential. Based on the theory of Nicol and Humphreys (1973) is that thermal sensation is part of the feedback system by which the human body is kept in thermal equilibrium and that deep-body temperature is controlled within narrow limits. Discomfort (or the perceived danger of discomfort) is the trigger for behavioural responses to the thermal environment. This knowledge has since been communicated within the shape of an adaptive guideline: if a alter happens such as to deliver discomfort, individuals respond in ways that tend to re-establish their consolation. (J. F. Nicol & Humphreys, 1973).

People react in one of two principal ways:

1. They alter 'themselves' to prevent discomfort within the prevailing conditions:
    - In numerous cases, this is often through clothing alterations, but moreover by other means – for instance, changes in pose or movement. (Humphreys et al., 2007)
2. They alter the environment to suit their needs:
    - changes such as opening windows (to alter temperature and air circulation), drawing blinds (to diminish approaching radiation) or changing their area to a more comfortable spot within the room. utilization of mechanical frameworks such as warming, cooling or fans can too be seen as cases of adaptive behaviour (J. F. Nicol & Humphreys, 1973)

2.2.3. ACTIVE AND PASSIVE COOLING SYSTEMS

Definition of passive and active buildings

The term 'passive' relates to building envelope arrange and building systems, whereas 'active' warming relates to the utilize of any exterior vitality source, other than sun based warm vitality, utilized for building talk about conditioning or undoubtedly sun arranged warming (Chan et al., 2010). Passive buildings can moreover be characterized as moderate buildings which are buildings with consistent energy and airflow that can keep up satisfactory thermal sensation benchmarks utilizing inactive cooling procedures and systems. (Manzano-Agugliaro et al., 2015)

Vernacular designs can be taken as a model system from passive design. Individuals live traditional ways of life in vernacular buildings in for all intents and purposes each climate within the world, from the Arctic Circle to the tropics, in temperatures from underneath zero to over 40^0C, and verifiably without the advantage of gas or electrically driven mechanized warming and cooling frameworks (F. Nicol & Roaf, 2012).

Most passive buildings in contrary to active building, require their occupants to take an active role in controlling the indoor environment. This makes the adaptive approach which can be taken as a model system, developed from observation of user behaviour which is better for buildings. Hence vernacular design may require differently sized and proportioned houses, different materials, and different dress codes, daily routines and levels of activity to achieve sustainability (F. Nicol & Roaf, 2012).

Vernacular architecture can be taken as an effective model system for achieving sustainability. The effectiveness of vernacular architecture in achieving a sustainable way of keeping thermal comfort can be seen from these examples. Components such as the wind catchers utilized in Nagapattinam (India) offer assistance to diminish the insides temperature by up to 10^0C (from 26 ^{0}Cto16^{0}C) at outside temperatures of 40^{0}C and tweak the insides relative stickiness by lessening the crest level from 95% to 75%. (Shanthi Priya et al., 2012). The utilization of rooftop water tanks for passive cooling through night-time convection cooling could be a demonstration taken from Greek coastal zones and permits the decrease of cooling loads by 87% (Manzano-Agugliaro et al., 2015). The misconception of passively designed modern buildings won't be as comfortable as actively designed buildings have to be remodified. The steady and slow-building methods and advantages have to be redefined. Climate chamber tests that exclude social contrasts – conclude that individuals around the world have comparative consolation needs, a presumption that has been demonstrated wrong in any number of field studies of thermal comfort. (Humphreys et al., 2007)

Air-conditioned buildings use cooled and, possibly, dehumidified air, circulated buildings in systems of ducts, using mainly electrical power. It completely disconnects the buildings indoor environment apparently from the outdoor so the building is very vulnerable (F. Nicol & Roaf, 2012).

In addition, the cost of the buildings increments due to the costly HAVC framework equipment and the expense for the engineers and temporary workers. energy supply will get to be restrictively costly or will get to be less secure in its supply as grids are over-burden, especially in extraordinary climate. Within the last-mentioned case, the inhabitant is left in a building that's greatly uncomfortable or indeed perilous when the control grid does come up short. It makes the building depends upon its mechanical advantage and alarmingly inefficient in energy utilization.

A false image that has been created in the industry is even though a building didn't need air conditioning for the climate it exists the probability of having one is high. Its promoted as if it has

no problem and perfect for providing the best indoor environment. The importance of designing in passively ventilated standards and regulation is it makes the designers and architects actively participate and dig more to adapt the building in the given context.

In conclusion, Air conditioning has made it conceivable: to erect structures that must be emptied when the power fails, to create buildings in which people get wiped out, it swallows power, thunders, wheezes and cries, makes urban warm islands indeed more smoking with the deplete of a million air-conditioned cars and thousands of sealed buildings. (Marsha Ackermann, n.d.)

2.2.4. IMPACTS OF ACTIVELY COOLED BUILDINGS

The high degree of greenhouse gas outpourings coming approximately from significantly adjusted buildings is one of the fundamental disputes driving the move back to the utilize of common ventilation and confined. (F. Nicol & Roaf, 2012)

Table 2. 1: *Typical proportions of CO, production in the UK* (F. Nicol & Roaf, 2012)

System	The proportion of co^2 produced %
Fans and pumps	30
Cooling	13
Heating and hot water	32
Lights	21
Catering	4

Source: adapted from the data of Max Fordham, personal communication

Impacts on culture and health.

Cultural impact

Standardization of architectural design process and association of universal firms that have no social involvement supplant the vernacular and advances the same standardized air-conditioned way of life. This will result in alter and misfortune of nearby culture and convention. (F. Nicol & Roaf, 2012)

Health impact

Buildings are getting to be significantly 'sick'. Indoor air quality can be more undesirable in an air-conditioned building than in a comparable ventilated one. Worryingly, analysts are finding that the channels and plant of air conditioning frameworks are regularly smudged, presenting discussion that's dirtier than on the off chance that one essentially opened the window, indeed in cities. (F. Nicol & Roaf, 2012)

2.2.5. TOOLS TO STUDY THERMAL COMFORT OF A BUILDING

Bioclimatic diagrams

Different bioclimatic graphs are utilized as instruments with which to decide consolation levels. The foremost broadly utilized incorporate the graph created by Victor Olgyay, Baruch Givonito to decide outside and insides consolation which can be calculated utilizing the relative stickiness and insides temperature values and has been received by ASHRAE (Freire et al., 2008).

Givoni chart, shown in Fig. 1, could be a bioclimatic chart that has been isolated into distinctive zones. The x-axis speaks to the dry-bulb temperature and the y-axis appears the new discuss stickiness; psychrometric bends within the chart speak to the relative mugginess. (Givoni, 1992)

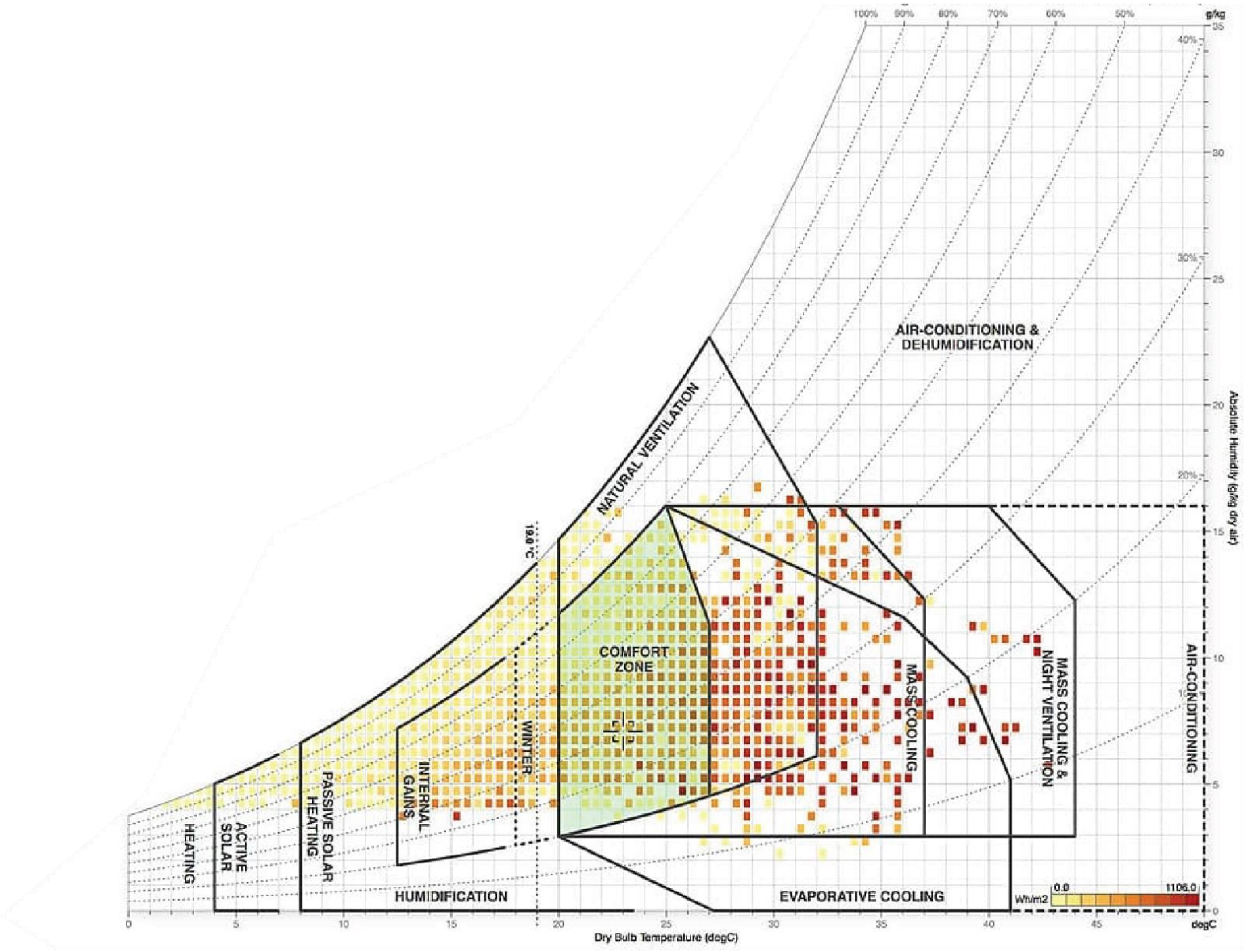


Figure 2. 2: Psychometric Chart_ Source (Psychrometric Chart, n.d.)

Table 2. 2: Zones and their perspective solution for achieving indoor thermal comfort _ sources: (Manzano-Agugliaro et al., 2015)

Zones and their perspective solution for achieving indoor thermal comfort (Tabular descriptions) Zones impacted hot and arid climates.

(Manzano-Agugliaro et al., 2015)

NO.	ZONE NO.	TYPE	SOLUTIONS
1.	Zone 9	using a material with high thermal mass to cool the air through	protection is cantered on the mass of the building envelope that gets and along these lines transmits radiation to the insides with a stage distinction to realize climate consistency all through the day. Capacitive materials offer assistance to make a stage distinction within the day-by-day vitality transmission and temper the escalated.
2.	Zone 10	Cooling using evaporation	Humidification can be accomplished utilizing outside vegetation, water (lakes or wellsprings, buried channels that are one-third filled with water the splashing of water on the roof, the showering of water inside to diminish the temperature of the overhead air.
3.	Zone 12	Utilization of both natural and mechanical ventilation	A more prominent thermal sensation is accomplished whereas the indoor air is at the same time cleaned. This may be accomplished normally utilizing cross-ventilation from north to south facades or prevailing winds, the chimney impact, a sun-powered chamber, underground ventilation, wind towers, evaporative towers, vertical spaces inside a building or patios.
4.	Zone 13	air conditioning	Air conditioning, exceptionally common proposals concerning air conditioning utilize incorporate not setting the indoor regulator at a lower-than-normal temperature, as this leads to energy waste, and turning off air conditioning equipment when clearing out the home.
5.	Zone 14	Conventional dehumidification	This can be fulfilled utilizing retentive salts and saline cells and requires complementation with other strategies.
6.	Zone 15	Air-conditioned dwelling unit	A dwelling unit with very well constructed insulations and roof and double-paned glass windows will accomplish a few reserve funds within the vitality utilization utilized for warming and cooling and will moreover encounter decreased sound contamination.

The variety of techniques is as wide as is the assortment of climates, well-known traditions and societies (Manríquez et al., 2006). Vernacular architectural methodologies offer assistance decrease energy utilization conjointly speak to the premise from which to create other techniques for superior adjustment to the social conditions of cutting edge design.(Indraganti, 2010)

2.2.6. THERMAL COMFORT STUDY APPROACH

Generally, there are two approaches are employed to evaluate thermal comfort: climate chamber study which is carried out in controlled environmental conditions and field study which is examining actual buildings with occupants.

A field study is the one that can give an adaptive solution that can be accepted by the residents. The versatile model of warm consolation is based on the field overview, an elective approach to understanding and inferring the conditions that individuals discover comfortable. In a field overview, members are inquired to require a portion within the study to survey their warm sensation on a subjective scale (see Table 1.1). The environmental variables are measured at the same time as the subjective reactions are recorded. (Shrestha et al., 2021)

Because the aim is to obtain a reaction to typical conditions, there is no attempt to interfere with the environmental conditions, the activity or the modes of dress, and thus the full complexity of the context is included in the responses of the participants. Other influential factors regarding the thermal sensations are: The outdoor climate, the availability and use of environmental controls, the building type and function, and the social setting can all be recorded as potential influences on the participants' response.

Bedford scales of user response.

ASHRAE descriptor	Numerical equivalent	Bedford descriptor	Thermal sensation	Over all comfort
Hot	3	Much too hot	Very hot	
Warm	2	Too hot	Hot	Very uncomfortable
Slightly warm	1	Comfortably warm	Slightly hot	Moderately uncomfortable
Neutral	0	Comfortable	Neutral	Slightly uncomfortable
Slightly cool	-1	Comfortably cool	Slightly cold	Slightly comfortable
Cool	-2	Too cool	Cold	Moderately comfortable
Cold	-3	Much too cool	Very cold	Very uncomfortable

Table 2. 3: American Society of Heating, refrigerating and air-Conditioning Engineers (ASHRAE) _ *(Williamson et al., 2003)*

The digital instrument used for measurement of environmental qualities

Parameter measured	Sensor	Range	Accuracy	Name of instrument
Air temperature	**Thermistor**	**0-55^{o}C**	**+-0.5 ^{o}C**	**TR-74Ui**
Globe Temperature	**Metallic globe**	**-60-155^{o}C**	**+-0.3 ^{o}C**	**Tr-52i**

Table 2. 4: The characteristics of the instruments used in thermal environmental measurement.

2.3. VERNACULAR ARCHITECTURE

2.3.1. DEFINITION OF VERNACULAR ARCHITECTURE

Vernacular buildings are dwellings that result from the interrelations between environmental, economic, material (accessible resources), political and social components. It appears human civilizations are maintained and transferred through improvements from one era to another. (Lawrence, 2005)

vernacular architecture is developed and evolved through time by considering the climate and social structure of a given community. One way of examining climate and design relationship is by considering vernacular plan illustrations. Structural historian Thomas Hubka (1979) expounds on the concept of a vernacular plan to look at plans by individuals with no previous plan instruction and how they plan their living spaces. He contends that vernacular creators begin their forms with the constant and afterwards accommodate change. (Aktas, 2019)

Earlier vernacular architectural approaches consider shelter as a generative concept of vernacular architecture. More important for our purposes is the generative concept of the 'primitive hut':

primitive hut relates with the cave as a generative concept. The cave and its related shapes, not as it were since the prove proposes that these appear to have been the earliest primordial architectural concepts, but since they were, in any case, included as fundamental primitive concepts nearby the 'primitive hut'. Simplicity or simple configuration of lines as a generative concept. Mimi Lobell (1983) has proposed another kind of generative concept, the basic setup of lines inside a square, the circle, the triangle (or pyramid), the emanating axes of a star and the grid. (Lewcock, 2005)

fast forward we as humans evolved and developed our construction methods and developed new construction materials through time. contemporary materials have a negative impact in developing countries with a hot and arid climate. Industrialization, be that as it may, mass-produced materials such as cement, steel and glass have continuously supplanted the fundamental constituents of conventional building development. At a more common level, nowadays, there are choices between conventional materials and strategies, manufactured materials and unused advances: the previous as a rule empowers the utilization and reuse of

renewable assets, though the last mentioned requires more energy and more specialized mastery. They moreover create more non-recyclable squander items. (Lawrence, 2005)

The ways of engaging with normal situations in a way that does not misuse the characteristic resources but or maybe consolidates with them. This approach includes re-examining our everyday propensities in nature-compatible ways and utilizing natural resources in regenerative ways. (Aktas, 2019) Confronted with the opportunities and issues created by the method of globalization and with the expanding impacts of natural alter, vernacular builders all around the world will require unused thoughts and implies to benefit their buildings in line with changing social needs and wants and to ensure them from the developing impacts of climate alter and the expanded hazard of normal dangers. To begin with, of all, vernacular architecture ought to be expressly treated as a social handle instead of as simply a fabric item. Dynamic interrelationships between building conventions, social personalities and situations on an ethnographic and clear, as well as a comparative and hypothetical level (Rapoport, 2005) When studied the study should mention:

- achievements
- qualities
- failure

Today's corrugated sheet metal rooftops common in numerous developing nations have a greatly negative impact on indoor temperatures, both in summer and in winter. One of the vital results of this ponder, so distant, stems from the counter-intuitive comes about of the observing and recreation studies. It is such 'intuition' stemming from 'common knowledge' and hypothetically 'thoroughly established' verifiable standards that cause misinterpretations and arranged issues, not slightest among NGOs and improvement organizations working in creating nations, numerous of which are characterized as deserts. Such misguided judgments have given birth to lodging units with gigantic dividers and lightweight sheet metal material, as awful an arrangement as one may conceive. (Meir & Roaf, 2005)

2.3.2. FACTORS AFFECTING VERNACULAR ARCHITECTURE AND STUDY APPROACH

Parameters affecting design decision

Vernacular architecture depends on the material choice and energy efficiency throughout the whole building cycle. Also, it must address the social and social values of the community. Second, human environments are not closed, limited frameworks since they are open to

outside impacts of a biological kind (e.g., sun oriented energy, earthquakes), of an organic kind conjointly of an anthropological kind (e.g., illness and fighting). (Rapoport, 2005)

In this way, vernacular environments give an unequalled, and as it were conceivable, 'laboratory' with a tremendous run of human reactions to a similarly tremendous extend of issues; To ponder the components that can influence our design choices, the taking after components ought to be inspected. (Aktas, 2019)

- climate, vegetation, landscape and slope, Economy (Site)
- living habits,
    - Animals, materials (Resources), mobility, interaction with the nearby urban existence,
- Construction and thermal cooling techniques
    - construction technique (Vernacular technology), construction process, neighbourhood design
- Thermal sensation influenced both by a material and non-material factor.
    - socio-cultural structure functionality, Thermal sensation, Economy, ways of living

The following listed Factors affects the design decision of a vernacular design. Jane Bennett (2010) proposes the concept of dynamic matter. Bennett contends that things have free control in their presences which empower them to perform unexpectedly beneath different conditions. Considering that natural materials advance based on the climate, considering the material and design relationship can advise considering the relationship between design and climate. (Aktas, 2019)

Vernacular design inputs and thermal performance

Curved rooftops were found to perform thermally superior to level ones by advancing more comfortable inside. The geometric focal points of such rooftops were initially explored tentatively by Pearlmutter on test cells with irrelevant mass rooftops. The most reason for moved forward indoor conditions beneath a bent roof is precisely this extended surface region, which permits for more warmth to be disseminated at night through radiation and convection. (Pearlmutter et al., 1993)

The role of openings in structures existing in harsh environments

The part of the unimportant windows situated on the upper portion of gable walls in such structures demonstrated to be of exceptionally critical significance within the general conduct of the structures when ventilation was connected to the show and the recreations.

How framing affects the building thermal comfort

Fenestration in such structures is regularly insignificant. In numerous cases, it is constrained to one opening as it were, an entryway. Where windows do exist, they tend to be exceptionally little, a truth managed by the development procedures and materials, as said already.

Where activities affecting the thermal standard of a building will be carried out.

Cooking is still done outside the main living quarters referring to many traditional settlements, either in a separate structure or in the open-air courtyard.

Material and design decision

Accessible resources influence the design decisions of vernacular architecture. This understanding of developing and designing buildings regarding existing conditions enables us to examine how to attune to our surrounding and how it actively affects design decisions. (Aktas, 2019). They took the advantage of the structural and thermal property of these materials. (Meir & Roaf, 2005)

Climate and design decision

The areas that utilize climate-responsive technique ordinarily point at lessening vitality utilize in buildings or spaces. Ordinarily, climate-responsive design examines ways in which architects can create models that cooperate with different climate sorts and the changing climate. (Aktas, 2019)

2.3.3. INFLUENCE OF CULTURE IN VERNACULAR ARCHITECTURE

Adaptability and resilience are essential characteristics of human culture, which ought to be related to the characteristics of human environments, counting vernacular buildings. The relationship can be utilized to distinguish key standards approximately vernacular buildings, human settlements and maintainability. Be that as it may, climatic contemplations may frequently have been of auxiliary significance, after behavioural, financial and social impacts, within the advancement of the point by point plan of these buildings. (Lawrence, 2005)

To understand the influence of cultural interaction on vernacular architecture it's vital to understand small group social interactions. In House, Form and Culture, Rapoport (1969) analyses and outlines what he terms the ‘genre de vie’ (mode of life) that influences built frame. He records a few of the variables that he concludes have a vital impact on the way a staying is built. (Asquith, 2003) They are socio-cultural variables as contradicted to physical components such as climate, innovation, economy and materials. The five variables are:

- some basic needs,
- family,
- position of women,
- privacy,

- social intercourse.

The communication between family individuals ought to be analysed not as it were by considering their communication but moreover organizing and re-structuring of time and the spatial sort itself. In addition, rules as a variable have a significant aspect in shaping vernacular architecture. Manners, kinship frameworks, evasion relations, and subsequently protection rules, laws of immaculateness and other rules concerning social relations, intelligence and behaviour (who does what, where, when including/excluding whom, and why). (Rapoport, 2005)

Sets of rules by which a community live up to are much clearer, since they are 'tighter', in a vernacular design, making it simpler to distinguish the components included, (Rapoport, 2005). The reliable application of rules leads to style; distinctive styles are a result of diverse run the show frameworks, and so are distinctive orders. Since vernacular designs are products of human culture and follow rules, they reflect some order organization of:

- space,
- time,
- meaning and communication

The relationship between vernacular architecture and inhabitants with meaning can be explained using the following illustrations. The first is what, in the archaeology of Israel, is called the 'four-room house'. Whereas the arrange was utilized in an awesome assortment of topographical and climatic locales and, Bunimovitz and Faust contend that the 'four-room house was a typical expression of the Israelite mind', i.e., of their ethos and world-view; at the same time, it moreover made a difference to structure that intellect. This imperative part of high-level implications would not be found in modern, particularly high-style architecture.

Vernacular design approaches react to the biggest run of connection frameworks, family structures, parts, statuses, social systems and so on. There are numerous sorts of human settlement formats counting direct, nodal, compact and scattered (Oliver 1997a). The concentration of exercises, the built environment and the inhabitant populace has numerous environmental and financial focal points compared with a more scattered shape of human settlement.

Socio-cultural interactions variables for studying vernacular architecture focused on:

- Physiology (comfort, adaptation, hence standards, etc.)
    - Thermal comfort, interior space organizations, furniture.
    - Adaptation can be expressed through response to the environment
    - Like eating
    - Movement (Mobility)
- Anatomy (ergonomics, different ways of doing things, different postures)
    - Documentation
    - In the case of anatomy, the great variety of statures and, more important, postures clarify the range of possible ways of carrying out activities. (Rapoport, 2005)
- Cognition (structuring and ordering the world, mental maps, orientational systems and their importance (i.e., moving easy or difficult) Perception (understood as the perceptual aspects of environmental quality)

Several methods and techniques were employed, for studying the above parameter including monitoring, modelling, numerical analysis, simulation and infra-red thermography. Furthermore Investigations included different building technologies and materials, morphologies and details. (Meir & Roaf, 2005) The following analysing tools can be used to study the influence of culture in shaping vernacular architecture.

The time diary

To record action, time and space utilization in connection to each person, which can at that point be inspected concerning age and sex, a time journal can be utilized. It can capture the pith of each individual's everyday design of space utilization. subjective strategies, interviews, surveys and time journals, genuine on-site estimation. (My approach) to gather the information all individuals living in one staying can be recorded over time. Which the data can be entered into a coded worksheet where activities can be grouped accordingly. (Asquith, 2003)

Spatial mapping

The time journal records exercises and room use as they happen. In any case, what spaces each person relate with or claims is a critical perspective within the organizing of space inside the domestic, which can be progressive depending on age, sex or status exterior of the domestic. (Asquith, 2003)

Spatial configuration diagrams

Spatial setup charts tool that can distinguish how spaces inside the domestic relate to each other spatially, ought to be received. This tool is commonly known as the j-graph and may be a strategy determined from arithmetic and geometry and adjusted by Charge Hillier for space

language structure investigation. The graph can be spoken to with a bubble graph where Each room is spoken to by a bubble, but the measure of the bubble is demonstrative of the sum of time went through in each room by all family individuals. (Asquith, 2003)

Behavioural approaches in the study of the social-cultural structure

A behavioural approach to lodging investigates is concerned with the recognition, intuition, connections and personalities of the person as he or she accept their parts inside the physical boundaries of the dwelling. The study is conducted by analysing who does what (Which relates to the person with the activity) and the where and when relates to space and time. (Asquith, 2003) participation of inhabitants in the construction of their dwelling is very important to understand the influence of social structure on vernacular architecture. Like vernacular builders, architects and engineers got to be included in all angles of the production prepare, to create plan models that reflect the wants of the communities that will eventually stay in these houses. (Asquith, 2003)

2.3.4. IMPORTANCE OF VERNACULAR ARCHITECTURE

Inventive approaches of this kind not only offered assistance but also advance the neighbourhood environment and secure the cultural heritage of human settlements. Through innovation and design, we can adapt natural ventilation lessons from vernacular architecture to a modern design. Natural ventilation is different from mechanical frameworks of air-conditioning for all sorts of buildings. (Lawrence, 2005)

Reusable materials, such as wood clay and brick, ought to be utilized rather than non-biodegradable engineered items in unused building development and redesign projects. If the vernacular makes up 90 per cent of the world's buildings and comprises roughly 800 million residences, it arguably cannot be overlooked inside the setting of future housing research. (Asquith, 2003)

Through the Transfer of principles and lessons from vernacular to contemporary, we can develop modern vernacular architecture. "Learning from the past to design a better future"(Mele, 2017). 'Modern vernacular' buildings combine the lessons of conventional buildings with the benefits of fitting advanced innovation to supply truly sustainable buildings for the 21st century. Hence proper study and analysis then adaptation of vernacular architecture is important for the advancement and promotion of comfortable modern vernacular buildings that suit the human need of 21 century. (F. Nicol & Roaf, 2012)

Like Lawrence, Payne also reminds us of the truth that, in considering vernacular conventions, it is vital to centre on how human settlements as an entirety are organized and conceptualized, instead of on individual buildings only. Re-interpreting (understanding) instead of re-using (replicating) the technology'.(Asquith & Vellinga, 2006)

As Rapoport noted in his publications and studies Vernacular architecture has to study through the following variables: (Rapoport, 2005)

- Concepts (definition and general ideas)
- Models (Methodologies and ways of studies)
- Theories (Proven ways to study the structure of different parameters and factors)
- EBS theories

Vernacular architecture can be studied and analysed in a way which later it's impossible to extract lessons from it. In the following section wrong way of studying vernacular architecture is discussed in brief. (Asquith & Vellinga, 2006)

Vernacular design can be advanced through promotion: vernacular assets and innovations, and to create recommendations for the preservation or recovery of vernacular buildings or destinations.

Accepting that something can be learned, the foremost common approach is to duplicate certain formal qualities (shapes, massing, points of interest, etc.), regularly based on a romanticized adaptation of the vernacular. In common, this approach has not, does not and is progressively impossible to work. (Rapoport, 2005)

Vernacular examples contain both invaluable and disadvantageous circumstances. In like manner, instead of taking after these illustrations as they are, vernacular cases ought to be re-interpreted with current conceivable outcomes to create way better comes about. (Aktas, 2019)

A false image of vernacular design contributes to the lack of study and analysis. Vernacular architecture continues to be associated with the past, underdevelopment and poverty, and the Association of vernacular with past and undeveloped practice that was used when human beings were uncivilized, gives the discourse less attention and professionals interests. Generally, vernacular houses are regarded as challenges on the path to progress.

Studying vernacular architecture focusing on the physical dwelling is also important for understanding essential variables like material, construction technique, ergonometric etc. Vernacular study as a portion of the design thinks about, it's vital to show building documentation of the existing staying with significant points of interest and fabric catalogue counting cases of site-specific advancement to resume our understandings for end of the plan and its business is looking for unused conceivable outcomes. (Aktas, 2019)

Natural history

Natural History strategies take Lessons from the vernacular are frequently utilized basically to record and archive building conventions and typological changes through history (Lawrence, 2005). Overviews, plans, and measured drawings are all utilized to record changes in arranging sort and houses are decreased to absolutely typological centrality. North American vernacular engineering focusses on the,(Asquith & Vellinga, 2006)

- classification and dating of individual buildings, or of
- specific forms,
- materials or plans,
- tracing distribution and diffusion patterns
- as well as changes in type within the context of social history.

Tools and methods used for the analysis of these buildings. The parametric studies described here include:

- in situ monitoring; 1:1 scale model monitoring;
- infrared thermography; thermal and daylight simulations; and numerical analysis (see Figure 12.3). In several cases, a 1:1 scale model was used to calibrate simulation tools.

Investigations included different:

- building technologies and materials,
- morphologies and details, under typical arid conditions typical of the Afar climatic regions.

The indoor climate was analysed vis-à-vis visual and thermal comfort.

Problem-oriented

This strategy centres on issues of preparation instead of product, identifying general principles and ideas instead of essential actualities and figures. Most imperatively, it should be basic and effectively lock in the substances of the show, instead of remaining cantered on the past. The presumption that those included in the modern plan may learn from the vernacular shapes the beginning point of Amos Rapoport's chapter. By examining:(Asquith & Vellinga, 2006)

- physiology, perception, meaning, cognition, culture

Changing and unchanging factors

Unchanging factors are variables that are constant meaning they might have a chance but a very gradual one. For example, the climate could be listed as one. On the other hand, changing factors are factors that change like a temporary settlement. The factors are interlaced structure since all these components have been advancing together. These relationships are not based on step-by-step improvement but or maybe a co-evolvement through time. (Aktas, 2019)

2.4. NOMADIC VERNACULAR ARCHITECTURE

Nomadic vernacular architecture represents dwellings formed by a community that travels from place to place. Their lifestyle, cultural values and dwellings are influenced by mobility (Asquith & Vellinga, 2006). Stationary life among travellers proceeds to speak to a distinctive social direction, it's generative systems', not one or the other a 'simple mechanical reproduction' of periodic social shapes, nor a unique take-off from the structures of migrant life. Like numerous other shapes of migrant culture, it shows complexity, toughness, and adaptability. (Hoare, 2005)

Its social and political significance is obvious, for occurrence, from how it proceeds to illuminate the:

- the social composition of the settlements,
- to shape the structure of connections and characters,
- to impact the generation and built shapes of residences, and to outline the encounter of a bigger world. Despite the constrained changes to the vernacular way of living and building, at that point, life among travellers proceeds to speak to a distinctive social direction. (Hoare, 2005)

Definition of pastoral nomads and non-pastoral nomads

The difference between pastoral nomads and non-pastoral nomads is based on their economic activities. (Hoare, 2005)

- Pastoral nomads live off by herding their livestock searching for fresh grazing land and water. Hence their existence relies on their livestock. Afar Pastorals can be an example.
- The non-pastoral nomads are not based on livestock they may be involved in different economic activity, but they have an irregular pattern of movement. Mongolian nomads and Turkish travellers can be taken as an example.

Tapper (1979: 45) comments that for a few Centres Eastern people groups, 'movement, tent-dwelling, and stock-rearing are not saturated with central implications at all' which, 'in these cases, nomadism is a financial instead of an environmental, social or political adaptation'.

The socio-cultural structure of Nomads is somehow different from other non-nomad communities. Inter-family relations, marriage and residential courses of action, interfacing and modifying bunches with changing needs and capacities; fortifying or diminishing shared reliance and co-operation between the well-off and the destitute, kin and their marital families, and the ancient and the youthful. The development offers ways to oversee strife and competition in politically un-centralized social orders. (Cronk, 1995)

strong social bonds among nomads are important for their intact existence. To maximize opportunities, skills and knowledge. The control and exchange of relatedness through connection and private closeness, in adaptable, full of feeling and utilitarian interactions , implies people and marital families can mobilize social bolster from diverse sources, for different purposes.

2.4.1. SPATIAL MOBILITY AND ITS IMPORTANCE

"All the Basseri communicated their response as one of continuing relocation – not as 'becoming pastoralists again'. As a matter of reality, most of them had exceptionally few creatures, and a few shows up to have continued movement completely without stock – the incomparable esteem to them lay within the freedom emigrate, not within the circumstances that make it financially viable."

(Barth 1961: 149)

Basseri may energetically continue development after a long time of stationary staying: the social structures, implications and verbalizations of portability are multi-layered. (Hoare, 2005)

In any case, the 'whole essential framework of activities included within the economic adjustment of the Basseri, of camping and grouping and voyaging, is pregnant with such implications, and . . . the setting inside which they take put, that of the incredible relocation, is vested with extraordinary value' (1961: 147). An encourage and want for movement is in some cases said to be 'in the blood' among individuals who have received stationary modes of life. 'Place' is hence frequently figured in terms of time and season, arrival and departure, not as a divisible protest in 'space', as Barth (1961) and others have watched. Person adaptability, activity, inter-personal co-operation, powerful group loyalties, as well as a taste for assortment and capacity for alter are hence the steady qualities irreplaceable for overseeing life expansive and complex places; and the thought of 'place' to which roaming individuals may be joined (within the sedentist sense), is development itself.

Mobility is reflected as an organization of social structure in a settlement of afar nomad communities. Versatility, as an organizational highlight of social relations, proceeds to shape

the arrangement of residential groups, to illuminate the values and community life of inhabitants, and to be reflected within the built shapes of the settlement. The development offers ways to oversee struggle and competition in politically un-centralized societies (Cronk, 1995) to resume, keep up and exchange collisions between family; and to maximize openings, abilities and information. The control and transaction of relatedness through connection and private closeness, in adaptable, emotional and utilitarian collectivities, implies people and marital families can mobilize social bolster from diverse sources, for different purposes. Spatial mobility can be influence by the following factors. Spatial movement concerning particular internal or external aspects of the life of a nomadic group of people, such as, (Hoare, 2005)

- economic systems, ecological adaptation and herd management.
- spatial mobility has been described in a variety of terms, as a strategy, mechanism, technology or mode of life.

By ideals of their capacities, their materials and their creation, the protect and bed tents were once in the past the foremost hint and imperative objects in roaming life. The tent parts, made and collected by the spouse, were routinely moved, reproduced, re-established and changed. Travelers experienced the misfortune of their vocations and commonplace parts, connections and designs of development among different areas of the settled populace. (Hoare, 2005)

- Change to their life made them lose their identity.
- The industrialization and the sprawl of urban settlements
- Importance of owning a land
- Public services and infrastructures
- Climate change
- The state policy

Streets were slowly extended to oblige a developing volume of engine activity, the two moves viably crushing numerous previous camp locales. A ‘boulder policy’ was in the long run presented, anticipating getting to lay-bys or other off-road camps. Additionally, it’s vital to ponder their vernacular design so that their exuberant hood thrives once more. Lockwood applies to the adaptable vocations of the Xoraxané, is suggestive of the capacity for ‘holding patterns’ inside other angles of migrant life:

- Residential groups,
- Sedentary and mobile versatile dwelling units, relocation designs – as well as livelihoods.

2.4.2. SOCIAL STRUCTURE (INTERACTION OF NOMADS)

Bronner notes, deep and fair examination of buildings on how they existed like the way they do in today's world and came into being through evolution and improvement is important but moreover by whose measures, by what points of reference and with whose skills of creation, transmission and alterations happen. (Asquith & Vellinga, 2006). The prevalent notion that, at the beginning of a new millennium, nomadism has outlived its usefulness, and that the way of life and behaviour associated with it have become redundant and inappropriate.

travelling is still a culture in a nomadic community. families within a single locus, and seeking to distil some of the social activities and values of 'coming and going', which took place through time and movement, into the spatially fixed community of the site.

mobility is still a distinctive element of traveller culture, even though the groups are now no longer 'on the road'. Through coming and going, a young married couple gradually widened their geographical knowledge of different travelling circuits, and their varied opportunities or limitations. (Hoare, 2005)

The restrictions of sedentary life have severed the scope for the important social, strategic and practical functions of 'coming and going' through movement. Contacts with the wider group of family and friends are nowadays limited to family visits and larger gatherings where marriages or christenings are celebrated, or at funerals.

Gender is an important parameter for studying the social structure of nomadic communities. At the level of inter-family relations, the movements of women between camps represent a further important social and political function of movement (Stenning 1994; Marx 1978), although receiving little attention.

How nomadic mobility has served to describe the vernacular dwelling properties nomadic movement may be said to possess many of the characteristics of the vernacular dwelling. Spatial movement is, in some senses, flexibly 'inhabited', made to fit varied, changing, yet broadly predictable circumstances. This suggests that the motivations for movement may not always be what they seem, or be acknowledged to be what they are (Gulliver 1975). Individual members of a residential group or conjugal family may be mobile in different ways, in different social spaces or time frames, and for different reasons. The partibility of mechanisms that generate structural fluidity is an important point, in considering mobility within sedentarized traveller culture.

Pros and merits of nomadic architecture

Using less material means very environmentally friendly. This approach is supported with the right techniques and systems it can be very useful and solve the problem that we encounter regarding our environment and energy usage in the production of materials and the construction process. This can be inspired by nomadic vernacular architecture. (Mele, 2017)

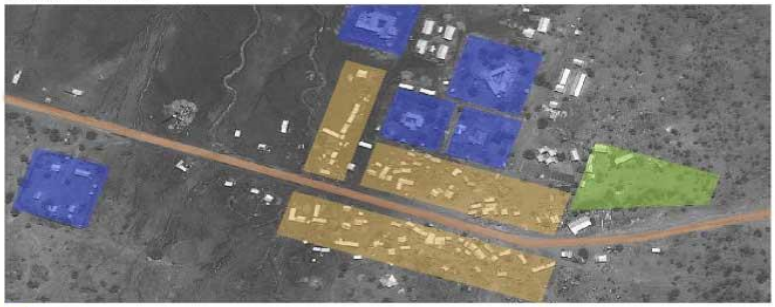
CASE STUDY : BY_CATARINA GUIMARAES and GoDesign

Project name: KOMAME SCHOOL

Location: Afar, Ethiopia

SITE ANALYSIS

Komame Settlement

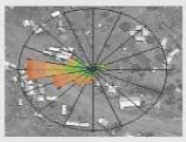


The Komame village was settled around the Komame School. Slowly, this settlement evolved into the first city of the Afar region.

Seasonal Analysis

Climate Analysis

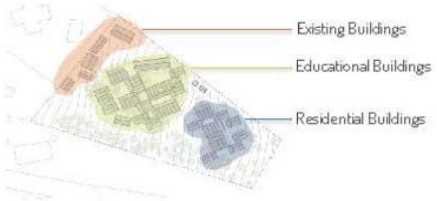
The existing buildings occupy the northern part of the site.



Current buildings on site do not work against the wind, their positioning seems random.

Being about 9 degrees north of the equator, this zone gets direct sun radiation almost perpendicularly during the entire day.

SITE PLAN



Three major areas have been designed along with this site plan. The area of the existing buildings, that will consist of office and dining spaces, the area of the educational buildings, and the area of the residential buildings that will house teachers and staff from the school. The three areas have been separated accordingly. The residential area resides at the southern part of the site, for privacy and comfort. The educational buildings have naturally been located closer to the existing buildings and have been assembled in a grid system that provides courtyard spaces and hallways. Along the south-western side of the site sits the tree barrier that will block the stronger wind currents and also provide a privacy from the housing settlements made by the villagers.

EXTERIOR RENDERINGS

Best Solar Orientation

According to several studies using programs like Ecotech and Climate Consultant, optimum solar orientation is achieved when facing the east and west facades to the northeast and southwest. This allows for less direct sunlight and best ventilation.

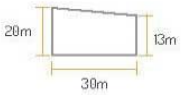
Woven Courtyards

Due to the interconnected circulation paths caused by the shaded and unshaded areas that transition from building to building, the courtyards are formed. This creates an interactive campus with small spaces that can be enjoyed by all of the students that happen to walk past them.

COURTYARD ANALYSIS

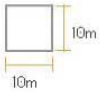
Courtyard A

Bigger courtyard spaces have good ventilation , with overhangs from buildings potentially shading most of the open area.



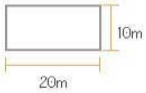
Courtyard B

Smaller courtyard spaces will be almost fully shaded by the overhangs of the surrounding buildings.



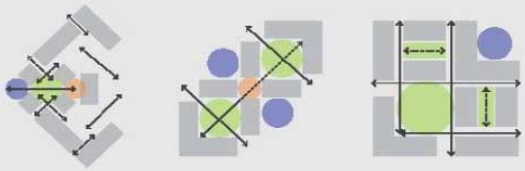
Courtyard C

A medium-sized courtyard would provide a good area for activities regarding more than one classroom or smaller playground areas for specific grades.



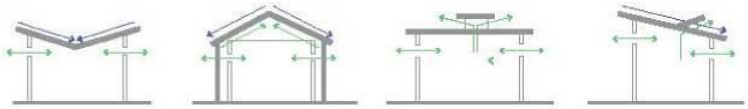
BUILDING LAYOUT DEVELOPMENT

- Shaded Learning Space
- Unshaded Entries / Connections
- Courtyard Spaces
- Building Footprint
- Shaded Learning Space



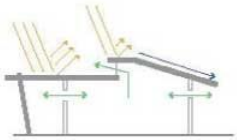
The hot-arid climate asks for a design with courtyards and plenty of shaded areas. The buildings will provide shade on the courtyards and the corridors formed by their placement will provide a constant airflow.

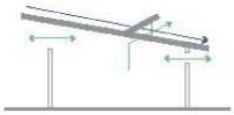
ROOF DESIGN



Roof has to be adapted to the required factors provided by the site and its location. These factors include: Protection from strong winds, ventilation, water collection, and protection from direct sunlight.

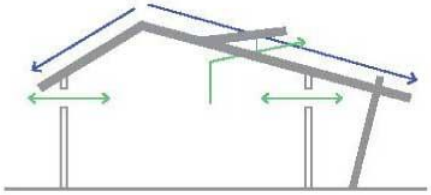
Combinations





Final Design

With this roof, two different ambients are created, one being a circulatory space between wall and column, and the other being open space for courtyards and secondary space areas. Stack ventilation is performed by the small openings on the longer side, as well as ventilation from openings placed high on the walls. Due to asymmetrical hipped-roof characteristic, water collection is possible on both sides.



SOUTH ELEVATION

3. RESEARCH METHODOLOGY

3.1. INTRODUCTION

This paper based on the description, evaluation and correlation of Nomadic afar vernacular architecture intended to suggest that contemporary design could take a lesson from principle of vernacular architecture. The lessons are focused on design decision regarding material and construction techniques and process, integration of cultural values and providing thermal comfort through passive design techniques and strategies. As the case of the study area containing the outskirts of Semera and Dubti, which are adapting contemporary design solution without asking why. The nomadic pastoralists living near these urban areas are adapting these methods fast than the other living far.

Taking the mobility patterns of the nomadic pastoralists living near urban areas and their interaction with the nearby urban settlements including the immediate context they can be categorized into two: highly affected and moderately affected with external context. The factors can be explained as proximity to urban areas. To change the lifestyle and living adaptation from nomadic vernacular becoming contemporary to contemporary becoming modern vernacular it's important to study the values of nomadic vernacular architecture using the right methods.

Once the pastoralist nomadic settlement- zones are categorized based on proximity to the urban areas and their relation to the settled community using maps their mobility pattern and their relationship with the urban area could be identified. Additionally, the outlook from individuals living in the urban areas permanently on the nomads living around 10 Km will be collected using questionaries to analyse the interrelation and cultural integration of these two same people having different lifestyles.

Principles will be developed based on the studies and deep examination of the collected data. The effectiveness of the extracted principles will be assessed using standards from sustainability and thermal comfort. Similar cases shall be studied to evaluate the potential and limitation of the evaluation and introduction of vernacular principles with contemporary technologies and to assimilate them to fit into the contextual factors of the study area. For each of the settlement zones of the pastoral nomads in the proximity of urban areas are to be defined based on the map, proposals and recommendations are to be made in reference to the specific area.

In this chapter methods used to answer the research questions will be discussed in detail. The section essentially contains chosen methods based on proven theories employed on relevant former related research, Source and data type, selection and analysis techniques. It also shows the reliability and validity of the research along with reflection on the methodology used.
The chapter is organized into four parts: the first part shows the location of the study area and discusses the selection and description of the case, the second and third parts layout the method employed to collect and analyse the data consecutively and the last part introduces the organization of the research.

3.1.1. PURPOSE OF DATA COLLECTION

The study is mainly to address the characteristics and principles behind the vernacular of nomadic afar dwellings. The data is collected to explore and define the nature of vernacular houses and sustainable features to provide acceptable thermal comfort.

3.2. DATA COLLECTION AND METHODOLOGY SELECTION

According to research methodology researchers (Yin, 2009) design is the logical sequence that connects the empirical data to a studies' initial research questions and ultimately to its conclusion. In this case, a research design is a logical plan for getting from here to there, where here may be defined as the initial set of questions to be and conclusions to be drawn. Research methodology is influenced by two things one with types of data to answer the research question, how data is being collected, (type, source and tools used to collect the data) and the types of analysis.

Collected data for this dissertation paper has a distinct purpose in the research to identify, evaluate and extract principles of vernacular architecture. Specific sites, government offices, Nomadic dwellings and individuals are chosen for the collection of data.

The method mainly focuses on a case study and survey approach.
Survey: Involve collecting information, usually from fairly large groups of people, utilizing questionnaires but other techniques such as interviews or telephoning may also be used. Case study: Case studies usually involve the detailed study of a particular case (a person or small group). Various methods of data collection and analysis are used but this typically includes observation and interviews and may involve consulting other people and personal or public records.

The intensive study of a single case where the purpose of that study is – at least in part – to shed light on a larger class of cases (Gerring 2007). The book architectural research methods

identify the five primary characteristics of the case study:(1) a focus on either single or multiple cases, studied in their real-life contexts; (2) the capacity to explain causal links; (3) the importance of theory development in the research design phase; (4) a reliance on multiple sources of evidence, with data converging in a triangular fashion; and (5) the power to generalize to theory (Wang, et al 2013).

The type of data and method used to collect it is briefly described as follows:

Type	Source	Method
Purpose- **Identification of interrelation and influence of urban settlement on nomadic vernacular afar architecture near Semera and Dubti in 10 Km radius. Questionary is prepared both for inhabitants living in urban areas and inhabitants living in nomadic architecture.**		
Qualitative	Primary (Questionaries for a selected group (professional government officials and non-professional) of individuals living in urban areas)	Open ended questions and interviews
Purpose- **Evaluation of the indoor thermal value of Afar nomadic architecture and contrasting it with the outdoor average global temperature. (Technical parameters).**		
Quantitative	Primary (Temperature data of indoor spaces)	Measurement
Purpose- **Identify the thermal sensation of the inhabitants of Nomadic afar vernacular architecture.**		
Qualitative	Primary (questionaries assessing the level of thermal comfort of the inhabitants)	Survey
Purpose- **Examine socio-cultural structure through daily activities and mobility pattern of inhabitants living in afar nomadic vernacular dwellings.**		
Qualitative	Primary (questionaries assessing the level of thermal comfort of the inhabitants)	Interview and questionaries of focused group_ Deep focused grouped interview
Purpose- **Documentation and description of nomadic afar vernacular architecture. (Technical parameters).**		

Quantitative	Primary (on-site measurement)	Physical measurement, Observation, and interview of inhabitants)
Purpose- **Identification and description of external contextual factors like natural resources vegetation and access to the site (Neighbourhood design analysis).**		
Quantitative	Primary and secondary (on-site observation, images and books published by the regional government of afar)	Case study (Observation and interview of inhabitants)
Purpose- **Identification and examination of features and passive strategies used for achieving thermal comfort for nomadic afar vernacular dwellings.**		
Quantitative	Primary (on-site observation and images)	Case study (Observation and interview of inhabitants)

Figure 3. 1: Data sources and methods

To research Nomadic Afar vernacular design and strategies for its thermal comfort, a community in Dubti and Semera Nomadic and non-nomadic residential area in Afar is taken as a case study. This area has been chosen to emphasize detailed contextual analysis focusing on answering unresolved and important questions such as what the features of Afar nomadic vernacular architecture and the principles are embedded in the vernacular architecture that helps them to provide thermal comfort without using mechanical ventilation.

3.2.1. DATA TYPE

Generally, the research is both qualitative and quantitative and employs a related literature review to assess the relationship of sustainable vernacular features with the thermal comfort of indoor spaces. Secondly, following the consultation of the different sources, in-depth interviews have been conducted. Thirdly, to complement and strengthen the interview and literature review, fieldwork has been carried out to assess and gather relevant data. Finally, analysis of the fieldwork data gathering and interviews have been made which helps to lead to the design guidelines based on the findings for the role of Nomadic vernacular architecture in the advancement of contemporary architecture to modern vernacular architecture.

- Primary and secondary

The research used primary and secondary data. The primary data was gathered from measurement, interviews, questionaries, focus group questionaries and interviews and on-site

observation. The secondary data was gathered from books written about Afar and maps produced by regional offices from the region.

- Qualitative and Quantitative (for my specific research I will use mixed)

The research used both data types. Temperature measurements, actual dwelling measurement for documentation and studying passive features and strategies are quantitative data. Whereby, interviews assessing socio-cultural interactions, thermals sensations of the inhabitants and interrelations and impacts of urban settlements on nomadic vernacular architecture are qualitative data.

3.2.2. SOURCE OF DATA

As it was described above both types of data were collected from both primary and secondary sources, for primary data which are interviews and questionaries sources are listed as follows:

- **Interviews:** The interview is an important data gathering technique involving verbal communication between the researcher and the subject. Interviews are commonly used in survey designs and exploratory and descriptive studies. The interview is carried out by the researcher and assistants for language translation purposes. (Mathers et al., n.d.)
    - Residents (Inhabitants of afar Nomadic vernacular architecture)
        - Grouping
            - Age
            - Gender
            - Position in the group
- **Questionaries:** Survey were conducted using questionaries as a source for data collection. Questionnaires are commonly used to gather first-hand information from a large audience, in the form of a survey. The questionaries are used to collect data from both communities living in urban areas and nomadic lifestyles. Also, from the nomadic community to assess the thermal comfort status of indoor environments of nomadic architecture. Both questionary types are used which are open-ended and close-ended.
- **On-site measurement:** Identification and documentation of physical afar nomadic architecture existence has been measured and documented using actual on-site as-built measurement as a data source. Which is later used as a drawing input to produce a compiled document.

For secondary data, the researcher gathered from researches conducted in the Afar area and books written regarding the study area. Book published by the regional government can be listed as an example.

3.2.3. DATA COLLECTION TECHNIQUE

The study mainly used tools like questionaries, in-depth interview, focused group discussion and direct observation to collect the data. Additionally, it employed sketches, mappings (to study settlement and mobility pattern), pictures, video and audio and on-site measurement (Temperature and as-built) for documentation as data collection techniques.

Interview

- **In-depth interview**

According to Yin (Yin, 2009), an interview is one of the most used sources of data for case study information. An in-depth interview is instrumental to produce and establish cases. The in-depth interview is used to find out facts and opinions about the determining factors for identifying and examining sustainable thermal cooling features of nomadic afar vernacular architecture. This research interview has been carried to identify the socio-cultural structure and identify the thermal cooling features and strategies embedded in the nomadic vernacular architecture of afar. The research paper uses the following interview types:

- Structured
- Semi-structured
- Unstructured

- **Focused group interview**

Focus Group Discussion (FGD) is a method of data collection that is frequently used to collect in-depth qualitative data in various descriptive studies such as case studies, phenomenological and naturalistic studies. The main goal of Focus Group Discussion is to provide an opportunity for the participants to talk to one another about a specific area of study. The facilitator is there to guide the discussion. The researcher used this with members of the inhabitant of the vernacular dwellings to identify, select and examine thermal cooling strategies from the local knowledge and expertise. From the discussion, diverse and multi-directional information that helped the study to see things from different angles were raised.

- **Direct observation**

Yin (Yin, 2009), states that a case study creates an opportunity for direct observation. Observational evidence is often useful in providing additional information about the topic to be studied. For this reason, the researcher employed observation as a data collection tool. I had spent days with the target population during the data collection period. The checklist was created before the site excursion happens this enables me to organize my questions and saves me time. Observation also allows me to gather actual data through my observation. Direct observation was sufficient for the data collection tool in that it enabled me to comparatively see the theoretical concepts studied in the class and what was practically taking place. Besides, it helped me to grasp the top important data for the study. (Checklist has to be adapted).

3.2.4. SELECTION OF CASES

According to Yin (Yin, 2009), the researcher has the right to select cases straight forward or using certain techniques based on the researcher's prior knowledge or complexity level of the cases. Therefore, two clustered case areas are selected which are known by the Woreda Administration. One of the Clusters is closer to the capital Semera which is in a 10 Km radius while the second cluster is near to the Zonal town Dubti which is also in a 10 Km radius.

Both cases are administered separately. The reason is that the researcher wanted to know if the closeness of the cases to the urban settlement's town has influenced the villages or not. Under the first case, two nomadic settlements were selected and in the second case one settlement is used to cross-check the reliability of the data in and across the cases. The walled nomadic settlements were chosen for the study in the first case are closer to each other and the same is true for the villages in the second case.

3.2.5. SAMPLING SIZE

In this research Stratified random sampling method is used, in this method, the population is first divided into subgroups who all share a similar characteristic. It is used when we might reasonably expect the measurement of interest to vary between the different subgroups, and we want to ensure representation from all the subgroups. Then using the simple Purposive sampling method, I took my sample. Hence the research is qualitative research it depends on a small but detailed analysis of a given sample size.

3.2.6. SAMPLING TECHNIQUE

Two factors are in place for the selection of the cases, looking for the place which was close to the urban areas to understand and the interrelation with the nomadic culture is the first factor. Accordingly, two urban settlements were selected Semera and Dubti and nomadic temporary settlements (villages) in 10 Km proximity were selected.

The second factor was the location. Since most of the nomads are in travel most of the time the best location to find them is through their link to natural resources. Those resources for instance like water and food when it's a drought season are being currently provided by the government and NGOs this makes the nomads available near urban areas through their link with government bodies. It is also useful to check the influence they get from the urban environment. Including the site, they choose in the area is favourable considering its access to the site and nearby infrastructures in the city the following variables were also considered in choosing the sites.

- Topography regarding their settlement or mobility pattern
- House type variation

Research tools

To conduct this research different measurement tools were used. A digital room thermometer is used to measure indoor temperature. Measuring instruments like camera and laser meter was used to measure the physical measurement of the dwellings, cameras and video recorders were also tools to collect visual data.

The tool used to measure temperature

Parameter measured	Sensor	Range	Accuracy	Name of instrument
Air temperature	**Thermistor**	**0-55ºC**	**+-0.5 ºC**	**TR-74Ui**

Figure 3. 2: Tools used for measuring temperature

3.3. METHODS OF DATA ANALYSIS

The data gathered for the study was first presented and then analysed using pictures, drawings, maps, sketches and tables. The analysis was done in line with the research questions.

The Framework approach is practical, comprising of five stages (familiarization; identifying a thematic framework; indexing; charting; mapping and interpretation), to managing and analysing large datasets particularly if time is limited**.** (Crowe et al., 2011)

Purpose- Identification of interrelation and influence of urban settlement on nomadic vernacular afar architecture near Semera and Dubti in 10 Km radius. Questionary is prepared both for inhabitants living in urban areas and inhabitants living in nomadic architecture.
Method of analysis- Mappings, graphs and charts showing how the urban areas affect the Nomadic settlement.

Purpose- Evaluation of the indoor thermal value of Afar nomadic architecture and contrasting it with the outdoor average global temperature. (Physical measurement)

Purpose- Identify the thermal sensation of the inhabitants of Nomadic afar vernacular architecture. (Subjective measurement using questionaries)
Method of analysis- Graphs and charts, statical analysis
Statistical analyses were carried out to understand:

- The difference between the PMV and AMV values,
- The robustness of the relationship between the PMV and AMV values,
- The effect of users' relative humidity perceptions on the thermal sensation and thermal acceptability,
- The effect of users' air velocity perceptions on the thermal sensation and thermal acceptability. (Keitsch, 2012)(Kuru & Calis, 2017)

Purpose- Examine socio-cultural structure through daily activities and mobility pattern of inhabitants living in afar nomadic vernacular dwellings.
Method of analysis:

- Activity
    - Time diary
- Space
    - Spatial mapping
- Meaning
    - Spatial configuration

Purpose- Documentation and description of nomadic afar vernacular architecture.
Method of analysis- Drawing (Plans, sections, elevations, site plan), 3d exploded, Material catalogue, construction technique and process and structural integration analysis.

Purpose- Identification and description of external contextual factors like natural resources vegetation and access to the site (Neighbourhood design analysis)
Method of analysis- Mappings, and pictures

Purpose- Identification and examination of features and passive strategies used for achieving thermal comfort for nomadic afar vernacular dwellings
Method of analysis- Pictures, Air flow diagram, geometry and shape analysis

3.4. VALIDITY AND RELIABILITY

The research was carried out to mainly answer 'what and how' of the characteristics and sustainable thermal cooling features of nomadic Afar vernacular houses. So, a case study is the appropriate design to do this. The data for the study was gathered from representative and informative samples using qualitative and quantitative data collection tools. The data collection tools enabled the target individuals to freely disclose all the information they knew to the last drop. The researcher also analysed and interpreted the data. Therefore, the study came up with all the valuable data and changed it to output using a reliable method.

Reflection on the methodology

The study used both qualitative and quantitative method to analyse and interpret the data. It enabled the researcher to comprehensively present all the information gathered from the target population and flexibly discuss every bit and pit of information in a way reader can easily understand. With no doubt, it is an appropriate method that helped the study to come up with the intended result.

4. CONTEXTUAL REVIEW

4.1. INTRODUCTION

The chapter came up with general information of vernacular housing characteristics beginning at the Africa level and then to Ethiopia. It also presented the contextual and historical background of the study area. In the information presented, the geographical location of the area, socio-economic and physical condition, approach, institutional framework, process actors and challenges faced during the study.

General background

African villages usually expressed physically by the social structure of the group of people living in them. Of course, the actual relationships varied from year to year as people were born, married, divorced or died, but the general structure remained fairly constant. (Silfverberg, December 1983) The ideal layout of some villages was often said to be entirely symbolic. Many of the village configurations were quite formal or symmetrical, for example, the circular plan with horse arranged around the circumference and an open grating space for cattle in the middle, found in South Africa. In societies where there was age differentiation, this was often reflected in settlement patterns. The Nyakusa who lived in the highlands, north of Lake Malawi, had an interesting system of age group. All boys of a certain age, usually about twelve years, would go off to form a new age village. They were joined in subsequent years by four or five successive cohorts of young boys. These villages were the permanent place of residence of the peer groups concerned and when they married, their wives joined them. (Silfverberg, December 1983).

“Some places are not meant to support life. The desert in the horn of Africa is one. Summer temperatures reach 45 to 50 degrees Celsius. It is so hot that it hurts just to breathe. There is nowhere to escape the sun. The landscape is sand and rock, with the old spiky plant stubbornly clinging to life. Scorpions, or maybe camels, might manage to survive here, it is hard to imagine that people would. Yet some do. They are called the AFAR.” (Browning, 2008) The Afar are pastoralist nomadic people. Their traditional form of architecture consists of flexible shelters made out of wood/twigs and covered with mats that can easily be transported. Since an important trade route runs through the Afar region some more permanent architecture has started to develop along with the “truck stops”. Permanent buildings are, based on nomadic building techniques, constructed out of wood/twigs and plastered with clay – which is quite fatal in a region where every tree is extremely valuable. (The Afar Project - IVA-ICRA, n.d.)

4.2. CONTEXTUAL BACKGROUND OF THE STUDY AREA

Afar National Regional State (NRS) makes up one of the nine administrative regional states of Ethiopia. The region has five (5) administrative zones namely: Awsi Rasu (Zone 1), Kilbeti Rasu (Zone 2), Gabi Rasu (Zone 3), Fantena Rasu (Zone 4), Hari Rasu (Zone 5) and 32 administrative weredas, including one special wereda (Argoba) and one city administration-Samara-Logia. The capital city of the region is Samara (Proclamation No. 14/2002, Article (6); CSA, 2015). (Afar Regional Atlas, 2018)

Afar NRS is located in the north-eastern part of Ethiopia. The region shares a national boundary with Oromia NRS in the south, Somali NRS in the southeast, Tigray NRS in the northwest and Amhara NRS in the southwest. In addition, the region shares an international boundary with Eritrea in the northeast and Djibouti in the eastern tip (Proclamation No. 14/2002, Article (2)).

The region's capital city Samara is 605KM northeast of Addis Ababa along the main asphalt road from Addis Ababa to Djibouti via Awash with geographic coordinates between 8.83o to 14.46o east and 39.73o, 42.41onorth, with an approximate geographic area of 94,806KM2 and perimeter of 1697KM. (Afar Regional Atlas, 2018)**. S**EMERA is the capital city of the afar region. The main developmental centre of the region. one of a potential institution" Semera University" is found here.

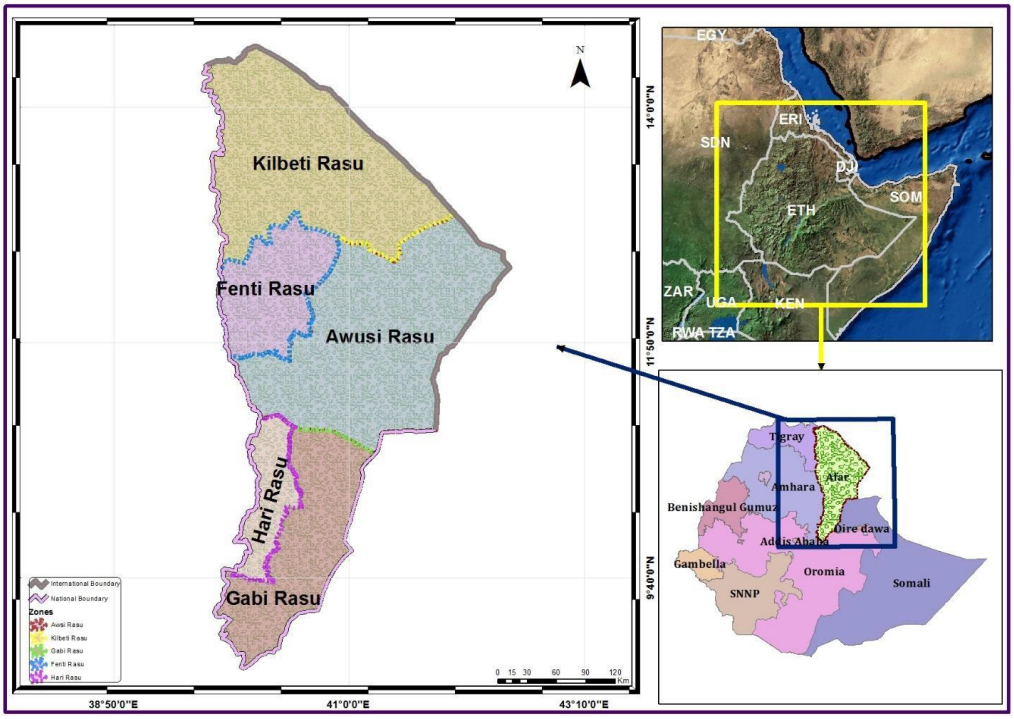


Figure 4. 1: Location map of Afar_ Afar region report_ (Afar Regional Atlas, 2018)

4.3. LOCATION OF THE CASE STUDY AREA

Awusi Rasu (Zone 1)

Awusi rasu constituents total of eight wereda namely, Ade'are, Millei, Chifra, Dubti, Assayta, Afambo, Elide'are, and Kory. A total of 17 towns located in this zone and Samara-logia city administration is the capital city of the region (Figure 12). The zone covers 34,871Km2 of area, which makes it the largest zone of the region.

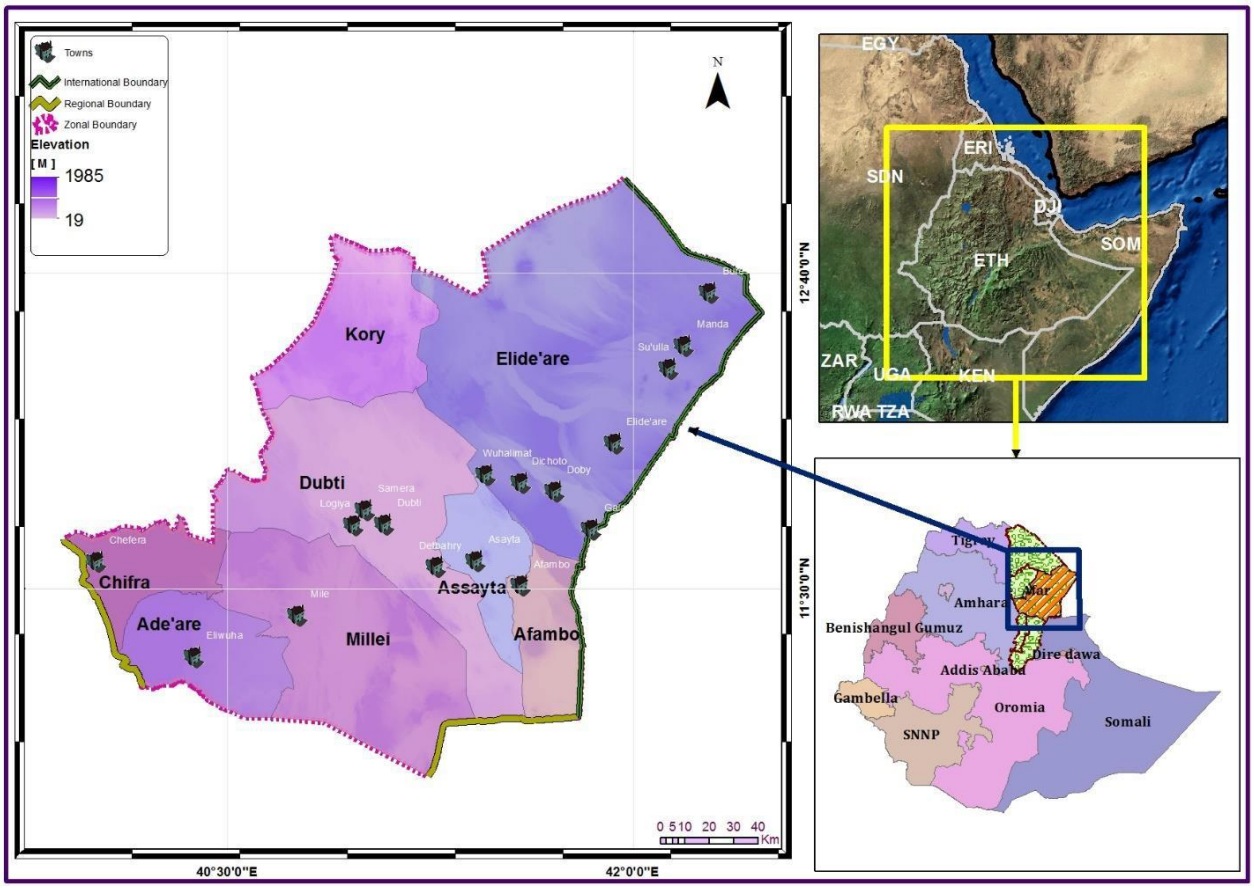


Figure 4. 2: Location map of Study region_ Afar region report_ (Afar Regional Atlas, 2018)

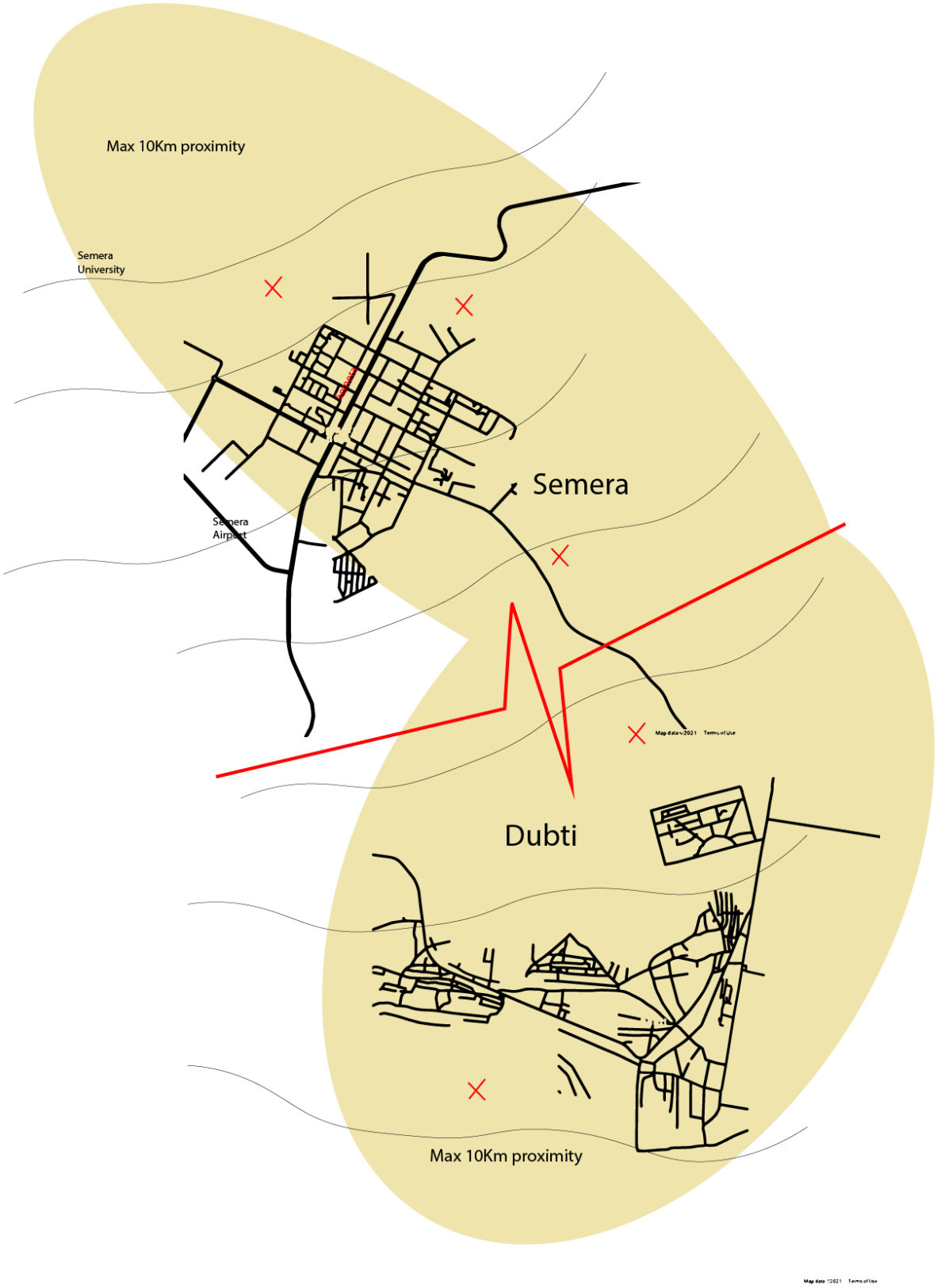


Figure 4. 3: Location map of Afar/ Study area_ Afar region report

4.3.1. PASTORAL ZONES

ASALE PASTORAL (ASP)

This is the northern-most zone, and pastoralists here live in a harsh, arid, hot environment. Camels and goats are dominant, with cattle no longer owned by most households.

ELI-DAAR PASTORAL (ELP)

The driest zone in the region, hot and remote conditions here have led to high levels of food and livelihood insecurity and a correspondingly high reliance on external aid. Camels, goats, sheep and a very few cattle are raised.

TERU PASTORAL (TER)

Located in the mid-western half of Afar, the environment here is not as harsh as in the zones to the east and north. Economic relationships with the highlands of Tigray and Amhara to the west are crucial. Camels, cattle, sheep, goats and donkeys are the foundation of the local economy.

ARAMIS ADAR PASTORAL (ARP)

This pastoral zone is located within the awash drainage system in the southwestern quadrant of the region. Grazing areas are fed by streams from the south-eastern highlands of Amhara. Camels, cattle, sheep, goats and donkeys are the mainstay of the economy.

NAMALEFANE BAADU PASTORAL (NMP)

This zone is located in the far southeast of Afar. It is similar to ARP, its neighbour to the west, but drier. Access to agricultural labour on private commercial and state farms distinguishes this zone from others. The availability of grazing in the floodplain of the Awash River is crucial for pastoralists here. Camels, cattle, goats, sheep and donkeys are all raised.

4.4. CLIMATE

Precipitation and Average Temperature

The mean temperature in the region ranges between 25 to 32 degree Celsius. June month is found to be the hottest month of the year. The main rainy season of the region is during July-September, with observed precipitation peak in August. The secondary rainy season is during March-May, with observed precipitation peak in April.

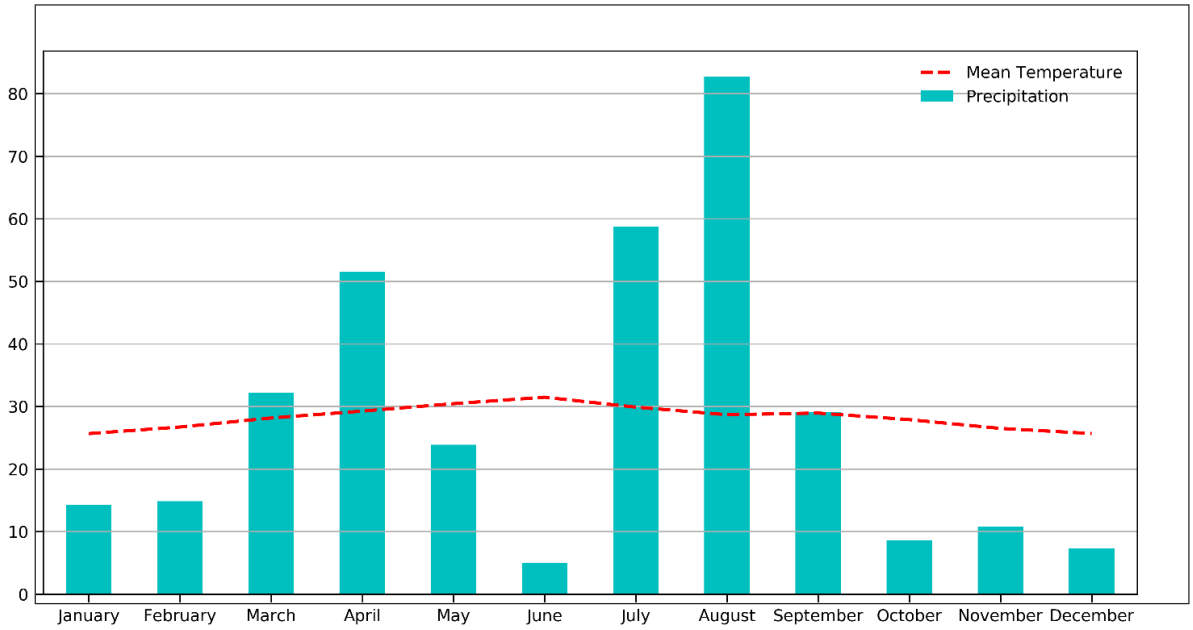


Figure 4. 4: Monthly precipitation and temperature pattern of the Afar region, 1981-2016_ (Afar Regional Atlas, 2018)

Annual and seasonal average temperature

Annual and seasonal average temperature climatology is presented in Figure 29 and Figure 30Figure 30. The annual average temperature in the region ranges from 24 to 31 degrees Celsius with low year to year variability. The spatial distribution of the mean temperature follows the precipitation. Precipitation increases and average temperature decreases as we cross from south-western to north-eastern part of the region. This is also expected as high amount of precipitation moderates the temperature.

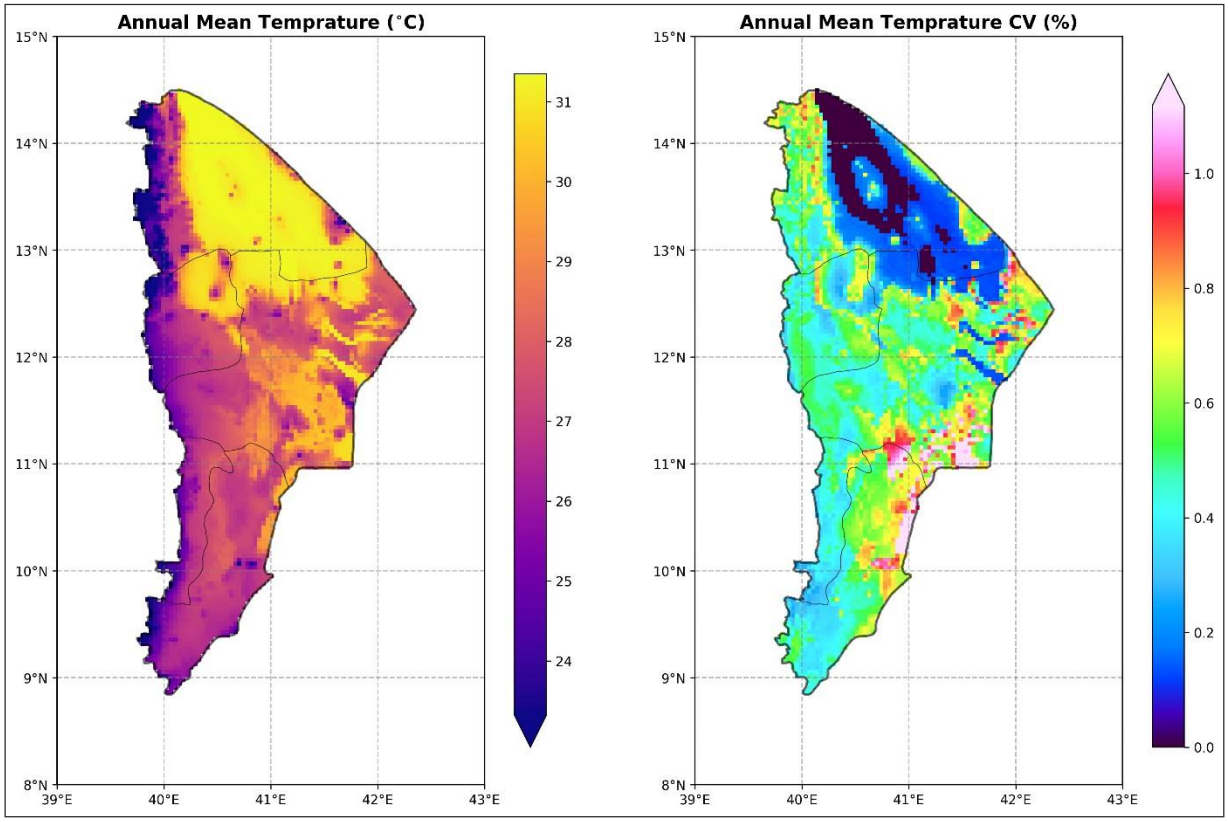


Figure 4. 5: Annual mean temperature (oC) and CV (%) in the Afar region, 1980-2014_ (Afar Regional Atlas, 2018)

4.5. TOPOGRAPHY

The elevation of the region ranges from 136m below sea level around the Danakil depression to 2927m above sea level. The highest pick of elevation is over the north-western part of the region over the highlands of Berhale wereda around the highlands of Tigray NRS. Figure (45) shows the elevation distribution of the region. In order to visualize the regions topographic distribution clearly, 3D view of the DEM was prepared.

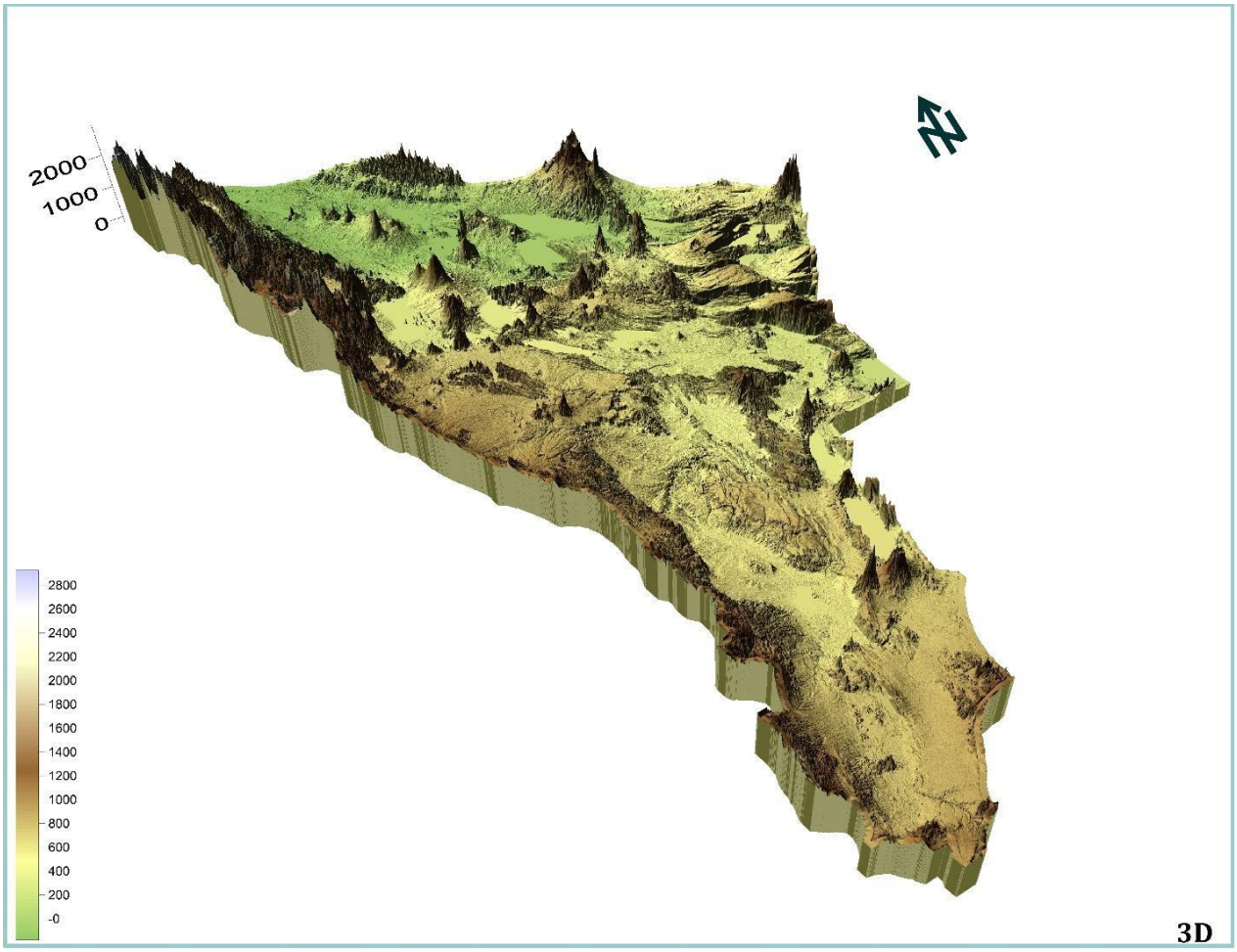


Figure 4. 6: Elevation Profile of the Region in 3D_ (Afar Regional Atlas, 2018)

Landscape character

With such extreme conditions, made even worse by external factors such as human and animal trampling around water points, vegetation cover is very scattered and sometimes completely absent, leaving big areas of bare soil and rocky outcrops. Where it is present, the natural vegetation is semi-desert scrubland, consisting of highly drought-tolerant species of small trees and shrubs, deciduous or with small evergreen leaves.

With the extreme weather and soil conditions, land use is very limited and consists almost exclusively of nomadic pastoralism. The natural scrubland is grazed very extensively by camels and goats, who often migrate hundreds of kilometres, according to where fodder is available, which depends largely on the seasonal rains.

The Afar for instance migrates as far as the Central Rift valley with their herds of camels, especially during July to September, when the Afar plains are at their hottest and driest, while the Central Rift valley receive the Monsoon rains and offer plenty of fresh vegetation. However, climate change, invasive plant species.

Living

Homesteads reflect the pastoral nomadic lifestyle of their inhabitants and the intricate relation with their livestock, which is their almost exclusive source of alimentation and income. Homesteads are always protected by fences made out of branches from thorny trees or shrubs (mostly Acacia, Commiphora and Ziziphus), dry stone walls or a combination of the two, the cattle being kept in well-protected enclosures next to the huts.

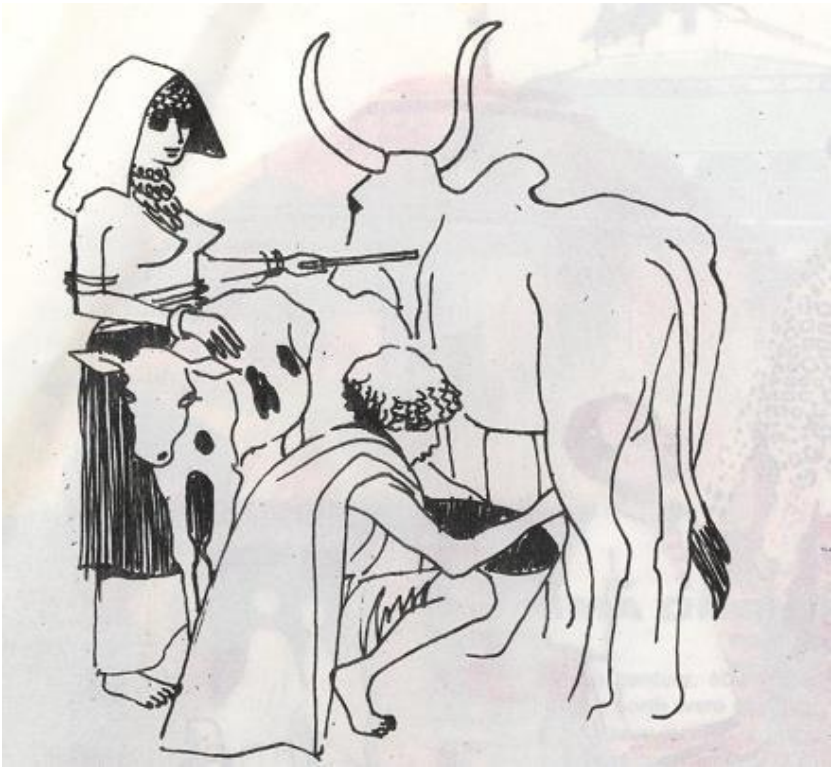


Figure 4. 7: Image showing Afar life style_ sources (Jill last refered in Abbink & Getachew, 2003)

Existing building tradition

The huts are very light constructions, made of materials which can easily be transported when the population is moving or easily be replaced. Thus, the ‘daboita’ of the Afar in northeast Ethiopia are made of an armature of branches and bundled palm leaves and covered with mats made woven out of leaves of the Doum palm. In larger settlements, drought-tolerant exotic tree species, like Schinus molle and Azadirachta indica, are widely planted for shade and various uses along roads and around homes.

Figure 4. 8: Image showing Afar life style_ sources (Jill last refered in Abbink & Getachew, 2003)

Architecture types

Afar architecture has three types of dwelling the camp consists of 2-6 tents enclosed by a thorn bush fence. Most of the nomadic pastoralists construct demountable tent thus, this research paper focuses on the demountable tent construction and cooling strategies.

Nomadic pastoralist communities of Afar

Historically, nomadic pastoralists of Afar have been migrating across the north-eastern and south-eastern part of Ethiopia with no permanent settlements. However, since 1960 the state image has gained more power in Ethiopia, and to provide formal education and infrastructure for the Afar's and some gets the experience of sedentary way of living while traveling and trading salt however they were not forced to settle down. The way of life and infrastructure coverage forces them to do.

Therefore, over the past four decades, various Afar groups followed three ways: some groups have permanently settled down, some have maintained a semi-nomadic life where they travel across the Northeast and south-east involved in trading and logistics of salt production and mining during the summertime and re-settle-down during the winter, and finally a small part has been maintaining a completely nomadic life.

The endemic vegetation and landforms of the afar regions provide suitable circumstances for camel and goat breeding which have been the main source of income and food generation for and also their life is based on livestock herding. Travelling from place to place in search of food and drink for their animals. Travel is difficult because it’s difficult to find vegetation and water for the animals in the deserts. However, currently, the government is working on providing water resource and vegetation for nomadic pastoralists of afar.

Afar climatic conditions and nomadic pastoralists

Considering that Afar is a hot and arid climate, most of the nomadic pastoralists of afar maintain a (semi)-nomadic lifestyle, the climate forms a crucial aspect of the decisions they make during the move while maintaining their nomadic pastoralist lifestyles.

The region of afar climate offers hot long summers, and short windy and rainy winters. Nomadic Pastoralists of afar have been moving also as a continuation of their long-lasting traditional way of living. Yet, similar to residents, afar nomadic pastoralists stay in one place longer during the wintertime because it's essentially short and if they get sufficient resources for their animals and safe comfortable place to construct their huts. The climate and the landscape are suitable for camel and goat breeding.

5. DATA PRESENTATION AND DISCUSSION

5.1. INTRODUCTION

The data presentation is organized under each research questions. All types of semi-structured interviews and focused group interview are presented and discussed in this section. This chapter has four sections discussing the four research questions. The last research question is addressed in the recommendation and conclusion section.

5.2. INTERRELATIONS OF VERNACULAR ARCHITECTURE OF THE PASTORAL NOMADS OF AFAR WITH THE SEDENTARIZED INNER URBANIZED SETTLEMENT

To identify the interrelations of Afar nomadic pastoralist communities with the sedentarized inner urbanized settlement's semi- structure questionaries were conducted with a selected key informant living in urban regions of Afar (Semera and Dubti). By interviewing the selected informants to understand the awareness of urban population insight and knowledge about Afar nomadic vernacular architecture and communities. In addition, their intake on the cultural representation of Afar culture through Afar nomadic vernacular dwelling as well rating the performances of original Afar nomadic vernacular architecture.

5.2.1. DATA PRESENTATION AND DISCUSSION FROM SEMI-STRUCTURED QUESTIONARY

Presentation: Semi-structured questionaries were conducted with a total of eighty residents who live in Semera and Dubti urban zones. Two questionaries were conducted one focusing on non-professional residents (working in transportation and small business owners) living in the urban areas on how they see the interrelationship of nomadic vernacular architecture near them. These non-professional groups were then categorized into two subgroups regarding their traveling frequency since the sites were selected on the outskirt of the respective city centres. The three respective groups are frequent travellers, not frequent travellers or stationery almost not travellers.

The professionals are also grouped and divided as professionals who own a business mainly a construction company and hotel and university lecturers as well government officials working in the following sectors. Environment and infrastructure, housing and urban design, admins. on the two sites having different urban qualities with varying experiences of the nomadic

pastoralist neighbourhood as well as their view towards them. While conducting the interviews, diverse personal profiles like age, gender and experience of the current residents who appreciate and interact with the nomadic pastoralists and those who don't were included. The following table includes the grouping of the data collected from the residents living in the above listed respective urban areas. Different types of grouping structure responses on the characteristics and experience of nomadic pastoralist vernacular architecture and its relation with the existing urban areas presented in the questionary summary boxes.

Questionaries collected from Non-professional respondents

Semera- site 1 (20 informants) and Dubti site -2 (20 informants)

	Frequent traveller	Non- traveller	Total Number of Respondents
Number of Respondents	**20**	**20**	**40**
Semera	**10**	**10**	**20**
Dubti	**10**	**10**	**20**

Table 5. 1: number of non-professional respondents

Non-Frequently travellers: Semera- site 1 (10 informants) and Dubti site -2 (10 informants)

	Female Participants	Male Participants	Total number of participants
Gender	12	8	20
Age	22-36	27-42	

Table 5. 2: number of non-Frequently travellers' respondents

Birthplace and interaction or experience of being a nomad. (Where were you born and have you ever lived in the same neighbourhood next to being pastoralist)
Seventeen (85%) individuals out of twenty are originally from the city. Out of these seventeen individuals, ten (58.82) are originally from the city. The other seven (41.18%) are from Neighbouring rural areas that are located outskirts in a 10-25 Km radius. The three (15%) individuals from the twenty are from other afar regions i.e., logia, Asayita etc. Of the total twenty respondents who are non-travellers, seven (35%) of them lived very closely with nomad communities in their past. The other thirteen (65%) haven't practiced or lived close to a nomad group of people.

From the total seven respondents who votes that they have with proximity with a nomadic community who are non-travellers, three (42.86%) of them lived in proximity more than 3 years with nomads the other four (57.14%) lived and observe nomadic lifestyle with far proximity and for a short period which is less than a year.

Observation of temporary Nomadic settlements and their architecture nearby.

Eight (40%) individuals out of twenty usually can see nomads in a 10-30 Km radius nearby the city when they travel besides, they said they usually interact selling and buying goat or camel milk including different artefacts from them. The other twelve (60%) don't usually have a visual observation of the nomads because they own a service giving shop that doesn't usually relate with nomads like internet service, photocopy and selling electronics.

Generally, all of the informants give the reason for the nomads to come to the city centres for economic activities like selling camel milk, buy goods and commodities and seek for public infrastructure in the city nearby.

Reason for Settlement of afar nomadic communities around the city centres.

The informants have raised three main reasons that the nomads have settled near the city areas. These are:

1. Public infrastructural needs like hospitals, schools, water and electricity.
2. Looking for jobs/ selling their goods or products like camel and goat milk. Making money.
3. Looking for comfortable environments with plants and vegetations.

Of the informants fourteen (70%) of them, vote nomads came near to urban areas to access public infrastructures, six (30%) of the vote for selling and buying items.

Representation of afar culture through afar nomadic architecture and lifestyle (Does afar nomadic architecture represent afar culture).

From the 20 respondents, all twenty (100%) agrees and votes that the Afar nomadic vernacular architecture and lifestyle represents the culture and identity of the Afar region. They explain and raise the following few points:

- The architectural style and form are the identity and reflection of afar culture and traditions.
- The activities and their values for their animals exhibits and defines the culture of afar
- Religion also respects the culture and it's the image for afar culture.
- Its historical existence of being nomads and the ability to live in harsh environments is also one identity and character that shows the endurance of the afar nomadic community.
- Their social connection and interaction of these afar people even though they practice nomadism is respected and can be taken as a very useful cultural practice.
- The way they solve disputes over clans and individuals is also important for the culture and tradition.

Considering all the above reasons that were raised by the informants it's clear to understand that the nomadic culture is one and major part of afar identity and tradition.

The researcher also sees the same thing within the three weeks of staying afar while collecting data. The nomads are supported and are seen as one and important member of the afar community.

Experience the indoor environment of afar Nomadic dwelling.

Out of twenty informants, six (30%) of them have said that they have experienced the indoor spaces of afar nomadic dwellings the rest fourteen (70%) individuals have limited to no experience. Informants with no experience raised that they haven't got a chance to be inside because of the proximity of their living area and the accessibility of nomadic community nearby.

From the fourteen individuals who said that they have limited to no experience in the indoor environments of the nomadic vernacular architecture of afar twelve (85.71%) of them said that they have limited experience when they were a child and describes the interior environments have acceptable thermal values considering they don't use any mechanical ventilator or active thermal cooling systems.

Two (14.29%) individual that has no experience mentions moving to a different region of Ethiopia as well as abroad for a long time contributes for the lack of experience of indoor environments.

Participation while construction of afar nomadic dwellings.
(a chance to participate in the construction of afar nomadic architecture)

From the twenty informants, none of them has the experience in building the nomadic afar dwellings. They raised the following reasons for the absence of participation of experience:

- The fact that the construction is only carried by women.
- The materials are specials and must be prepared by an individual who has a proper know-how.
- It's performed in a group.
- To practice and master it one needs to be a nomad

knowledge on construction of nomadic afar vernacular buildings.

From the Twenty informants six (30%) of them said that they know how it constructed, twelve (60%) of them said that they have general knowledge of how they are constructed the other two (10%) said they don't know the steps and materials they said the information they have is unclear.

The (30%) informants who said that they know the construction of afar nomadic vernacular architecture explains the following conditions:

- Construction techniques including the materials used and how the materials are made and modified.
- Who is responsible for the construction of the dwellings?
- How it made and techniques and strategies used to provide acceptable indoor thermal values.
- Construction process and how to also dismantle or deconstruct when it's time to move and travel.
- And how they pack their dwellings for travel and mobility.

Observation or experience of mobility pattern concerning the Afar nomadic community.

All twenty of the informants has seen when afar nomads travel from place to place. They have experienced the mobility of nomadic communities.

From the ten informants, fifteen (75%) have seen them usually herding their livestock for a search of natural resources for their animals like water and grazing lands.
The other five (20%) of the respondents vote for rarely because they permanently reside in the city and don't have frequent travels.

From the fifteen of the informants ten (66.67%) of them said they can guess the reason and rough estimation of where their next destination might be. Five (33.33%) of them said they have an only visual experience of nomadic groups while traveling.

Evaluation of advantages of changing nomadic way of living.

From the total of twenty respondents twelve (60%) of them said nomadic afar communities and individuals need to change their lifestyle they bring up the following idea to support their argument:

- Lack of infrastructural facilities and reachability. clean water, Health facilities, Education and Energy can be raised as an example.
- The way of living is too primitive and demanding for the individual.
- But they gave infancies on the change should incorporate and be derived from the culture and identity of the Afar nomadic community.

The other four (20%) of the informant's votes on the nomadic community needs partial lifestyle change meaning the lifestyle change of being traveller and sedentary community can be decided on their own but infrastructure distribution and integration and interaction with other parts of the area has to be achieved. The change which comes regarding this change can be accepted.

The third group comprises four (20%) individuals who vote on the lifestyle change can solely depend on their decisions and if this life gave them fulfilment and joy, they can continue doing it and live up to the consequence.

Description of increment or decrement of several nomadic communities in the past and now.

From the total of twenty respondents eighteen (90%) of them have noticed generally a decrease in the number of nomadic communities. The other two (10%) cannot tell the difference in the proximity of from 10 to 30 Km radius of the city centre Dubti.

From the eighteen informants who said they have noticed the decrement in number eight (44.44%) of they have seen a critical reduction of the community giving their friends and family members as an example. The other ten (55.56%) just saw a general reduction they are not usually seeing nomadic communities as before.

Evaluation of the appropriateness of current contemporary design and construction.

From the total of twenty informants sixteen (80%) of the vote for the material is appropriate besides the price of construction of the material. They indicated that using active cooling is a good way and preferred way of keeping the thermal cooling of indoor environments comfortable. The other four (20%) said that the design should be improved but not to keep the thermal comfort hence they said that it should be more considerate of the culture and identity of the Afar region the current designs are standardized and the same with communities with a different culture.
Based on your experience, from the contemporary and nomadic afar vernacular designs which one provides acceptable thermal cooling features.
From the twenty informants twelve (60%) of them said that they prefer contemporary dwellings for their comfort thermal values mentioning that most contemporary buildings will have active cooling the other eight (40%) said that vernacular buildings but the material and planning of the existing vernacular has to improve to accommodate the urban living style and deliver the thermal comfort level. Of the twelve of the informants who vote for contemporary design eight (66.67%) of them said that if there is no active cooling, they choose vernacular design hence it provides relatively good thermal comfort for the users. The other four (33.33%) still choose contemporary design regarding its spatial arrangement and overall comfort.

Table 5. 3: Detailed discussion of semi-structured questionary_ non-frequent respondents

Frequently travellers: Semera- site 1 (10 informants) and Dubti site -2 (10 informants)

	Female Participants	Male Participants	Total number of participants
Gender	6	14	20
Age	16-24	14-32	

Table 5. 4: Number of frequently travellers' respondents

Birthplace and interaction or experience of being a nomad. (Where were you born and have you ever lived in the same neighbourhood next to being nomad)
Sixteen (80%) individuals out of twenty moved from different places meaning they are not originally from cities Afar. Out of these sixteen individuals twelve (75%) are originally from other Afar regions like Logia, Asayita etc. The other four (25%) are from other Neighbouring regions like Tigray, Amhara, and Somali. The four (20%) individuals from the twenty are raised and born in Semera outskirts in a 10-25 Km radius. From the total twenty respondents who travels frequently six (30%) of them practiced being a nomad with nomad family members the other fourteen (70%) haven't practiced. From the total of twenty respondents who travels frequently eight (40%) of them lived in proximity for more than 3 years with nomads the other twelve (60%) lived and observe a nomadic lifestyle with far proximity and for a short period which is less than a year.

Observation of temporary Nomadic settlements and their architecture nearby.

Sixteen (80%) individuals out of ten usually can see nomads in a 10-30 Km radius nearby the city when they travel. The other four (20%) don't usually have a visual observation of the nomads because of the travel time difference with the nomads. Also, they raised a reason that nomads construct their dwellings quite far from the main road. The respondents confirm from the seven days from the week on average they travel four (57.14%) to five times (71.43%). They travel from one city to another, most of them work on transportations living in the city of Semera permanently.

Generally, most of the informants add on they observe the nomads while selling camel milk, buy goods and commodities and seek public infrastructure in the city nearby.

Reason for Settlement of afar nomadic communities around the city centres. (Infrastructural distribution for afar nomadic communities)

The informants have raised three main reasons that the nomads have settled near the city areas. These are:

4. Public infrastructural needs like hospitals, schools, water and electricity.
5. Looking for jobs/ selling their goods or products like camel and goat milk. Making money.
6. Looking for comfortable environments with plants and vegetations.

From the informants, ten (50%) of them vote nomads came near to urban areas to access public infrastructures, six (30%) of the vote for selling and buying items, the other four (20%) said because they can find good natural environments for their settlement.

Representation of afar culture through afar nomadic architecture and lifestyle (Does afar nomadic architecture represent afar culture).

From the 20 respondents, all twenty (100%) of them agrees and votes that afar nomadic vernacular architecture and lifestyle represents the culture and identity of the Afar region. They explain and raise the following few points:

- The architectural style and form are the identity and reflection of afar culture and traditions.
- The activities and their values for their animals exhibits and defines the culture of afar
- Religion also respects the culture and it's the image for afar culture.
- Its historical existence of being nomads and the ability to live in harsh environments is also one identity and character that shows the endurance of the afar nomadic community.
- Their social connection and interaction of these afar people even though they practice nomadism is respected and can be taken as a very useful cultural practice.
- The way they solve disputes over clans and individuals is also important for the culture and tradition.

Considering all the above reasons that were raised by the informants it's clear to understand that the nomadic culture is one and major part of afar identity and tradition.

The researcher also sees the same thing within the three weeks of staying afar while collecting data. The nomads are supported and are seen as one and important member of the afar community.

Experience the indoor environment of afar Nomadic dwelling.

Out of twenty informants fourteen (70%) of them have said that they have experienced the indoor spaces of afar nomadic dwellings the rest six (30%) individuals have no experience. Informants with no experience raised that they haven't got a chance to be inside because of the proximity of their living area and the accessibility of nomadic community nearby.

From the fourteen individuals who said that they have experience in the indoor environments of the nomadic vernacular architecture of afar twelve (85.71%) of them said that the interior environments have acceptable thermal values considering they don't use any mechanical ventilator or active thermal cooling systems.

Two (14.29%) individual votes for the indoor space of nomadic afar vernacular architecture don't have acceptable thermal values for day-to-day activities. The informant also raised that activity as a factor besides what the physical dwelling solely provides. The informant suggests also proper use of outdoor environments treated with vegetation can enhance the thermal cooling ability of the dwelling.

Participation while construction of afar nomadic dwellings.
(a chance to participate in the construction of afar nomadic architecture)

From the twenty informants, none of them has the experience in building the nomadic afar dwellings. They raised the following reasons for the absence of participation of experience:

- The fact that the construction is only carried by women.
- The materials are specials and have to be prepared by an individual who has a proper know-how.
- It's performed in a group.
- To practice and master it one needs to be a nomad.

knowledge on construction of nomadic afar vernacular buildings.

From the twenty informants six (30%) of them said that they know how its constructed, ten (50%) of them said that they have general knowledge on how they are constructed the other four (20%) said they don't know the steps and materials they said the information they have is unclear.

The (30%) informants who said that they know the construction of afar nomadic vernacular architecture explains the following conditions:

- Construction techniques including the materials used and how the materials are made and modified.
- Who is responsible for the construction of the dwellings?
- How it made and techniques and strategies used to provide acceptable indoor thermal values.
- Construction process and how to also dismantle or deconstruct when it's time to move and travel.
- And how they pack their dwellings for travel and mobility.

Observation or experience of mobility pattern concerning the afar nomadic community.

All twenty of the informants has seen when afar nomads travel from place to place. They have experienced the mobility of nomadic communities.

From the ten informants sixteen (80%) have seen them usually herding their livestock for a search of natural resources for their animals like water and grazing lands.
The other four (20%) of the respondents vote for rarely because of the behaviour of their work they usually travel during the night-time so it's hard to encounter while they are traveling.

From the sixteen of the informants ten (62.5%) of them said they can guess the reason and rough estimation of where their next destination might be. six (37.5%) of them said they have an only visual experience of nomadic groups while traveling.

Evaluation of advantages of changing nomadic way of living.

From the total of twenty respondents twelve (60%) of them said nomadic afar communities and individuals need to change their lifestyle they bring up the following idea to support their argument:

- Lack of infrastructural facilities and reachability. clean water, Health facilities, Education and Energy can be raised as an example.
- The way of living is too primitive and demanding for the individual.
- But they gave infancies on the change should incorporate and be derived from the culture and identity of the afar nomadic community.

The other four (20%) of the informant's votes on the nomadic community needs partial lifestyle change meaning the lifestyle change of being traveller and sedentary community can be decided on their own but infrastructure distribution and integration and interaction with another part of the area has to be achieved. The change which comes regarding this change can be accepted.

The third group comprises four (20%) individuals who vote on the lifestyle change that can solely depend on their decisions and if this life gave them fulfilment and joy, they could continue doing it and live up to the consequence.

Description of increment or decrement of several nomadic communities in the past and now.

From the total twenty respondents, eight (80%) of them have noticed generally a decrease in the number of nomadic communities. The other four (20%) cannot tell the difference in the proximity of from 10 to 30 Km radius of the capital Semera.

From the eight informants who said they have noticed the decrement in number six (37.5%) of they have seen a critical reduction of the community giving their friends and family members as an example. The other ten (62.5%) just saw a general reduction they are not usually seeing nomadic communities as before.

Evaluation of the appropriateness of current contemporary design and construction.
From the total of twenty informants sixteen (80%) of the vote for the material is appropriate besides the price of construction of the material. They indicated that using active cooling is a good way and preferred way of keeping the thermal cooling of indoor environments comfortable. The other four (20%) said that the design should be improved but not to keep the thermal comfort hence they said that it should be more considerate of the culture and identity of the Afar region the current designs are standardized and the same with communities with a different culture.
Based on your experience, from the contemporary and nomadic afar vernacular designs which one provides acceptable thermal cooling features.
From the twenty informants twelve (60%) of them said that they prefer contemporary dwellings for their comfort thermal values mentioning that most contemporary buildings will have active cooling the other eight (40%) said that vernacular buildings, but the material and planning of the existing vernacular has to improve to accommodate the urban living style and deliver the thermal comfort level. Of the twelve of the informants who vote for contemporary design eight (66.67%) of them said that if there is no active cooling, they choose vernacular design hence it provides relatively good thermal comfort for the users. The other four (33.33%) still choose contemporary design regarding its spatial arrangement and overall comfort.

Table 5. 5: Detailed discussion of semi-structured questionary_ Frequent respondents

Questionaries collected from professional respondents

	Professional business owners	Government, and international organization officers	Total Number of Respondents
Number of Respondents	**21**	**19**	**40**
Semera	**15**	**13**	**28**
Dubti	**6**	**6**	**12**

Table 5. 6: Total number of professional respondents

Semera- site 1 (28 informants) and Dubti site -2 (12 informants)

Professional business owners are construction company owners, hotel owners, Diasporas originally from afar investing in agriculture and technology.

Government officers are officers working in infrastructure planning in the municipality, Administrations, housing and urban planning officers, university teachers in sociology, NGOs (GIZ).

Professional business owners: Semera- site 1 (15 informants) and Dubti site -2 (6 informants)

	Female Participants	Male Participants	Total number of participants
Gender	3	18	21
Age	34-42	41-67	

Table 5. 7: Number of professional business owners informants

Place of birth (Is it near to the city centre), estimation of years living in Afar permanently.
Of the total of twenty-one respondents thirteen (61.9%) are born and raised in Afar. The rest eight (38.1%) are from the neighbouring region Tigray. From the total informants, fifteen 71.43% lived afar for more than 20 years the rest six (28.57%) lived under 20 years. This group gave multiple reasons like living abroad in Europe and UAS for many years, moving to Addis Ababa looking for a job and education when they were young.
Environmental impacts of contemporary design and construction
Of the total of twenty-one respondents sixteen (76.19%) said the impacts are economical hence these days construction and construction materials are so expensive Ethiopia is spending a huge amount of its capital on construction that can also help and go to support and finance the environmental sector. The other five (23.81%) vote for Consumption of excess energy to keep the thermal comfort of hotels and government offices and fossil fuel usage and transpiration of building materials from far.
Nomadic afar vernacular architecture performance on decreasing environmental impacts
From the total of twenty-one, respondents thirteen (61.9%) said they do not know of this. They explained they need a deep understanding of the factors affecting the environment to conclude nomadic vernacular architecture decrease impact or stress on the environment. The other eight (38.1%) vote for vernacular architecture, in general, will decrease environmental impacts from the construction industry. They raise the following points: • Using locally available materials • Local knowledge the whole budget will decrease
Do you believe it's important to document afar vernacular architecture if so, what is the importance of documentation of vernacular architecture?

All the informants (100%) agree on these specific questions. They believe it's important to document vernacular architecture and cultural activities in general. They state the following important points:

- Transferring knowledge
- It Will be used for further studies.
- Will be input also for other studies like social and cultural studies.

Have you seen any contemporary design of a building in Afar that is constructed inspired by nomadic afar vernacular architecture?

Two out of twenty-one (9.52%) said that they haven't seen any architecture that resembles the architectural design principles of afar nomadic vernacular architecture. The rest nineteen out of twenty-one (90.48%) have seen architectural styles that have close design look as afar nomadic vernacular architecture. They mentioned the following buildings:

- The region agriculture research institute
- The region guest house
- Ruftana hotel gate design
- The region assembly hall

Afar future urban planning to include the nomadic lifestyle and culture as well take some principles from their temporary settlement.

From the total informants eight (38.1%) of them have said that they have no clue about this specific subject. But they prefer that afar nomadic communities will be civilized and stops settling temporarily in a given area.

The other thirteen (61.9%) hopes and would also appreciate that if afar urban planning would take some principles from nomadic settlement typologies together it will also help to keep the identity of the region, in addition, they assume current urban planning should also start Consideration of mobility and livestock herding as a variable in designing our cities and housing because they are also part of the communities.

Pros and cons of nomadic afar vernacular architecture.

Seventeen respondents from the total (80.95%) mention the following pros or advantage of afar nomadic vernacular architecture. They didn't state any cons or disadvantages. The stated advantages are:

- Pros
    - Availability of material
    - Using strategies and principles from evolved local knowledge to provide acceptable thermal cooling features.
    - The ability of adaptability, flexibility, and mobility

The rest three (19.05%) mentions both the above pros and the following cons or disadvantages of afar nomadic vernacular architecture.

- Cons
    - Comfort
    - Space size
    - Daylighting

• Limited activities can be carried inside
Possibility of infrastructural provisions for the nomadic community.
From the total of twenty-one, respondents sixteen (76.19%) said it's possible to provide reachable infrastructure for the nomads either in the city centres or in the most visited temporary settlement areas. They also emphasize this needs creativity and innovation. The other five (23.81%) vote for it's impossible to address infrastructural problems if they are always in the move hence, to provide infrastructure for these nomads they believe the nomad community has to be more sedentarized.
Do you believe that afar nomadic architecture materials can provide acceptable thermal cooling features for the harsh contextual climate that it exists?
From the total of twenty-one respondents thirteen (61.9%) explained in detail and vote for a nomadic vernacular architecture of afar capable of providing sustainable thermal cooling. they mentioned the following points on how it can deliver acceptable thermal comfort values as follows: • Through material and design strategies and principles • Way of living and relation of activities, space and the time that they are carried out The other eight (38.1%) also vote for what they might have used but state that the dwellings are primitive and need improvement for attaining 21-century human comfort.
Do you view afar nomadic architecture as a primitive way of living? Which specific way of living and architectural approaches has to be improved for a better holistic improvement?
Nine (42.86%) individuals from the total informants that they believe that nomadic afar vernacular architecture is primitive in the sense of providing a comfortable space in accommodating a proper activity for the 21-century man. The other twelve (57.14%) didn't saw the architecture as primitive architecture but they also noted the following specific ways of changes. So, 100% of the informants decided on they need a change to accommodate today's activity. The following points are points raised by the respondents: • Space syntax analysis • Immediate surrounding design
To what extent do nomadic afar communities influence the culture and economic activities of the region?
All of the informants agree on the influence of nomadic communities on the culture and economic activity and status of the region. Even most of the informants gave a high value for these nomads in a way they are authentic communities who purely portraits afar culture and traditions. The average to what extent they affect the economic and cultural status of the informants is expressed as follows: • Highly _ Seventeen respondents from the total (80.95%) • Moderately _ The rest three (19.05%)
Afar vernacular strategies are used to combat the harsh environment.
The following strategies are voted with full acceptance from all the informants hence they are 100 % accepted. The following are the strategies they mentioned: • Location • Size

• Form • Material • Techniques used with the envelope and structural elements
What are the advantages of transferring principles of sustainable design and construction technique to a contemporary design?
The following advantages are voted with full acceptance from all the informants hence they are 100 % accepted. The following are the strategies they mentioned: • Better design that has qualities from both • Will transfer the culture and identity

Table 5. 8: detailed discussion of professional business owners' informants

Government officers: Semera- site 1 (13 informants) and Dubti site -2 (6 informants)

	Female Participants	Male Participants	Total number of participants
Gender	7	12	19
Age	46-52	39-53	

Table 5. 9: Total number of government officers' informants

Place of birth (Is it near to the city centre), estimation of years living in Afar permanently.
Of the total of nineteen respondents seventeen (89.47%) are born and raised in Afar. The rest two (10.53%) are from different part of the world including one foreigner working there at NGOs. From the total informants, fifteen (78.95%) lived afar for more than 20 years the rest four (21.05%) lived under 20 years. This group gave multiple reasons like living abroad in Europe and UAS for many years, moving to Addis Ababa looking for a job and education when they were young.
Environmental impacts of contemporary design and construction
From the total of nineteen respondents seven (36.84%) said the impacts are economical hence these days construction and construction materials are so expensive Ethiopia is spending a huge amount of its capital on construction that can also help and go to support and finance the environmental sector. The other twelve (63.16%) vote for Consumption of excess energy to keep the thermal comfort of hotels and government offices and fossil fuel usage and transpiration of building materials from far.
Nomadic afar vernacular architecture performance on decreasing environmental impacts
Of the total of twenty-one, respondents six (31.58%) said they do not know of this. They explained they need a deep understanding of the factors affecting the environment to conclude nomadic vernacular architecture decrease impact or stress on the environment.

The other thirteen (68.42%) vote for vernacular architecture, in general, will decrease environmental impacts from the construction industry. They raise the following points:

- Using locally available materials
- Local knowledge the whole budget will decrease

Do you believe it's important to document afar vernacular architecture if so, what is the importance of documentation of vernacular architecture?

All the informants (100%) agree on these specific questions. They believe it's important to document vernacular architecture and cultural activities in general. They state the following important points:

- Transferring knowledge
- It Will be used for further studies
- Will be input also for other studies like social and cultural studies.

Have you seen any contemporary design of a building in Afar that is constructed inspired by nomadic afar vernacular architecture?

The twenty-one respondents all confirm that they have seen vernacular architecture that is built by taking inspiration from the afar nomadic vernacular architecture. They explained most of the designs that they have seen architectural styles that have close design look as afar nomadic vernacular architecture. They mentioned the following buildings:

- The region agriculture research institute
- The region guest house
- Ruftana hotel gate design
- The region assembly hall

Afar future urban planning to include the nomadic lifestyle and culture as well take some principles from their temporary settlement.

From the total informants six (31.58%) of them have said that they have no clue about this specific subject. But they prefer that afar nomadic communities will be civilized and stops settling temporarily in a given area.

The other thirteen (68.42%) hopes and would also appreciate that if afar urban planning would take some principles from nomadic settlement typologies together it will also help to keep the identity of the region, in addition, they assume current urban planning should also start Consideration of mobility and livestock herding as a variable in designing our cities and housing because they are also part of the communities.

Pros and cons of nomadic afar vernacular architecture.

All 100% of the informants vote for the following pros and cons during the data collection sessions and briefly describe some of them. The stated advantages and disadvantages are:

- Pros
    - Availability of material
    - Using strategies and principles from evolved local knowledge to provide acceptable thermal cooling features
    - The ability of adaptability, flexibility and mobility

- Cons
    - Comfort
    - Space size
    - Daylighting
    - Limited activities can be carried inside

Possibility of infrastructural provisions for the nomadic community.

From the total of nineteen respondents sixteen (84.21%) said it's possible to provide reachable infrastructure for the nomads either in the city centres or in the most visited temporary settlement areas. They also emphasize this needs creativity and innovation.

The other three (15.79%) vote for it's impossible to address infrastructural problems if they are always in the move hence, to provide infrastructure for these nomads they believe the nomad community has to be more sedentarized.

Do you believe that afar nomadic architecture materials can provide acceptable thermal cooling features for the harsh contextual climate that it exists?

All nineteen respondents agree on the ability of afar vernacular architecture to provide acceptable thermal comfort. They explained in detail and vote for a nomadic vernacular architecture of afar capable of providing sustainable thermal cooling. they mentioned the following points on how it can deliver acceptable thermal comfort values as follows:

- Through material and design strategies and principles
- Way of living and relation of activities, space and the time that they are carried out

Do you view afar nomadic architecture as a primitive way of living? Which specific way of living and architectural approaches has to be improved for a better holistic improvement?

four (21.05%) individuals from the total informants that they believe that nomadic afar vernacular architecture is primitive in the sense of providing a comfortable space in accommodating a proper activity for the 21-century man.

The other fifteen (78.95%) didn't saw the architecture as primitive architecture but they also noted the following specific ways of changes. So, 100% of the informants decided on they need a change to accommodate today's activity. The following points are points raised by the respondents:

- Space syntax analysis
- Immediate surrounding design

To what extent do nomadic afar communities influence the culture and economic activities of the region?

All of the informants agree on the influence of nomadic communities on the culture and economic activity and status of the region. Even most of the informants gave a high value for these nomads in a way they are authentic communities who purely portraits afar culture and traditions. The average to what extent they affect the economic and cultural status of the informants is expressed as follows:

- Highly _ Seventeen respondents from the total (89.47%)
- Moderately _ The rest two (10.53%)

Afar vernacular strategies are used to combat the harsh environment.

The following strategies are voted with full acceptance from all the informants hence they are 100 % accepted. The following are the strategies they mentioned: • Location • Size • Form • Material • Techniques used with the envelope and structural elements
What are the advantages of transferring principles of sustainable design and construction technique to a contemporary design?
The following advantages are voted with full acceptance from all the informants hence they are 100 % accepted. The following are the strategies they mentioned: • Better design that has qualities from both • Will transfer the culture and identity

Table 5. 10: Detailed discussion of government officers' informants

5.2.2. DISCUSSION:

From the above discussion and data presentation, it can be summarized with the following main three topics where the questionaries are grouped. The main three groups are listed below:

- Awareness and knowledge of nomadic Afar vernacular architecture
- Identity and tradition representation of the Afar people through its nomadic vernacular dwelling and lifestyle
- The thermal performance of Afar nomadic vernacular dwellings
- Environmental impacts of contemporary material and construction

The following result is derived from a total of 80 participants living in Dubti and Semera. These informants are divided into two subgroups professionals and non-professionals. The non-professionals group has a subgroup of frequent travellers and non-travels. As well the professional group is categorized into business professionals and professionals working in government and non-government offices.

Questionaries collected from professional respondents

	Professional business owners	Government, and international organization officers	Total Number of Respondents
Number of Respondents	**21**	**19**	**40**
Semera	**15**	**13**	**28**
Dubti	**6**	**6**	**12**

Table 5. 11: Total number of professional respondents

Professionals (40 respondents in total)

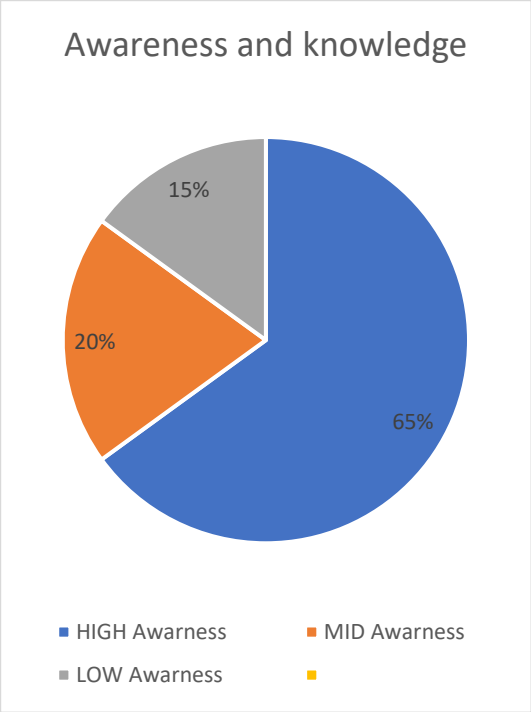


Figure 5. 1: Awareness and knowledge pie chart

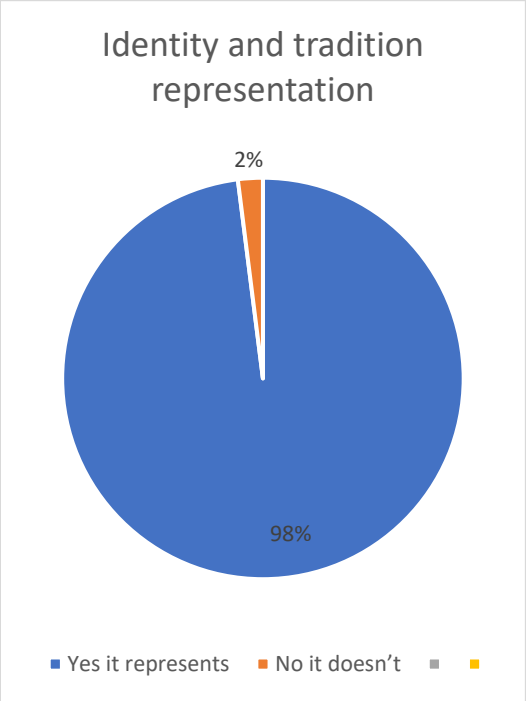


Figure 5. 2: Identity and tradition pie chart

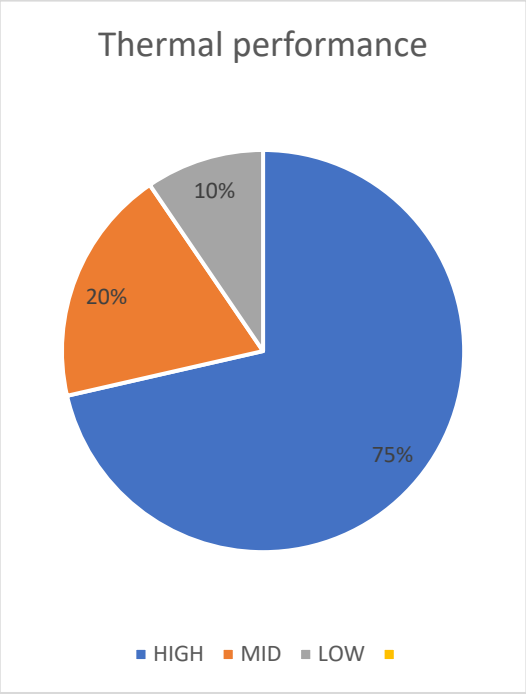


Figure 5. 3: Thermal performance pie chart

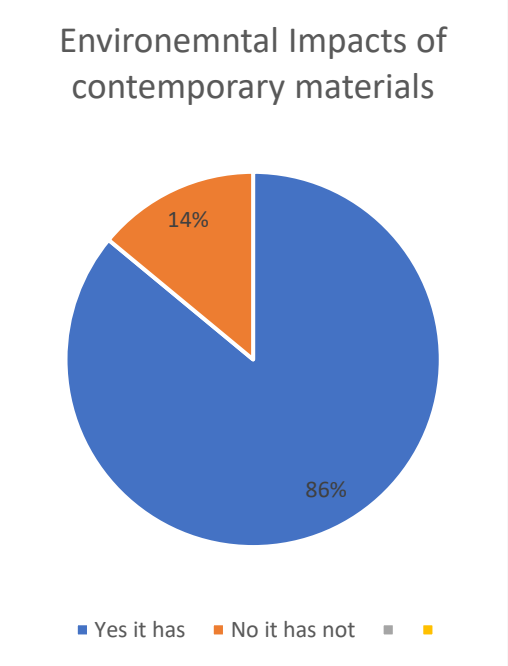


Figure 5. 4: Environmental impacts pie chart

Questionaries collected from Non-professional respondents

	Frequently traveller	Non- traveller	Total Number of Respondents
Number of Respondents	**20**	**20**	**40**
Semera	**10**	**10**	**20**
Dubti	**10**	**10**	**20**

Table 5. 12: Total number of non-professional respondents

Non - Professionals (40 respondents in total)

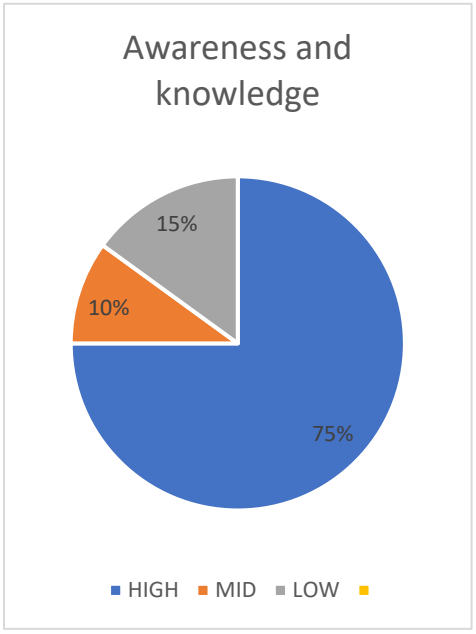


Figure 5. 5: Awareness and knowledge pie chart

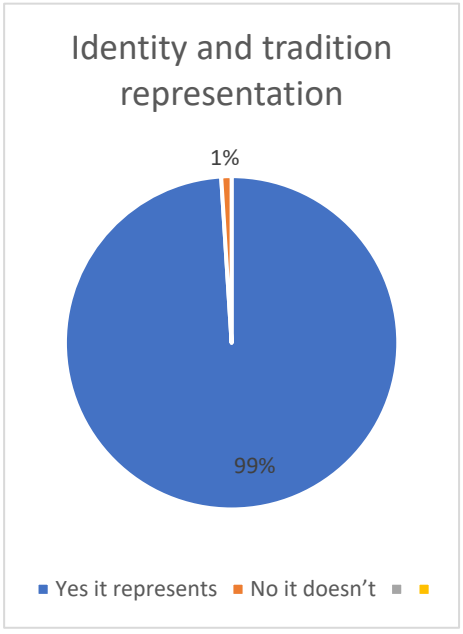


Figure 5. 6: Identity and tradition pie chart

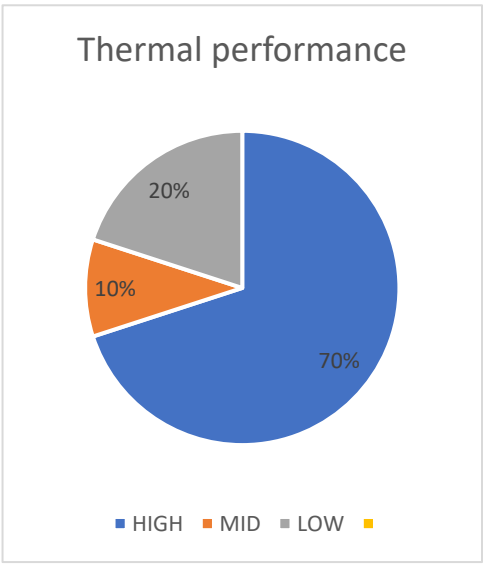


Figure 5. 7: Thermal performance pie chart

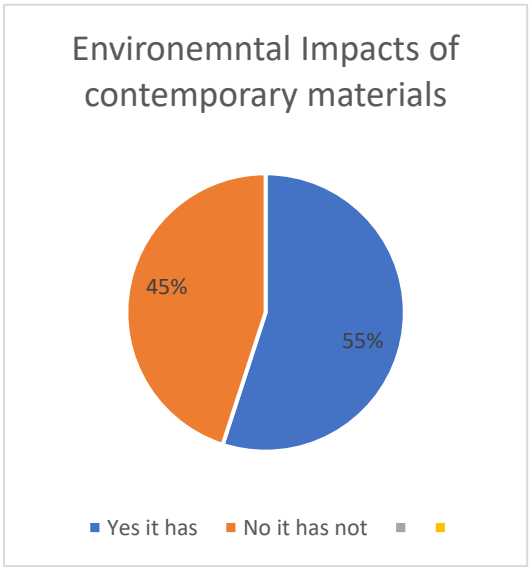


Figure 5. 8: Environmental impacts pie chart

5.3. DATA PRESENTATION AND DISCUSSION ON THERMAL COMFORT AND THERMAL SENSATION PERFORMANCE OF NOMADIC AFAR VERNACULAR ARCHITECTURE OF PASTORAL NOMADS OF AFAR

Presentation: Structured questionaries were conducted with a total of sixteen individuals living as pastoral nomads who live in a 10 km radius from the urban areas Semera and Dubti. The data collection is conducted using a questionnaire focused on an understanding of the thermal's sensations of Afar pastoral nomadic residents that will later help to understand the thermal comfort values and acceptance in the community. Two groups were selected in total which is calculated as one group for each site living in a different household together in the same neighbourhood. From Semera (Site-1) total of ten residents were taken which is the entire residents living in the area the same applies for site -2 Dubti where in total 6 residents were taken. The residents are an entirely pastoral nomadic individual who is livestock herders. They have several numbers camels and goats. Their life means of income surround these animals. The following table briefly describes the details.

Residents	Semera	Dubti	Age	Total
Wife	2	1	22-31	3
Husband	1	1	38-53	2
Kids	6	3	4-9	9
Gender for kids				
Female	2	1		
Male	4	2		
Old women	N/A	1	58	1
Young men	1	N/A	23	1
Total	10	6		16

Table 5. 13: Total number of informants for thermal performance of the vernacular dwelling

The major objectives of this study were to investigate the users and residents of afar nomadic vernacular architecture perception of thermal comfort, to determine the comfort temperature based on their perception. The thermal sensation is affected by the following factors:

- Age

Age difference has its effect on thermal sensations. This can be easily illustrated as considering activity different age groups has different activities hence activities affect the thermal sensation and thermal statues of our body.

- Climate

Indoor and outdoor climates are highly related hence the climate condition affects the thermal sensations of the inhabitants.

- mode of buildings operation

Indoor thermal conditions are affected by the type and strategies with which the dwellings are equipped. Their performance highly affects the thermal sensations of the residents living inside. Also, the building envelope has a huge impact on the indoor thermal comfort of a space.

- Gender/clothing

From the data, it can be seen that there is a different response from different genders. In Afar these days the ladies wore more layered cloths and cover their skins more comparing them with the guys as a result of the culture and the norms of the region this explains the result of most female votes goes to being uncomfortable in the indoor environments. They also mentioned this specific reason. Additionally, socio-cultural analysis is very important to understand thermal sensation and perception. The resident's thermal comfort is not determined by indoor microclimatic conditions alone. Previous studies suggested that their thermal comfort is significantly correlated with social parameters such as socio-economic background, culture, and what they experience at home. The next section covers the socio-cultural structure of the afar pastoral nomadic community. Hence the thermal sensation study assumes that the residents will consider all the factors that affect the thermal status by the time the data is collected.

The study area as it was described in detail above is within the 10 Km radius of the urban section Afar the capital Semera and the historical Dubti. In the area, there are generally two types of nomadic vernacular building; which differ in size and shape also the interior arrangement. Furthermore, the present thermal condition of Afar nomadic vernacular architecture is unknown; therefore, it is necessary to investigate the present condition of thermal comfort. Even though the thermal insulation of walls and roofs are poor it's not designed for insulation it's designed to shade the sun let the air and cool it while it's inside and create acceptable indoor environments.

5.3.1. DATA PRESENTATION

The survey was conducted in 11-unit temporary buildings of 5 groups under the condition of natural ventilation. In Semera there were 3 groups of dwelling units that are organized as a neighbourhood additionally, two dwellings have smaller two dwellings attached. In Dubti there are two dwelling units which are organized as well in two groups likewise, there is one bigger dwelling which has supporting smaller two temporary units. Each unit of buildings gets analysed separately even existing in the same conditions.

With the permission of the residents, each unit buildings were observed and analysed for investigation. What has been observed and what was the preparation for investigation. The structure and size of the unit buildings in the investigated areas were the same in most cases. The unit building is a simple temporary shelter that is covered with "selen" (A waved matt that is used as envelope for pastoral far vernacular buildings) or plastic or packaging material called "madaberia" inside there is a wooden structure that bends all over covering from one side of

the semi-dome to the other. The survey was conducted inside the unit buildings and around its area. The building walls were made of layered selen (A waved matt that is used as envelope for pastoral far vernacular buildings), clothing that can breathe or plastics, there are no finished but these layered materials can be opened in a different direction to let the wind in and cool the indoor environment. The roofs are made from the same materials. All unit buildings have no windows but they have slender/ narrow doors of different sizes for natural ventilation and daylighting the daylighting is very limited only the wind can get into the huts for ventilation. In some households, the doors remained open. None of the unit buildings was equipped with mechanical ventilation or fans.

Participants

Altogether, sixteen residents participated in the questionnaire survey, of which seven were females **43.75%** and nine were males **56.25%,** ranging in age for the kids 4 to 9 years, for the adults 22 to 58years. We used a seven-point thermal sensation scale with an Amharic language translation then a translator helped us to translate it to Afar language. We questioned the residents on their:

- thermal sensation,
- thermal preference,
- overall comfort, and
- thermal acceptance

The study assumed a constant metabolic rate of the residents for thermal sensation as the survey was conducted during regular days, with no intense physical activities being performed by the residents.

Data collection

First, the researcher and the assistant took 5-10 min to explain the purpose of this survey. After the first voting, we have asked then they will also vote in the evening. Therefore, in one day, the residents would have voted two times, resulting in two sets of measured values. We gathered sixteen valid votes: **ten** (near Semera), **six** (Near Dubti). Additionally, eleven sets of measurements of physical quantities were obtained: seven near Semera, and four Near Dubti. The coefficient of clothing was also considered in the studies. Standards used for thermal sensation reference vote.

Bedford scales of user response

ASHRAE descriptor	Numerical equivalent	Bedford descriptor	Thermal sensation	Over all comfort
Hot	3	Much too hot	Very hot	
Warm	2	Too hot	Hot	Very uncomfortable
Slightly warm	1	Comfortably warm	Slightly hot	Moderately uncomfortable
Neutral	0	Comfortable	Neutral	Slightly uncomfortable
Slightly cool	-1	Comfortably cool	Slightly cold	Slightly comfortable

Cool	-2	Too cool	Cold	Moderately comfortable
Cold	-3	Much too cool	Very cold	Very uncomfortable

Table 5. 14: American Society of Heating, refrigerating and air-Conditioning Engineers (ASHRAE)

Digital instrument

One digital instrument was prepared to measure the indoor and outdoor environmental physical quantities. The measured environmental quantities were air temperature.

Parameter measured	Sensor	Range	Accuracy	Name of instrument
Air temperature	Room Thermometer	0-55^{o}C	+-0.5 ^{o}C	

Table 5. 15: Digital instrument used for measurement of environmental qualities

5.3.2. THE INDOOR AND OUTDOOR THERMAL ENVIRONMENT DURING VOTING

On average the values of indoor globe temperature during the voting time ranged from **35 °C** to **39 °C**. The indoor globe temperature is correlated to the outdoor air temperature, but there are some cases in which the indoor globe temperature is **2 °C** to **3 °C** higher or lower than the outdoor air temperature. The factors could be the openings and the materials used to cover the unit building.

- Location can be raised as one factor
- Vegetation and shade around
- Water bodies
- Opening and layering
- Structure layering
- Stone laying etc.

The variation in the indoor globe temperature was observed by the materials they used as an envelope some of the dwellings were using plastic instead of the local vernacular covering material this results in actually rise in temperature of the indoor environments. Also, their location and proximity to vegetation can be considered as a factor. The mean indoor globe temperature of the dwellings that are covered with plastics was 37.9 °C, 38.6 °C, and 38.9 °C with mean outdoor air temperatures of 38.1 °C, 38.8 °C, and 38.2 °C, respectively. The plastic coverings have poor insulation performance it either increase either match the temperature with the outdoor temperature additionally they decrease the breathability property of the dwellings. This material hinders the performance of the dwellings considerably.

5.3.3. OVERALL RESULTS OF THERMAL RESPONSES

The following discussion, elaborated the statistical summary of the thermal responses from the residents of nomadic afar vernacular architecture. The thermal sensation and thermal preference show that most of the residents were neutral and preferred no change. But they need more large and open space using the same principles.

Below shows the percentage distribution of all resident's votes of thermal sensation with a total of sixteen votes. Approximately three-quarters of 75% of the residents expressed their thermal perception in the following thermal zones (either neutral, slightly hot). Comparison of thermal sensation between residents living in smaller houses and slightly bigger houses shows that residents living in a moderately bigger dwelling vote for a value that is close to what is accepted as comfortable.

Residents living in both sites responded mainly to the comfort zone and slightly hot, as expected from Very hot vote was obtained from females and some children and very few men living in a very small hut without any shade or other water bodies around them. As it was described earlier residents with natural vegetation near them and has a moderately bigger house with well-constructed huts manages to have acceptable indoor thermal comfort inside their house. A significant difference was confirmed between males and females. Due to the clothing insulation is more on the females. From the total number of seven females one of the **14.29%** very hot and one **14.29%** hot. Despite the former clothing standard practiced by the Afar these days, the ladies will cover most of their body parts because of religion and culture. The response on the very hot side was investigated in the case of resident living.

- Small houses
- The insulation and the construction of the was poor
- They used plastic as a covering material
- The openings are closed and are not efficient (Limited ventilation)
- Females wear layered cloth and cover most of their skins.

Activities for example cooking additional contributes to the rise in temperature. Or the feel of discomfort. Consequently, ineffective ventilation (Air circulation) must have caused an increase in the indoor air temperature, which resulted in the responses being on the hot side. Also, the material and construction technique have a huge role. The adaptive behaviour of residents regarding their clothing and its relation to comfort temperature is discussed in this section. Generally, occupants change:

- clothing, (The clothing worn by the residents differed by age as well as by gender)
- posture,
- activity levels and
- drink more or less water,
- among other adjustments, to adapt to the indoor thermal environment.

5.3.4. DISCUSSION

Thermal measurement and comfort survey were conducted in addition to the documentation and study of the vernacular architecture and the techniques in detail. Altogether, 6 sets of measured environmental quantities and 16 thermal sensation responses from 16 residents were obtained. The major findings are as follows:

- According to the comparison of the indoor globe and operative temperatures with the outdoor air temperature, and also from the response gathered from the residents, natural ventilation of a well-constructed unit housing of Afar nomadic hut performed relatively well.

- Approximately three-quarters of the residents participating in the survey were comfortable under similar indoor and outdoor shaded environments; this is probably because of natural ventilation.
    - Under given conditions.

- The discomfort was due to the higher temperature caused by the thermally poor characteristics of the building envelopes, such as poor construction and poor material or building envelope.

- The average indoor temperature estimated from the data was **37 °C.**
    - The comfort temperature of the residents living in moderately big and well-constructed unit buildings was lower than that of small and poorly constructed ones.
    - Female residents had higher comfort temperatures than male residents. The residents with comfort temperature beyond the temperature limits prescribed by ASHRAE showed a tendency to adapt to their indoor thermal environment.

- Differences in clothing insulation and comfort temperature in terms of gender and housing type were observed. The clothing adaptive behaviour was an additional factor for the increased thermal comfort values with the outdoor environment. This study showed that most of the residents adapted and felt comfortable under the condition of an indoor natural thermal environment. The comfort temperature for male and female residents is different owing to clothing insulation.

5.4. DATA PRESENTATION AND DISCUSSION ON SOCIO-CULTURAL STRUCTURE AS WELL AS PHYSICAL MEASUREMENTS OF THE DWELLING OF PASTORAL NOMADS OF AFAR

To get a better understanding of characteristics of nomadic afar vernacular architecture in the case study site it's important to study the socio-cultural structure meaning the relationship of activities time and space. To achieve a coherent study an in-depth life story interview was conducted in both sites selecting interviewee. From the total of seventeen resident from both sites ten from Semera **(62.5%)** and six **(37.5%)** from Dubti, the following respective number of informants selected based on their activities and relationships with space. From seven total residents located in Semera four **(57.14%)** were selected. from the total individuals, 1 is female, 1 is male, 1 is a kid and the last one is a young man. Likewise, in site-2 Dubti three **(42.86%)** informants were selected consisting of 1 female, 1 male and 1 old woman. These informants were selected through direct observation in the area by the researcher.

5.4.1. SOCIO CULTURAL STUDIES

Time

The time frame used to analyse the following activities in space is from noon till 4:00 before midnight in Ethiopian time. Meaning this will help to record the nomadic community activity within 14 hours.

Life story narration

Self-introduction and family in detail. This will include the position of women and the role of each individual will be indicated. Furthermore, Social intercourse and view towards the lifestyle and performance of the building will be discussed briefly.

Activity	**Daily activities**		**Rituals**	
	Individual		Group	
	Indoor	Outdoor	Indoor	Outdoor
Space (name tag of the place)	Main house		Other spaces	
	• Living room • Bed room • Store		• Outdoor kitchen • Outdoor toilet shade • Washing and hygienic • Small animal barn • Big animal barn • Outdoor sleeping and sitting area • Kids playing space • Kid's bedroom • Selling milk • Leisure activity	
Proximity to the main house	Near (3-8 Meters)		Not too far (8-12 Meters)	Far (More than 12 Meters)
Privacy	Confidential privacy		Normal privacy	Transitional privacy	No privacy
Lighting	Natural Sufficient/available		Artificial Sufficient/available	
Does it allow mobility	Yes		No	
Zoning	Fenced		Not fenced	

Presentation

Graphs will be presented to assess the activities in time and gender. This will later help us to compare and contrast which activities for the females and males took the most time.

J-graph/Bubble diagram

This will help to analyse the space, time and mobility of activities each individual spends in the nomadic community that will be later very helpful for discussion and analysis

Table 5. 16: List of activities and corresponding spaces that its possibly carried out

The activities are grouped into five groups that define the livelihood afar the nomads. The following is the grouping of the activities which has detailed activities as presented in the above table.

- Personal activity
- Family and relative
- Animals
- Construction of the dwelling
- Socializing

These activities also define the spaces where the activates occur.

Life story- 1

Semera site

- *Introduce yourself and your family in detail*

Mr Kedir Ibraim is from Afar nomadic community leaving near Semera. He is a 43 years old married man with four kids who are all males from the age of 4-9. Mr Kedir has practiced being a nomad his whole life adapting to this traveling life from early age. He took and learned this lifestyle from this family and they also gave him some cattle's so that he can start his family. He describes the following reason for being a nomad: The first reason for being a nomad as he explains it, he gets some satisfaction of practising this way of life the next and also most important definable reason is to get grazing land and water for his cattle's. The other reason is to use technology like using a phone when he wants to check his relatives living abroad and also his colleagues and friends and public facilities in the city areas. To choose the temporary areas the first criteria is it near to any natural resources like vegetations, hill areas and water. Additionally, he checks that the area is clean safe and suitable to live in.

Kedir believes that being a nomad helps in finding food for his cattle's which are considered as equal as his families so instead of staying at the same place for so long and starve his cattle's. he also mentioned that in the life of travelling and mobility he will be able to see and spends time with his relatives most of the times and they support each other form sharing information to building temporary dwellings and socializing. Another advantage as he explains he gets satisfaction from being a nomad and he likes it so much he won't even think to sedentarized including he wants the kids to be nomads like him.

He also mentioned that even though the government is working towards strengthening infrastructural distributions they still are very challenged to find one. For instance, it's really difficult to send their kids to school for the whole year because they won't stay at one place for a year. Nevertheless, he said that they don't Demand the public facilities so bad because they have local knowledge to manage most of the cases. For a religious place, he made a representation from a stone and place it inside the compound so that it can proceed with the dwellings, his kids and cattle's. for example, when his kids get sick, he gave him homemade medicine that is made from local herbs.

The duration he and his families stay depends on the amount and the quality of the place if it's a nice place they might stay there from 3-5 months in some cases even more. Sources of income came from selling milk and sometimes his goats if he gets a good offer. Sometimes they slaughter some for food consumption as well.

To get a good and plenty water source Kedir and his family has to search for it. He mentioned other sources likewise. The river and sometimes he collects it from rain the government also provides water sources points from tap water but he like the river. They used wood and fire as energy sources to cook and light up space he also has a simple small solar celled powered light that he bought from the city. Regarding any natural disaster, Kedir has no experience he hasn't faced devastating drought or flood however when there is heavy rain some of their cattle's die because they can't withstand the heavy rain and wind. But he said it's okay since the other will have water for so long and flourish.

- *Position of women*

Fatima his wife is the owner of the house. He told us she was also a nomad her whole life. She builds the dwelling units and because it's a smaller dwelling she did it alone with the help of her kids.

- *Social intercourse*

Regarding social interaction, He helps others also gave information to other nomads to strengthen the bond. He also asked when there is something. He asks about others health and well-being continuously. he and his neighbours also gathered to eat, chat and drinks coffee.

- *Design inputs and construction of the dwelling*

When it's time to move His wife will package and store it on a camel it will take her from 15-30 minutes approximately. She collects most of the raw materials used to construct the dwelling. Outdoor the following activities will be carried out. Cooking, bread making it is our main food, prepare food, grinding raw materials for making food, wash clothes, for children to play, milking the cows. He and his family enjoy the outside environment when the temperature is cool, he and his wife also his kids would like to spend the day outside the unit dwellings, mostly after 11:00 and 12:00. Between two compounds there is no defined boundary but they know their limit. The immediate surrounding is used by his family and himself. His cattle besides his family shared the outdoor space. He has in total fifteen (15) camels and thirty-six (36) goats. In Indoors the following activities were carried out: They sleep, sit and prepare food. It has multiple functions, it is both storage, kitchen, bedroom and living room. To build the dwelling they spend up to 2400 ETB.

- *Its performance*

"Yes", he said it's very effective because of the material property. Hence the material is made from breathable material and has a special weaving and construction technique it helps to circulate the air at the same time blocking the harsh sun.

Grouped Activity Daily activities Individual		**Time**	**Space tag/ Name**	**Proximity** ***(to main house)***	**Privacy**	**Lighting**	**Mobility** ***(Does it allow)***
Indoor	Sleeping	Night 3:00-11:30	Bed room	Main house	Private	Not-sufficient	No
	Washing	Morning 12:00-12:30	Washing area	3 meters	Semi-private	Sufficient	No
	Using toilets	Morning 11:30-12:00	Outdoor toilet shade	8-10 m	Private	Sufficient	Yes
	Checking on his cattle's	Morning 1:00-1:30	Main house	Main house	Semi-private	Not-sufficient	No
	Resting	Morning 2:00-2:30	Living room	Main house	Private	Not-sufficient	No
Outdoor	Making fences for this cattle's	Morning 2:00-11:30	Surrounding	3-8 meters	Not-private	Sufficient	Yes
	Chilling and sitting under a shaded area	Morning 2:00-11:30	Surrounding	3-8 meters	Not-private	Sufficient	Yes
Group							
Indoor	Making simple furniture's	Mid-day 5:30-7:30	living room	Main house	Semi-private	Sufficient	Yes
	Drinking coffee with neighbours and family members	Mid-day 5:30-7:30	living room	Main house	Not-private	Sufficient	No
outdoor	Chilling and chatting with neighbours and family members	Afternoon 2:00-10:30	Outdoor sitting area	3-8 meters	Not-private	Sufficient	Yes
	Going to the urban sections to sell milk and buy other items for his family	Afternoon 9:00-10:30	Urban place	More than 12 meters	Not-private	Sufficient	Yes
	Talking his cattle to a grazing land where water and other resource materials are available	Afternoon 11:00-12:30	Animal barn	8-10 m	Not-private	Sufficient	Yes
	Talking care of the cattle's binging them and making sure they all are safe in their barn	Afternoon 10:00-10:30	Outdoor sitting area	1-3 meters	Not-private	Not-sufficient	Yes
	Checking his cattle's randomly	Afternoon 10:00-10:30	Urban place	More than 12 meters	Not-private	Sufficient	Yes
Special ritual activities *Activities related with being nomads (Outdoor)*							
Individual	Making sure all his cattle are okay in harsh weather	Mid-day 5:30-7:30	living room	Main house	Semi-private	Sufficient	Yes
Religious rituals							
Group	Going to mosque once in a while when there is one near by	Morning 3:00-5:30	Urban place	More than 12 meters	Private	Sufficient	Yes

Individual	Praying	Morning 3:00-5:30	Outdoor shade	8-10 m	Private	Sufficient	Yes

Table 5. 17: Activity study table_ Semera life story 1

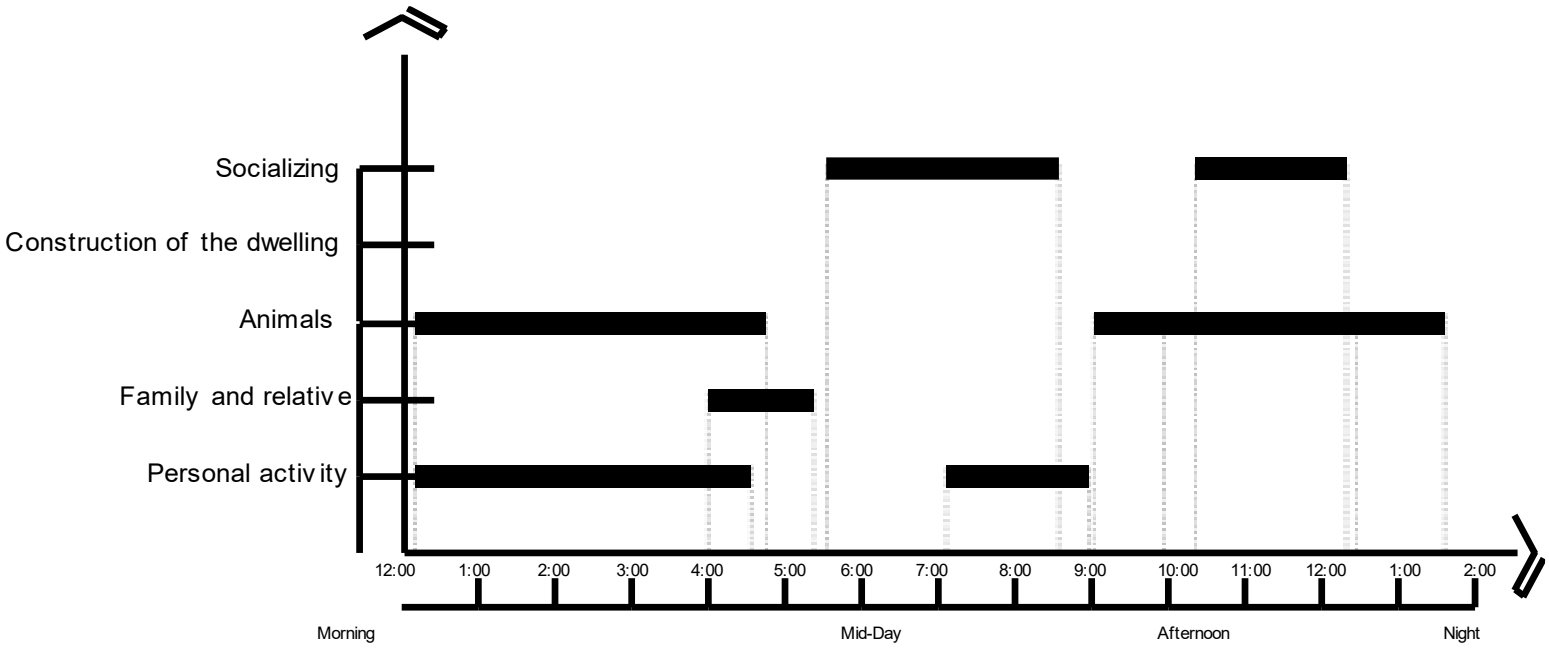


Figure 5. 9: Activity study Figure_ Semera life story 1

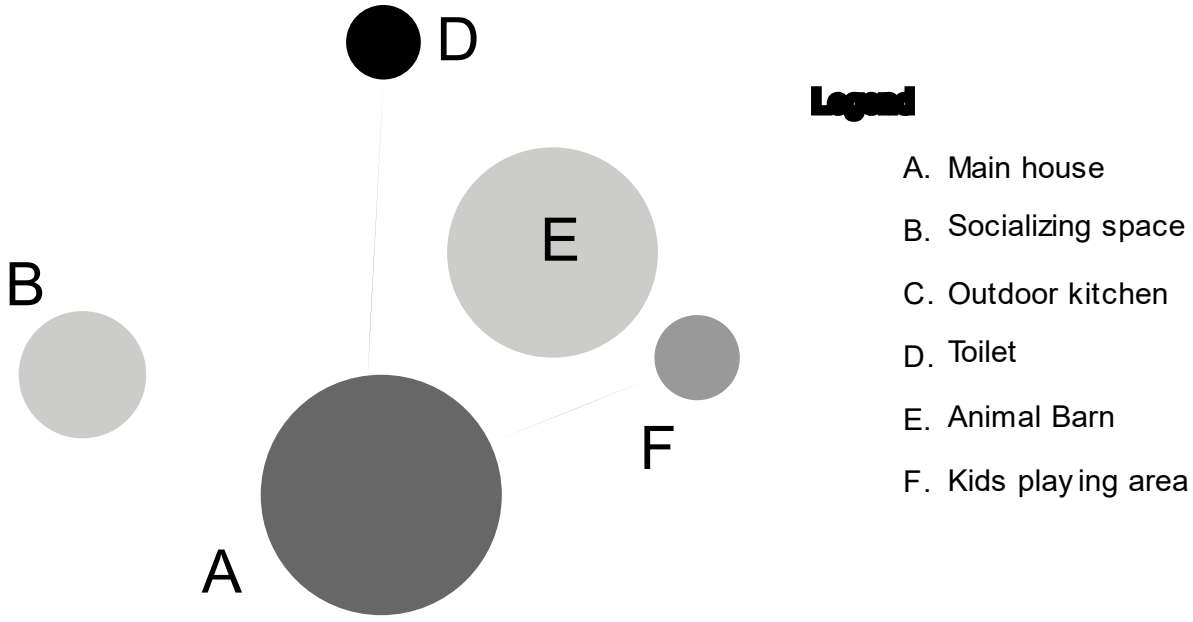


Figure 5. 10: Activity study bubble diagram_ Semera life story 1

Life story- 2

Semera site

- *Introduce yourself and your family in detail*

Mrs Jemila kemil is 25 years old married women with two kids who are all males from the age of 4-9. It's been 6 years since she has started practicing a nomadic lifestyle. She is not the first generation of nomadic pastoralist women from her family even though they have settled now her parents practiced being a pastoral nomad for years. She explains being a pastoral nomad gave her some satisfaction she gets the pleasure of practicing this way of life. Her husband left herding his numerous livestock looking for grazing land. He gave her a few goats and two camels to take care of the kids. To choose the temporary areas the first criteria is it near to any natural resources like vegetations, hill areas and water. Also, they check if it's clean safe and suitable to live in.

Jemila supposes that this way of life gave her a sense of freedom and belongingness everywhere. she also emphasized that in the life of traveling and mobility he will be able to see and spends time with his relatives most of the times and they support each other from sharing information to building temporary dwellings and socializing.

The only disadvantage Jemila raised is that she and also other communities of afar pastoral nomads couldn't get any public facilities easily like finding a hospital and clean water for drinking is very difficult. In today's world, he also indicated the importance of energy in day-to-day life related to light and communication. She will stay as long as her husband brother stays there. The income source came from selling goat milk. For the time being her husband brother will take care of that. Small water sources could be from rivers and small ponds nearby. She used wood fire as energy sources to cook and light up space.

- *Position of women*

She is the owner of the house. She builds it alone because it's a smaller dwelling she did it alone with the help of her kids.

- *Social intercourse*

She helps other women when they are building their dwelling. She drinks coffee to take care of neighbour kids and relatives. Help her neighbours when preparing food.

- *Design inputs and construction of the dwelling*

She will package and store it on a camel when it's time to hit the road to the next destination, it will take her from 15-30 minutes. Jemila told us she enjoys the indoor environment she likes her privacy in addition it's also a multifunctional space. The following activities will be carried out by Jemila in an indoor environment: Cooking, bread making our main food, prepare food,

grinding raw materials for making food, wash clothes, for children to play, milking the cows. By night time mostly after 11:00 and 12:00 she also likes to take advantage of the cool air and chill with her neighbours. The immediate surrounding is used by herself and kids. She has in total two (2) camels and six (6) goats. she said they shared the space and there is no defined boundary but they know their limit. She usually buys the raw material and weaves it.

Its performance

She said it's warm in mid-day however she agrees on its effectiveness because of the material property.

Grouped Activity Daily activities Individual		**Time** **(In Ethiopian time)**	**Space tag/ Name**	**Proximity** ***(to main house)***	**Privacy**	**Lighting** **(Only natural light)**	***mobility (Does it allow)***
Indoor	Sleeping	Night 3:00-11:30	Bed room	Main house	Private	Not-sufficient	No
	Washing	Morning 12:00-12:30	Washing area	3 meters	Semi-private	Sufficient	No
	Using toilets	Morning 11:30-12:00	Outdoor toilet shade	8-10 m	Private	Sufficient	Yes
	Cleaning the house	Morning 1:00-1:30	Main house	Main house	Semi-private	Not-sufficient	No
	Feeding her small child *(Under 3 years old)*	Morning 2:00-2:30	Living room	Main house	Private	Not-sufficient	No
	Cleaning her kids	Morning 1:30-2:00	Living room	Main house	Semi-private	Not-sufficient	No
	Preparing food for her kids *(Under 3 years old)*	Morning 2:00-11:30	Outdoor kitchen	1-3 meters	Semi-private	Sufficient	No
Outdoor	Organizing and cleaning the surrounding	Morning 2:00-11:30	Surrounding	3-8 meters	Not-private	Sufficient	Yes
	Maintaining the tent (Casually)	Morning 2:00-11:30	Surrounding	3-8 meters	Not-private	Sufficient	Yes
	Cooking	Morning/afternoon 2:00-3:30 12:00-1:00	Outdoor kitchen	1-3 meters	Semi-private	Sufficient	Yes
	Preparing raw materials for food	Morning/afternoon 2:00-5:30 11:00-1:30	Living room/ Outdoor kitchen	1-3 meters	Not-private	Sufficient	Yes
	Washing clothes	Morning 3:00-5:30	Washing and hygienic area	8-10 m	Not-private	Sufficient	Yes
	Milking the goats and camels	Morning/afternoon 1:00-2:30 11:30-1:30	Animal barn	8-10 m	Semi-private	Not-sufficient	Yes
Group							
Indoor	Making artifacts *"senel"*	Mid-day 5:30-7:30	living room	Main house	Semi-private	Sufficient	Yes
	Drinking coffee with neighbours and family members	Mid-day 5:30-7:30	living room	Main house	Not-private	Sufficient	No

outdoor	Chilling and chatting with neighbours and family members	Afternoon 2:00-10:30	Outdoor sitting area	3-8 meters	Not-private	Sufficient	Yes
	Going to the urban sections to buy goods for herself and her child. (Casually)	Afternoon 9:00-10:30	Urban place	More than 12 meters	Not-private	Sufficient	Yes
	Talking care of the cattle's	Afternoon 11:00-12:30	Animal barn	8-10 m	Not-private	Sufficient	Yes
	Preparing materials to make the dwelling	Afternoon 10:00-10:30	Outdoor sitting area	1-3 meters	Not-private	Not-sufficient	Yes
	Talking her kids to a hospital for vaccination. (Casually)	Afternoon 10:00-10:30	Urban place	More than 12 meters	Not-private	Sufficient	Yes
Special ritual activities							
Activities related to being nomads (Outdoor)							
Group	Making the dwelling units *(performed in groups)*	Morning/afternoon 2:00-5:30 11:00-1:30	On chosen site	On site	Not-private	Sufficient	Yes
Individual	Making the dwelling units *(performed in groups)*	Morning/afternoon 2:00-5:30 11:00-1:30	On chosen site	On site	Not-private	Sufficient	Yes
Religious rituals							
Group	Going to mosque once in a while when there is one near by	Morning 3:00-5:30	Urban place	More than 12 meters	Private	Sufficient	Yes
Individual	Praying	Morning 3:00-5:30	Outdoor shade	8-10 m	Private	Sufficient	Yes

Table 5. 18: Activity study table_ Semera life story 2

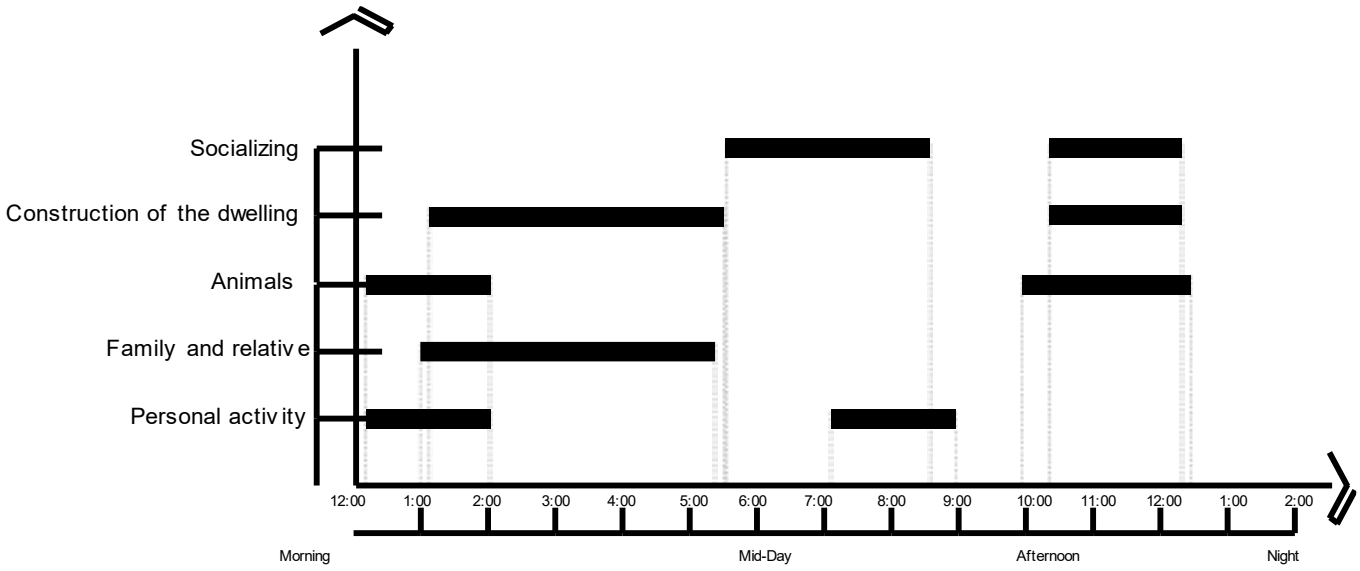


Figure 5. 11: Activity study figure_ Semera life story 2

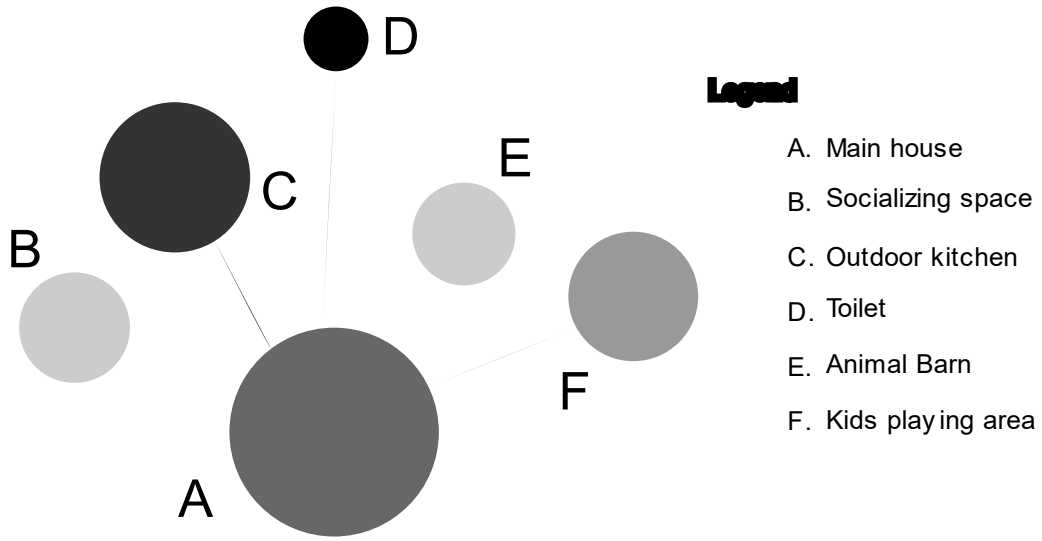


Figure 5. 12: Activity study bubble diagram_ Semera life story 2

Life story- 3

Semera site

- *Introduce yourself and your family in detail*

Mohamed Ibrahim is a 9 years old kid living with his parents he has two brothers in the age range of 4-9. He has practiced being a nomad his whole life and his families are also nomads. He likes the nomadic way of life he said he gets to play with different kinds and makes a lot of friends when they move from place to place additionally, he loves playing with the small camels and goats. He also loves to see different places once in a while even though the ravelling was hard as he explains. Mohamed thinks it's very difficult to find water for the cattle in the dries season of the year and it's hot. He sometimes goes to school but he didn't attend regularly he is in grade 2 now. Mohamed said he helps his mother when she is cooking by bringing her wood.

- *Position of women*

His mother and his father own the house. His mother Fatima builds the dwelling units and because he sometimes helps her with maintenance of the dwelling and packing.

- *Social intercourse*

He plays with his friends and brother most of the day. He also sleeps in the daytime.

- *Design inputs and construction of the dwelling*

His mother will pack it and store it on a camel when they move. Inside the house Fatima his mother does the following activities: Cooking, bread making our main food, prepare food, grinding raw materials for making food, wash clothes, for children to play, milking the cows. When the temperature is he run around and play with the smaller camels and goats. The immediate surrounding is used by his family and himself. his parents own in total fifteen (15) camels and thirty-six (36) goats. The outdoor space is shared by anyone and He said they shared the space and there is no defined boundary. At night time he sleeps, sits and help his mother preparing food.

- *Its performance*

He said it's nice and he likes it he wants to learn how to build one.

Grouped Activity Daily activities Individual		**Time**	**Space tag/ Name**	**Proximity** ***(to main house)***	**Privacy**	**Lighting**	**Mobility** ***(Does it allow)***
Indoor	Sleeping	Night 3:00-11:30	Bed room	Main house	Private	Not-sufficient	No

	Washing	Morning 12:00-12:30	Washing area	3 meters	Semi-private	Sufficient	No
	Using toilets	Morning 11:30-12:00	Outdoor toilet shade	8-10 m	Private	Sufficient	Yes
	Checking on his parent's cattle's	Morning 1:00-1:30	Main house	Main house	Semi-private	Not-sufficient	No
	Resting	Morning 2:00-2:30	Living room	Main house	Private	Not-sufficient	No
Outdoor	Making fences for small cattle's	Morning 2:00-11:30	Surrounding	3-8 meters	Not-private	Sufficient	Yes
	Chilling and playing under a shaded area	Morning 2:00-11:30	Surrounding	3-8 meters	Not-private	Sufficient	Yes
Group							
Indoor	Assisted while eating	Mid-day 5:30-7:30	living room	Main house	Semi-private	Sufficient	Yes
	Playing with friends	Mid-day 5:30-7:30	living room	Main house	Not-private	Sufficient	No
outdoor	Chilling and chatting with neighbours and family members	Mid-day 5:30-7:30	living room	Main house	Semi-private	Sufficient	Yes
	Going to the urban sections with her mothers	Mid-day 5:30-7:30	living room	Main house	Not-private	Sufficient	No
	Going to school	Morning 2:00-11:30	Surrounding	3-8 meters	Not-private	Sufficient	Yes
	Playing with friends	Morning/afternoon 2:00-5:30 11:00-1:30	On chosen site	On site	Not-private	Sufficient	Yes
Special ritual activities							
Activities related with being nomads (Outdoor)							
Religious rituals							
Group	Going to mosque once in a while when there is one near by	Morning 3:00-5:30	Urban place	More than 12 meters	Private	Sufficient	Yes
Individual	Praying	Morning 3:00-5:30	Outdoor shade	8-10 m	Private	Sufficient	Yes

Table 5. 19: Activity study table_ Semera life story 3

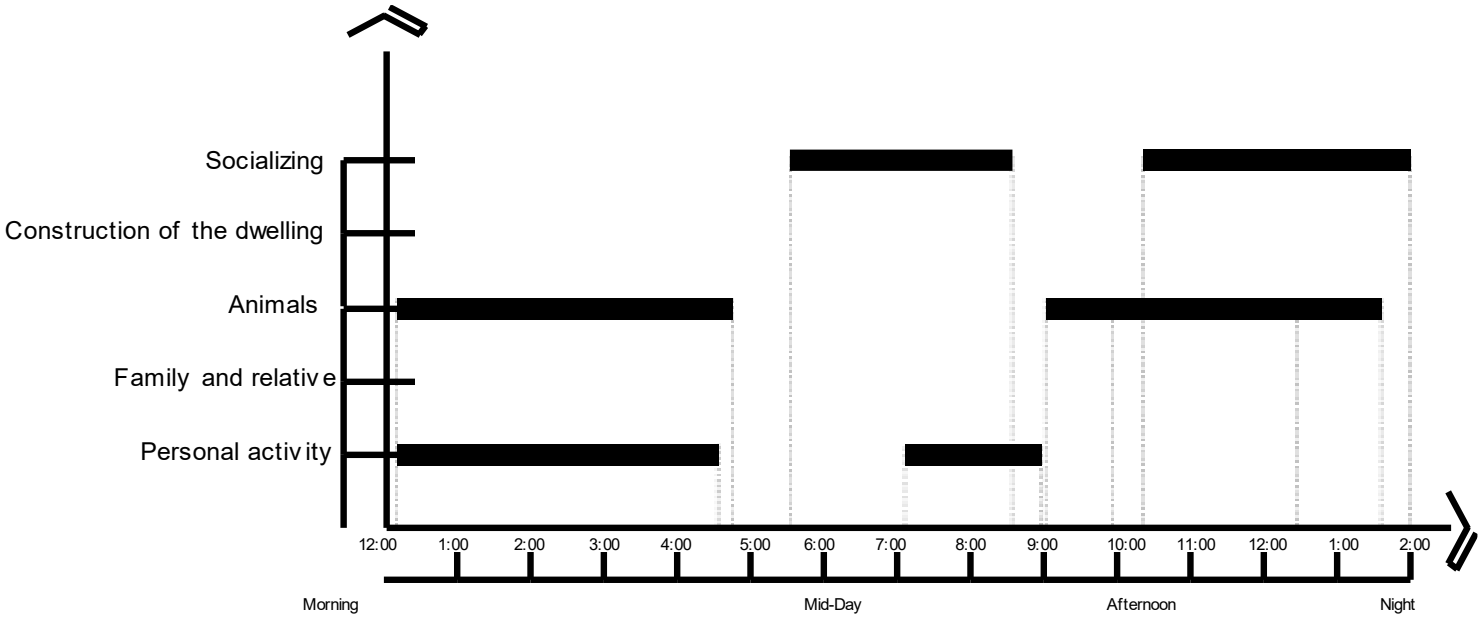


Figure 5. 13: Activity study figure_ Semera life story 3

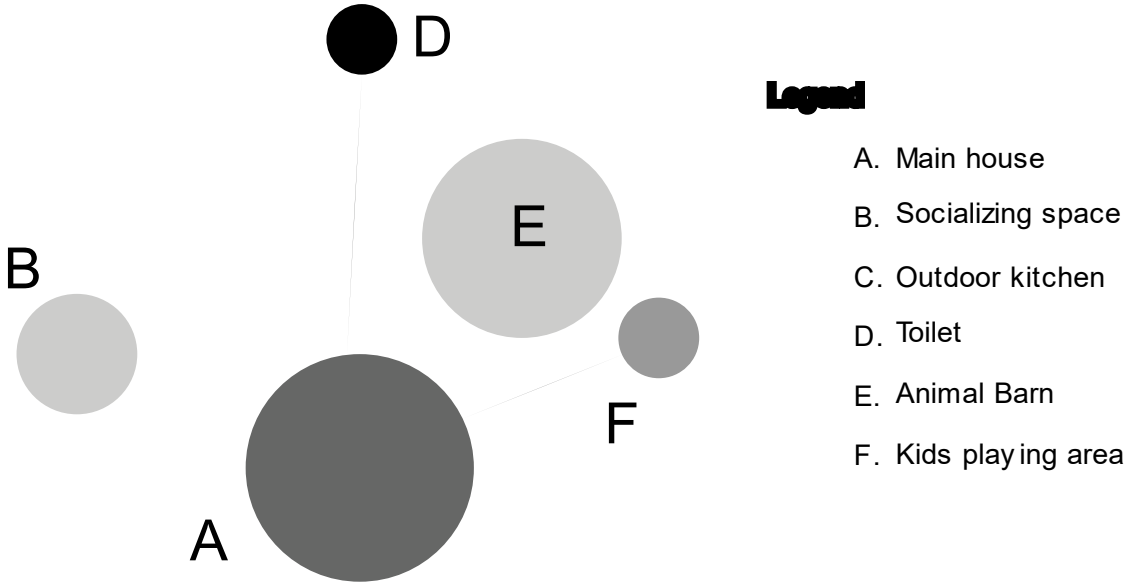


Figure 5. 14: Activity study bubble diagram_ Semera life story 3

Life story- 4

Semera site

- *Introduce yourself and your family in detail*

Mr Ali Muctar is from Afar nomadic community leaving near to Semera. He is a 26 years old young man who is looking for a wife. He is currently living with his uncle Mr Kedir. Ali has been a nomad his whole life following his parent's footsteps from an early age. He has a few cattle's he owns.

He describes being a nomad as a way to be free in this bounded environment and world, he loves the fact that he doesn't own a thing and he just can travel from place to place. He also explains the love he has for his animals the connection is something deep that he can't explain so taking care of them is the best thing that he can do. He chooses temporary areas by observing the area if it resource-rich, does it have privacy and is safe for himself and his animals. He noted on this depends on the experience of being nomads on top of that the women are the most experienced with things related to location and building the dwellings.

Ali believes that being a nomad helps in finding food for his cattle's. he appreciates life because it allows him to connect and communicate with relatives and members of the community. This will make the quest of finding a mate easy.

He stated he and member of the nomadic community struggles in finding public infrastructures like hospitals and schools. The only thing that he thinks he missed from the sedentary life is going to school and be educated. For instance, it's really difficult for a kid to school for the whole year because they won't stay at one place for a year. Nevertheless, this balances with local knowledge said Ali for example, when his kids get sick, parents will give him homemade medicine that is made from local herbs.

The duration he and his families stay depends on the amount and the quality of the place if it's a nice place they might stay there from 3-5 months in some cases even more. Sources of income came from selling milk and sometimes his goats if he gets a good offer. Sometimes they slaughter some for food consumption as well.

To get a good and plenty water source Ali and his relatives has to search for it. He mentioned other sources likewise. The river and sometimes he collects it from rain the government also provides water sources points from tap water but he like the river. They used wood and fire as

energy sources to cook and light up space. Regarding any natural disaster, Ali has no experience but he is always worried for his animals more than himself.

- *Position of women*

Fatima his uncle wife is the owner of the house. He told us she was also a nomad her whole life. She builds the dwelling units and because it's a smaller dwelling she did it alone with the help of her kids.

- *Social intercourse*

Regarding social interaction, He helps others also gave information to other nomads to strengthen the bond. He also asked when there is something. He asks about others health and wellbeing continuously. he and his neighbours also gathered to eat, chat and drinks coffee. More importantly, he went to the city and markets place in search of a wife.

- *Design inputs and construction of the dwelling*

When it's time to move His uncle's wife will package and store it on a camel it will take her from 15-30 minutes approximately. She collects most of the raw materials used to construct the dwelling. Outdoor the following activities will be carried out. Cooking, bread making our main food, prepare food, grinding raw materials for making food, wash clothes, for children to play, milking the cows he gets a lot of help from his uncle and his wife Fatima. He usually went to a marketplace where many girls are chatting and playing the spends most of the time there with them, mostly after 11:00 and 12:00. Between two compounds there is no defined boundary but they know their limit. The immediate surrounding is used by his family and himself. His cattle besides his family shared the outdoor space. He has in total five (5) camels and twenty (36) goats.

Indoors the following activities were carried out: They sleep, sit and prepare food. It has multiple functions, it is both storage, kitchen, bedroom and living room.

- *Its performance*

"Yes", he said it's effective because of the material property and the techniques used to cool the indoors using different techniques through material and structure.

Grouped Activity Daily activities Individual		**Time**	**Space tag/ Name**	**Proximity** ***(to main house)***	**Privacy**	**Lighting**	**Mobility** ***(Does it allow)***
Indoor	Sleeping	Night 3:00-11:30	Bed room	Main house	Private	Not-sufficient	No
	Washing	Morning 12:00-12:30	Washing area	3 meters	Semi-private	Sufficient	No
	Using toilets	Morning 11:30-12:00	Outdoor toilet shade	8-10 m	Private	Sufficient	Yes

	Checking on his cattle's	Morning 1:00-1:30	Main house	Main house	Semi-private	Not-sufficient	No
	Resting	Morning 2:00-2:30	Living room	Main house	Private	Not-sufficient	No
Outdoor	Making fences for this cattle's	Morning 2:00-11:30	Surrounding	3-8 meters	Not-private	Sufficient	Yes
	Chilling and sitting under a shaded area	Morning 2:00-11:30	Surrounding	3-8 meters	Not-private	Sufficient	Yes
Group							
Indoor	Drinking coffee with neighbours and family members	Mid-day 5:30-7:30	living room	Main house	Semi-private	Sufficient	Yes
outdoor	Chilling and chatting with neighbours and family members	Mid-day 5:30-7:30	living room	Main house	Semi-private	Sufficient	Yes
	Going to the urban sections to sell milk and buy other items for his family	Mid-day 5:30-6:30	living room	Main house	Not-private	Sufficient	No
	Going to other neighbours looking for a mate	Afternoon 10:00-10:30	Urban place	More than 12 meters	Not-private	Sufficient	Yes
	Talking his cattle to a grazing land where water and other resource materials are available	Mid-day 5:30-7:30	living room	Main house	Semi-private	Sufficient	Yes
	Talking care of the cattle's binging them and making sure they all are safe in their barn	Mid-day 5:30-7:30	living room	Main house	Not-private	Sufficient	No
	Checking his cattle's randomly	Mid-day 5:30-7:30	living room	Main house	Semi-private	Sufficient	Yes
Special ritual activities							
Activities related with being nomads (Outdoor)							
Individual	Making sure all his cattle are okay in harsh weather	Mid-day 5:30-7:30	living room	Main house	Semi-private	Sufficient	Yes
Religious rituals							
Group	Going to mosque once in a while when there is one near by	Morning 3:00-5:30	Urban place	More than 12 meters	Private	Sufficient	Yes
Individual	Praying	Morning 3:00-5:30	Outdoor shade	8-10 m	Private	Sufficient	Yes

Table 5. 20: Activity study table_ Semera life story 4

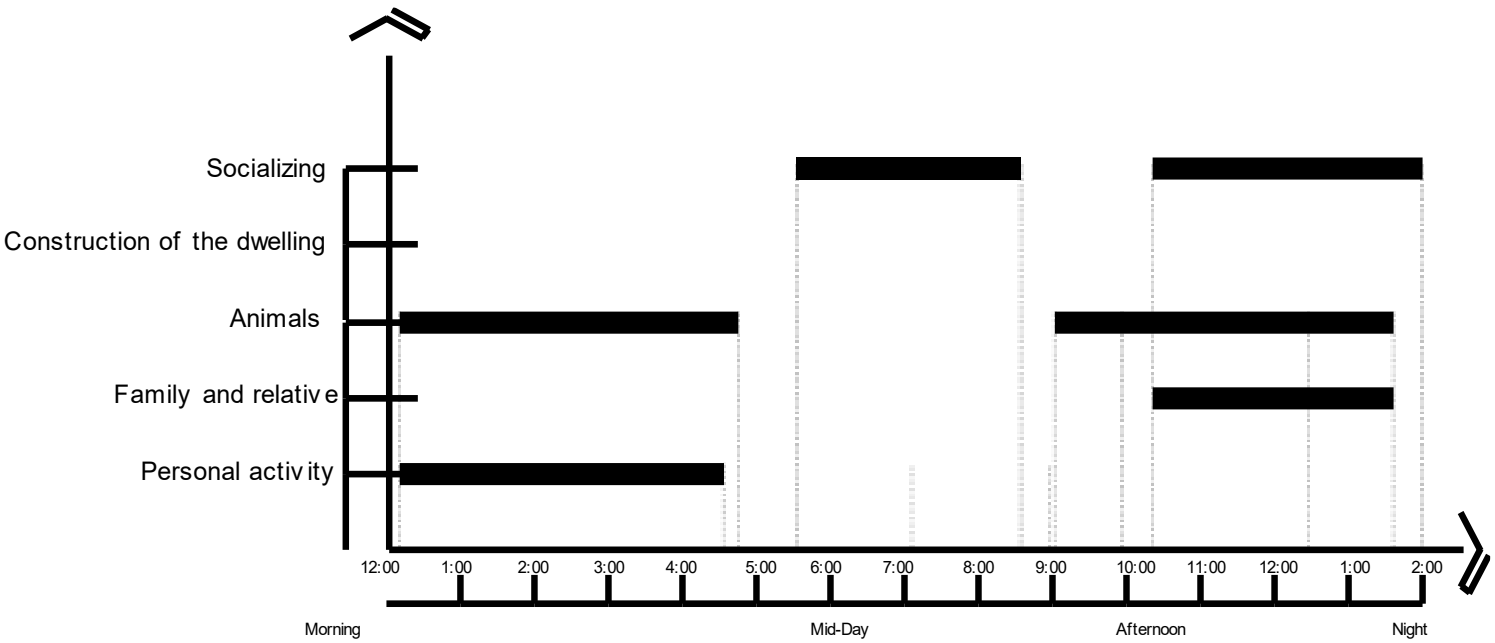
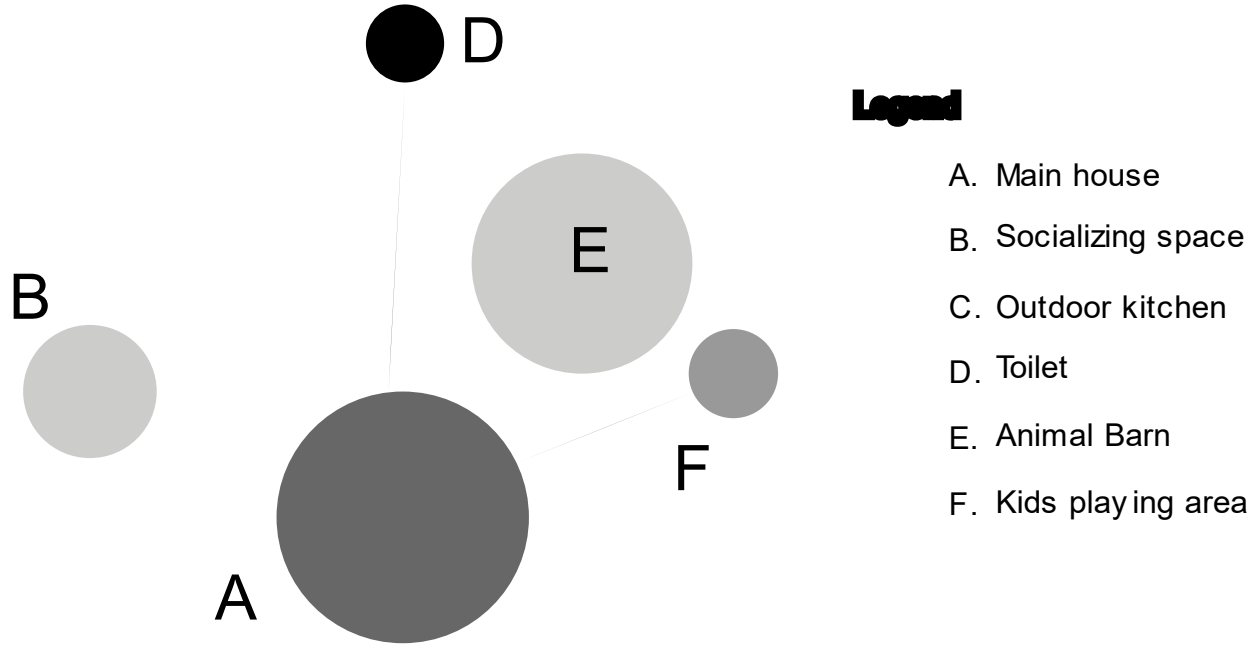


Figure 5. 15: Activity study figure_ Semera life story 4

Figure 5. 16: Activity study bubble diagram_ Semera life story 4



Life story- 1

Dubti site

- *Introduce yourself and your family in detail*

Mr Seid Shemsu is a member of traveller community leaving it near to Dubti approximately 8 Km far. He is a 49 years old married man with three kids who are all males from the age of 4-9. Mr Seid has practiced being a nomad his whole life adapting this traveling life from an early age. How took and learned this lifestyle from this family. He describes the following reason for being a nomad: The first reason for being a nomad as he explains it, he gets some satisfaction of practicing this way of life the next and also most important definable reason is to get grazing land and water for his cattle's. according to Seid: sites are chosen based on the following criteria. The first criteria are it near to any natural resources like vegetations, hill areas and water. Additionally, he checks that the area is clean safe and suitable to live in.

Seid believes that being a nomad helps in finding food for his cattle's which are considered as equal as his families so instead of staying at the same place for so long and starve his cattle's. he also mentioned that in the life of travelling and mobility he will be able to see and spends time with his relatives most of the times and they support each other form sharing information to building temporary dwellings and socializing. Another advantage as he explains he gets satisfaction from being a nomad and he likes it so much he won't even think to sedentarized including he wants the kids to be nomads like him.

He also mentioned that even though the government is working towards strengthening infrastructural distributions they still are very challenged to find one. For instance, it's really difficult to send their kids to school for the whole year because they won't stay at one place for a year. Nevertheless, he said that they don't Demand the public facilities so bad because they have local knowledge to manage most of the cases.

The duration he and his families stay depends on the amount and the quality of the place if it's a nice place they might stay there from 2-6 months in some cases even more. Sources of income came from selling milk and sometimes his goats if he gets a good offer. Sometimes they slaughter some for food consumption as well.

Seid mentioned the following water sources: the river and, sometimes he collects it from rain, the government also provides water sources points from tap water but he like the river. They used wood and fire as energy sources to cook and light up space he also has a simple small

torchlight powered by a couple of batters. Seid experience flooding a couple of times which it kills some of his animals. But he hasn't experienced drought.

- *Position of women*

Nehemiya his wife is the owner of the house. He told us she was also a nomad her whole life. She builds the dwelling units with her neighbour Nasra.

- *Social intercourse*

Regarding social interaction, He helps others also gave information to other nomads to strengthen the bond. He also asked when there is something. He asks about others health and wellbeing continuously. he and his neighbours also gathered to eat, chat and drinks coffee.

- *Design inputs and construction of the dwelling*

When it's time to move His wife will package and store it on a camel it will take her from 15-30 minutes approximately. She collects most of the raw materials used to construct the dwelling. Outdoor the following activities will be carried out. Cooking, bread making it's our main food, prepare food, grinding raw materials for making food, wash clothes, for children to play, milking the cows. He and his family enjoy the outside environment when the temperature is cool, he and his wife also his kids would like to spend the day outside the unit dwellings, mostly after 11:00 and 12:00. Between two compounds there is no defined boundary but they know their limit. The immediate surrounding is used by his family and himself. His cattle besides his family shared the outdoor space. He has in total Ten (10) camels and twenty-six (26) goats.

Indoors the following activities were carried out: They sleep, sit and prepare food. It has multiple functions, it is both storage, kitchen, bedroom and living room. He has no idea how much the house might cost him or his wife.

- *Its performance*

He noted that the material property and thermal cooling strategies with local knowledge of sun path analysis with the knowhow of wind direction make the dwelling suitable for the area.

Grouped Activity Daily activities Individual		**Time**	**Space tag/ Name**	**Proximity *(to main house)***	**Privacy**	**Lighting**	**Mobility *(Does it allow)***
Indoor	Sleeping	Night 3:00-11:30	Bed room	Main house	Private	Not-sufficient	No
	Washing	Morning 12:00-12:30	Washing area	3 meters	Semi-private	Sufficient	No

	Using toilets	Morning 11:30-12:00	Outdoor toilet shade	8-10 m	Private	Sufficient	Yes
	Checking on his cattle's	Morning 1:00-1:30	Main house	Main house	Semi-private	Not-sufficient	No
	Resting	Morning 2:00-2:30	Living room	Main house	Private	Not-sufficient	No
Outdoor	Making fences for this cattle's	Morning 2:00-11:30	Surrounding	3-8 meters	Not-private	Sufficient	Yes
	Chilling and sitting under a shaded area	Morning 2:00-11:30	Surrounding	3-8 meters	Not-private	Sufficient	Yes
Group							
Indoor	Making simple furniture's	Mid-day 5:30-7:30	living room	Main house	Semi-private	Sufficient	Yes
	Drinking coffee with neighbours and family members	Mid-day 5:30-7:30	living room	Main house	Not-private	Sufficient	No
outdoor	Chilling and chatting with neighbours and family members	Afternoon 2:00-10:30	Outdoor sitting area	3-8 meters	Not-private	Sufficient	Yes
	Going to the urban sections to sell milk and buy other items for his family	Afternoon 9:00-10:30	Urban place	More than 12 meters	Not-private	Sufficient	Yes
	Talking his cattle to a grazing land where water and other resource materials are available	Afternoon 11:00-12:30	Animal barn	8-10 m	Not-private	Sufficient	Yes
	Talking care of the cattle's binging them and making sure they all are safe in their barn	Afternoon 10:00-10:30	Outdoor sitting area	1-3 meters	Not-private	Not-sufficient	Yes
	Checking his cattle's randomly	Afternoon 10:00-10:30	Urban place	More than 12 meters	Not-private	Sufficient	Yes
Special ritual activities							
Activities related with being nomads (Outdoor)							
Individual	Making sure all his cattle are okay in harsh weather	Mid-day 5:30-7:30	living room	Main house	Semi-private	Sufficient	Yes
Religious rituals							
Group	Going to mosque once in a while when there is one near by	Morning 3:00-5:30	Urban place	More than 12 meters	Private	Sufficient	Yes
Individual	Praying	Morning 3:00-5:30	Outdoor shade	8-10 m	Private	Sufficient	Yes

Table 5. 21: Activity study table_ Dubti life story 1

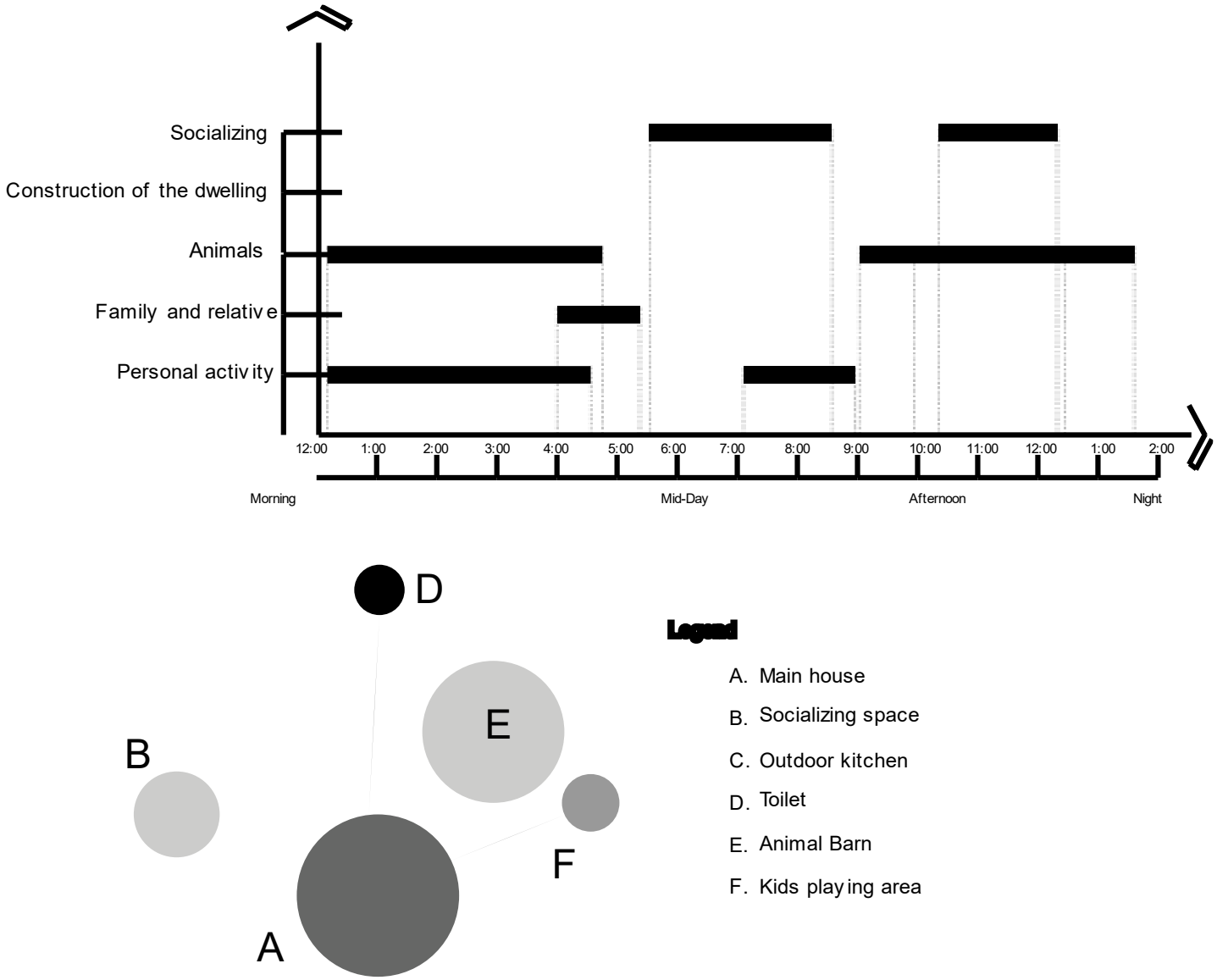


Figure 5. 17: Activity study figure and bubble diagram_ Dubti life story 1

Life story- 2

Dubti site

- *Introduce yourself and your family in detail*

Mrs Nehmiya Yemer is 28 years old married women with three kids living with her husband who are all males from the age of 4-9. It's been 6 years since she has started practicing a nomadic lifestyle. She is not the first generation of nomadic women from her family even though they have settled now her parents practiced being a nomad for years. As she claims she gets indescribable satisfaction off it she chooses the location for temporary settlements according to the quality of the site meaning through consideration of safety and cleanness of the area.

Nehmiya supposes that this way of life gave her a sense of freedom and belongingness everywhere. she also emphasized that in the life of travelling and mobility she will be able to see and spends time with his relatives most of the times and they support each other from sharing information to building temporary dwellings and socializing.

Nehmiya raised the difficulty of accessing public facilities easily like finding hospital and clean water for drinking is very difficult. Also, artificial lighting is sometimes important. She will stay as long as her husband stays there. The income source came from selling goat milk. This is her husband responsibility. Small water sources could be from rivers and small ponds nearby. She used wood fire as energy sources to cook and light up space.

- *Position of women*

She is the owner of the house. She builds it alone because it's a smaller dwelling she did it alone with the help of her kids.

- *Social intercourse*

She helps other women when they are building their dwelling. She drinks coffee to take care of neighbour kids and relatives. Help her neighbours when preparing food.

- *Design inputs and construction of the dwelling*

She will package and store it on a camel when it's time to hit the road to the next destination, it will take her from 10-25 minutes. Nehmiya is a very sociable person and she engages with almost most of the nomadic communities and government site workers who focus on nomadic education and health. The following activities will be carried out by Nehmiya in an indoor environment: Cooking, bread making our main food, prepare food, grinding raw materials for making food, wash clothes, for children to play, milking the cows. By night time mostly after 11:00 and 12:00 she also likes to take advantage of the cool air and chill with her neighbours. The immediate surrounding is used by herself and kids. They have in total nine (9) camels and

forty (40) goats. she said they shared the space and there is no defined boundary but they know their limit. She usually buys the raw material and weaves it.

- *Its performance*

She appreciates the performance of the dwelling it's the coolant in this harsh environment. She said it might take up to 2000 ETB to construct it.

Grouped Activity Daily activities Individual		**Time** **(In Ethiopian time)**	**Space tag/ Name**	**Proximity** *(to main house)*	**Privacy**	**Lighting** **(Only natural light)**	***mobility (Does it allow)***
Indoor	Sleeping	Night 3:00-11:30	Bed room	Main house	Private	Not-sufficient	No
	Washing	Morning 12:00-12:30	Washing area	3 meters	Semi-private	Sufficient	No
	Using toilets	Morning 11:30-12:00	Outdoor toilet shade	8-10 m	Private	Sufficient	Yes
	Cleaning the house	Morning 1:00-1:30	Main house	Main house	Semi-private	Not-sufficient	No
	Feeding her small child *(Under 3 years old)*	Morning 2:00-2:30	Living room	Main house	Private	Not-sufficient	No
	Cleaning her kids	Morning 1:30-2:00	Living room	Main house	Semi-private	Not-sufficient	No
	Preparing food for her kids *(Under 3 years old)*	Morning 2:00-11:30	Outdoor kitchen	1-3 meters	Semi-private	Sufficient	No
Outdoor	Organizing and cleaning the surrounding	Morning 2:00-11:30	Surrounding	3-8 meters	Not-private	Sufficient	Yes
	Maintaining the tent (Casually)	Morning 2:00-11:30	Surrounding	3-8 meters	Not-private	Sufficient	Yes
	Cooking	Morning/afternoon 2:00-3:30 12:00-1:00	Outdoor kitchen	1-3 meters	Semi-private	Sufficient	Yes
	Preparing raw materials for food	Morning/afternoon 2:00-5:30 11:00-1:30	Living room/ Outdoor kitchen	1-3 meters	Not-private	Sufficient	Yes
	Washing clothes	Morning 3:00-5:30	Washing and hygienic area	8-10 m	Not-private	Sufficient	Yes
	Milking the goats and camels	Morning/afternoon 1:00-2:30 11:30-1:30	Animal barn	8-10 m	Semi-private	Not-sufficient	Yes
Group							
Indoor	Making artifacts *"senel"*	Mid-day 5:30-7:30	living room	Main house	Semi-private	Sufficient	Yes
	Drinking coffee with neighbours and family members	Mid-day 5:30-7:30	living room	Main house	Not-private	Sufficient	No
outdoor	Chilling and chatting with neighbours and family members	Afternoon 2:00-10:30	Outdoor sitting area	3-8 meters	Not-private	Sufficient	Yes

	Going to the urban sections to buy goods for herself and her child. (Casually)	Afternoon 9:00-10:30	Urban place	More than 12 meters	Not-private	Sufficient	Yes
	Talking care of the cattle's	Afternoon 11:00-12:30	Animal barn	8-10 m	Not-private	Sufficient	Yes
	Preparing materials to make the dwelling	Afternoon 10:00-10:30	Outdoor sitting area	1-3 meters	Not-private	Not-sufficient	Yes
	Talking her kids to a hospital for vaccination. (Casually)	Afternoon 10:00-10:30	Urban place	More than 12 meters	Not-private	Sufficient	Yes
Special ritual activities							
Activities related to being nomads (Outdoor)							
Group	Making the dwelling units *(performed in groups)*	Morning/afternoon 2:00-5:30 11:00-1:30	On chosen site	On site	Not-private	Sufficient	Yes
Individual	Making the dwelling units *(performed in groups)*	Morning/afternoon 2:00-5:30 11:00-1:30	On chosen site	On site	Not-private	Sufficient	Yes
Religious rituals							
Group	Going to mosque once in a while when there is one near by	Morning 3:00-5:30	Urban place	More than 12 meters	Private	Sufficient	Yes
Individual	Praying	Morning 3:00-5:30	Outdoor shade	8-10 m	Private	Sufficient	Yes

Table 5. 22: Activity study table_ Dubti life story 2

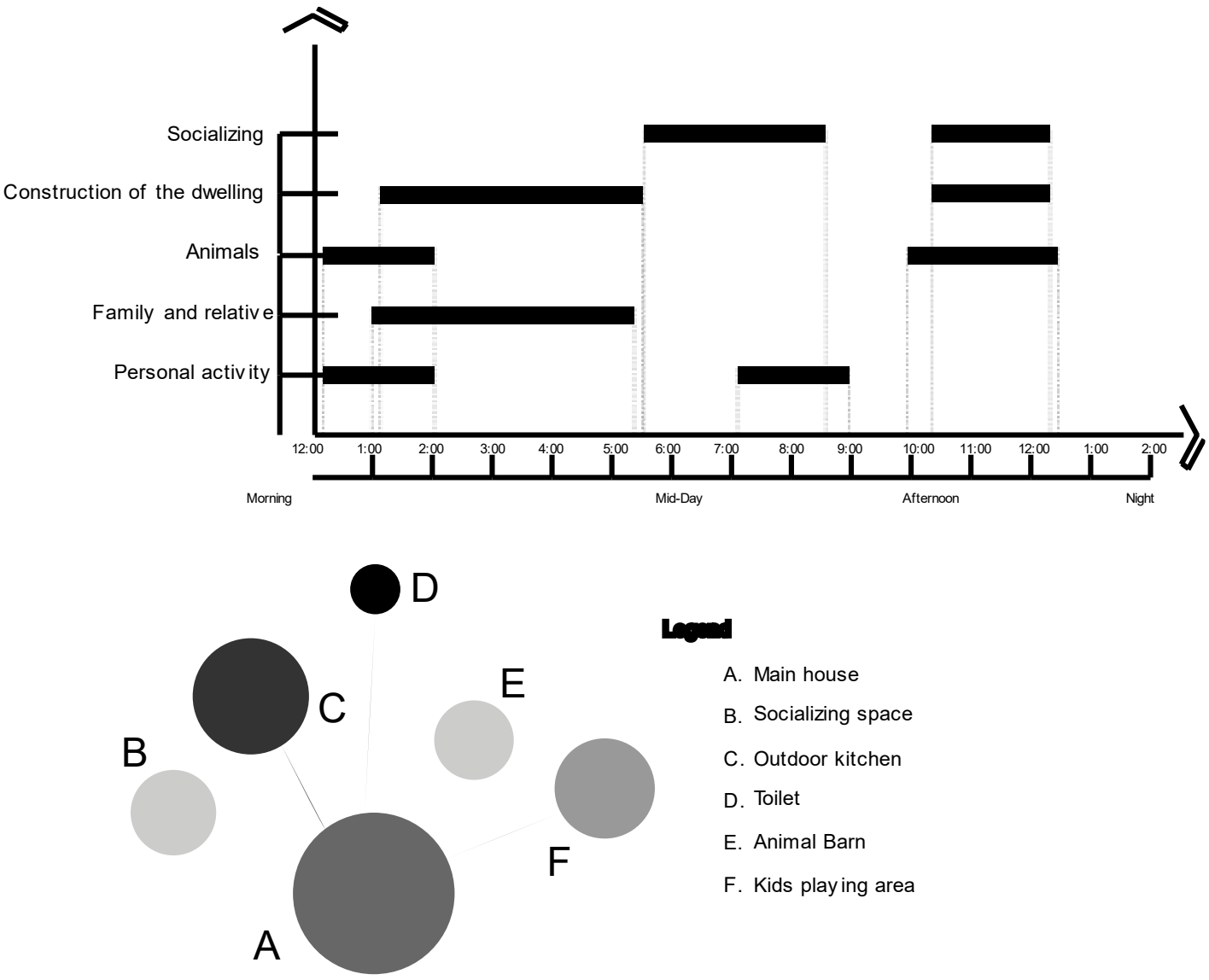


Figure 5. 18: Activity study figure and bubble diagram of_ Dubti life story 2

Life story- 3

Dubti site

- *Introduce yourself and your family in detail*

Mrs Faiza Nuredin is 48 years old widow with three grown kids who no longer live with her except one. She is currently living in the same neighbourhood as her youngest girl. She claims that she gets a lot of help from her kid. She is a nomad her whole life it's a life that she knows she couldn't be sedentarized she have tried it after her husband died but she can't. She is not the first generation of nomadic women from her most of her relatives has passed away. She explains being a nomad gave her some satisfaction she gets the pleasure of practicing this way of life. She also has some cattle's that her son in law takes care of, she loves her grandchildren very much and they gave her joy. Her husband left herding his numerous livestock looking for grazing land. He gave her a few goats and two camels to take care of the kids. To choose the temporary areas the first criteria is it near to any natural resources like vegetations, hill areas and water. Also, they check if it's clean safe and suitable to live in.

Faiza supposes that this way of life gave her a sense of freedom and belongingness everywhere. she also emphasized that in the life of traveling and mobility he will be able to see and spends time close with her grandkids in addition to socializing with her relatives. Faiza emphasizes the struggle to get public facilities easily especially health centres. She said her husband died because they couldn't find a hospital nearby. She noted finding a hospital and clean water for drinking is very difficult. The income source came from selling goat milk that her son in law takes care of it. For the time being her husband brother will take care of that. Small water sources could be from rivers and small ponds nearby. She used wood fire as energy sources to cook and light up space.

- *Position of women*

She is the owner of the house. She builds it with her child Nehmiya.

- *Social intercourse*

She helps other women when they are building their dwelling. She drinks coffee to take care of neighbour kids and relatives. Help her neighbours when preparing food.

- *Design inputs and construction of the dwelling*

She will package and store it on a camel when it's time to start traveling to the next destination, it will take her from 15-30 minutes. Faiza told us she enjoys the indoor environment she likes her privacy and most of the time she rests since it's also a multifunctional space she can do her chores inside. The following activities will be carried out by Jemila in an indoor environment: Cooking, bread making our main food, prepare food, grinding raw materials for making food, wash clothes, playing with her grandchildren, milking the cows. By night time mostly after 11:00

and 12:00 she also likes to take advantage of the cool air and chill with her neighbours. The immediate surrounding is used by herself and kids. She has in total one (1) camel and eight (8) goats. She usually buys the raw material and weaves it.

- *Its performance*

She said it's the performance of the dwelling is very efficient and the indoor environment is very cool.

Grouped Activity Daily activities		**Time**	**Space tag/ Name**	**Proximity** ***(to main house)***	**Privacy**	**Lighting**	**mobility** ***(Does it allow)***
Individual							
Indoor	Sleeping	Night 3:00-11:30	Bed room	Main house	Private	Not-sufficient	No
	Washing	Morning 12:00-12:30	Washing area	3 meters	Semi-private	Sufficient	No
	Using toilets	Morning 11:30-12:00	Outdoor toilet shade	8-10 m	Private	Sufficient	Yes
	Cleaning the house	Morning 1:00-1:30	Main house	Main house	Semi-private	Not-sufficient	No
Outdoor	Organizing and cleaning the surrounding	Morning 2:00-11:30	Surrounding	3-8 meters	Not-private	Sufficient	Yes
	Maintaining the tent	Morning 2:00-11:30	Surrounding	3-8 meters	Not-private	Sufficient	Yes
	Cooking	Morning/afternoon 9:00-3:30 12:00-1:00	Outdoor kitchen	1-3 meters	Semi-private	Sufficient	Yes
	Washing clothes	Morning/afternoon 2:00-5:30 11:00-1:30	Living room/ Outdoor kitchen	1-3 meters	Not-private	Sufficient	Yes
	Milking the goats and camels	Morning 3:00-5:30	Washing and hygienic area	8-10 m	Not-private	Sufficient	Yes
Group							
Indoor	Making artifacts *"senel"*	Mid-day 5:30-7:30	living room	Main house	Semi-private	Sufficient	Yes
	Drinking coffee with neighbours and family members	Mid-day 5:30-7:30	living room	Main house	Not-private	Sufficient	No
outdoor	Chilling and chatting with neighbours and family members	Afternoon 2:00-10:30	Outdoor sitting area	3-8 meters	Not-private	Sufficient	Yes
	Going to the urban sections to buy goods for herself and her child	Afternoon 9:00-10:30	Urban place	More than 12 meters	Not-private	Sufficient	Yes
	Preparing materials to make the dwelling	Afternoon 11:00-12:30	Animal barn	8-10 m	Not-private	Sufficient	Yes
Special ritual activities							
Activities related to being nomads (Outdoor)							

Group	Making the dwelling units *(performed in groups)*	Morning/afternoon 2:00-5:30 11:00-1:30	On chosen site	On site	Not-private	Sufficient	Yes
Individual	Making the dwelling units *(performed in groups)*	Morning/afternoon 2:00-5:30 11:00-1:30	On chosen site	On site	Not-private	Sufficient	Yes
Religious rituals							
Group	Going to the mosque once in a while when there is one nearby	Morning 3:00-5:30	Urban place	More than 12 meters	Private	Sufficient	Yes
Individual	Praying	Morning 3:00-5:30	Outdoor shade	8-10 m	Private	Sufficient	Yes

Table 5. 23: Activity study table_ Dubti life story 3

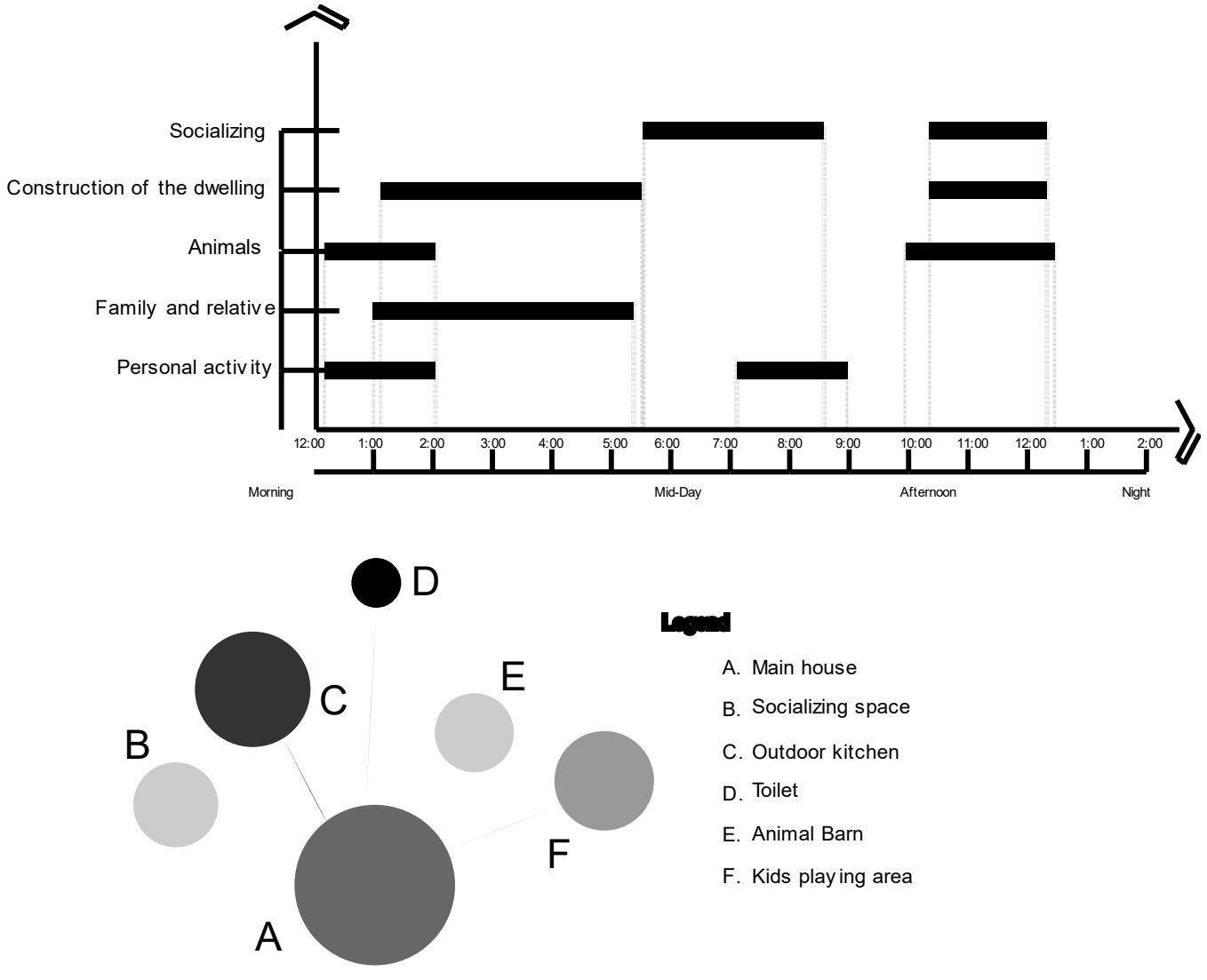


Figure 5. 19: Activity study figure and bubble diagram_ Dubti life story 3

Discussion:

From the above in-depth analysis and life story narrations, we can summarize the spatial usage of inhabitants in a given space. This spatial usage is influenced by age and gender since the activities differ according to gender and age. The same with the analysis sections the activities are grouped in five groups that define the livelihood afar nomads. The following is the grouping of the activities which has detailed activities as presented in the above table.

- Personal activity
- Family and relative
- Animals
- Construction of the dwelling
- Socializing

These activities also define the spaces where the activates occur. To elaborate personal activities are activities related to intimate privacy like taking a shower and using a toilet etc. as it can be shown in the pie chart there is a fair time allocation and distribution of these activities. The activity is carried out in a private outdoor space. Most of the time small children are accompanied by their mother to take the activity. On the other hand, family and relative activities are carried both in the indoor spaces as well in outdoor space. Women do spend most of the time in these activities. These activities are cooking, preparing food, cleaning the household and taking care of the kids. Next activities that relate with animals such activity is related with taking care of the animals and protecting them. More men and kids are involved in this activity. Construction of dwelling is carried out by the women. Following socializing with other relatives and with each other has a fair distribution among the families but it's a bit strong with the women. Most of the socializing activities are carried out in outdoor space.

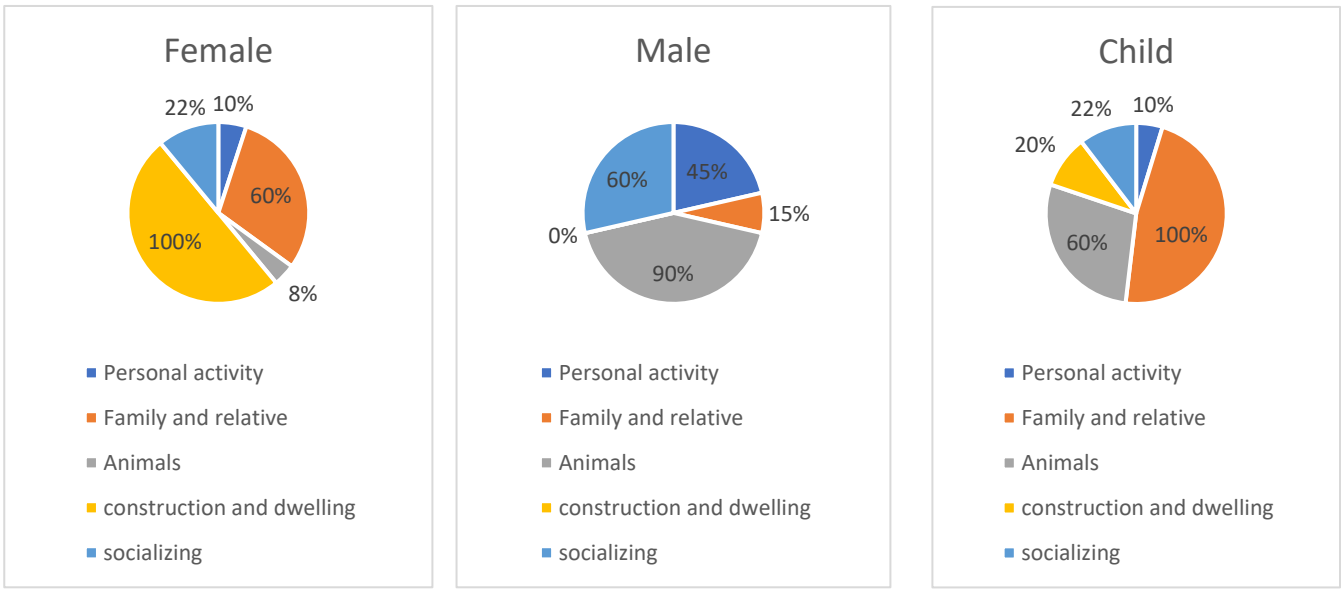


Figure 5. 20: Activity distribution and allocation of Female, Male and a child

5.4.2. MATERIAL AND PHYSICAL STRUCTURES STUDIES

Summary of **focus group** discussion with afar nomadic vernacular dwelling experts.

In this section summaries of the focused grouped interview will be presented. The group interview focused on the building material and construction process of afar vernacular dwellings. The discussion has been carried out on the Semera site consisting of four women who have experience in building a nomadic dwelling for years. The Afar nomadic vernacular houses are constructed with local material using local knowledge by the owners of the building this makes it suitable because it's accustomed to the spatial need and comfort standard of the dweller. Since the shape of the dwelling are a half-dome structure the roof structure and cover, column, and wall surfaces are all connected and one structure. The experts of these dwellings are women. They learnt the skill from their mother.

Every dwelling is constructed by women this promotes marriage since they are the only ones who can build it this makes the role of women very strong in the afar nomadic communities. When they were young girls, they start practicing constructing the dwelling with their mothers and master the workmanship and production of building material as well. When the girl marries for the first time her mother will help her to build her first house before she leaves her parents and starts her own life. Before construction, the women collect, modify and produce building materials used to build and new dwelling also modify an existing one. Following there is a summary of how they process the building materials and construct the dwellings discussed briefly.

5.4.3. DESIGN DECISION AND MATERIALS

'selane'

Textile and plant artefacts both woven and unwoven have been used as an envelope and constitutes a significant part of the Afar culture. They collect and handcraft materials through simple modification. They use tree products to build and fabricate materials for the construction of their mobile dwellings. Making soft finishing and envelope provide several benefits: the raw material (plant) from a local plant called *"UNGAYUTO"* is available, the production does not require an established workshop and the soft artefacts can be foldable, stackable, and light by nature of the material. Especially as a result of living in nature and not having structures to protect themselves from cold or insects. Applying a smock on the material will make it durable

and insect repellent. The material has been part of afar nomad's material culture. The material will gain its insulation property when its layer on top of the other.
Since afar nomads construct the same living spaces, namely tents, both in summer and winter, the tents need an insulating material that should also be easy to carry and assemble. The layered material used as an envelope will have good insulation at the same time being flexible to pass air. Thus, afar nomads utilize their already accessible material, namely plant residue and branches, to produce all their envelopes and structures. They not only weave but also felt, which has a firmer structure and provides a better insulation structure.

In the next section, I will specifically discuss the covering envelope materials used as facades and examine their connections to climate to discuss the entangled factors. The material is made by weaving in two- or three-dimensional forms. With the help of warmth and smocking, and following their flexible and elastic nature, the fibres are entangled in intended forms that can be resulted in artefacts like shelter and covers for the structures. The tight entanglement of fibres provides a closed surface that offers a suitable structure to protect from weather depends on the layering to which weather it fits and beetle-like animals. On the other hand, the rawness and simplicity of felt as a material can reflect the simplistic thinking of afar nomads in a sustainable way.

Structural materials

Structural materials are strong tree branches that can bend. It's found locally and used without that much modification. The structures might be connected to create the desired size and space. They mind the space between the structures since they might change the position of the door according to wind directions and access of the sites since it also defines the privacy daylighting.

Tree branches from the following trees can be used as a structural material. ***"Weyane" "mechanita" "adengali" "Eieibito" "tikbli" "damehu" "alayito".*** After modification of slight bending and hardening using smocking, it can be used numerous times. In addition, it makes it easy to disassemble, pack and store ready to be used for next time. Construction steps are explained briefly below.

Producing construction materials is highly influenced by a lot of factors. For instance, nomadic lifestyle and mastering craftsmanship including camel breeding affect managing the material and climate so the material is generated through camel breeding indirectly. In return, façade/

envelope material making can affect camel breeding as well since people will travel more in need of raw material based on their needs, they may increase their mobility and travel time.

Differently, the material affects the making space since it requires a certain organization of space for suitable ways of practicing. However, the making space can exist on its own without requiring a material or practice. Therefore, the relationship between material and making space creates one-way dependency.

Construction process and materials

The first thing they did is to allocate an appropriate site as per their needs. The major thing they see is natural vegetations and shades nearby safety and access. One they make sure that the place is good to temporary settle then they unload their packed building material to build the dwelling then build barns for their livestock according to their number after deciding the rough placement of the barn their dwelling and access. using simple wide spiny branches from around then logging their animals in their barn.

Next, they collect enough stones to support the structures all the women will participate in the construction of the dwellings. Next, they start digging holes to approximately 20-25 cm depth that serves as foundations. When they finished digging the holes, they organize the structures and decide on the shape and size of the dwelling. There are different types of afar nomadic vernacular dwellings. They are different in shape very slightly and size. This difference came from the size of families, building material quality, know-how and knowledge of the construction of the dwellings and the intended time they are going to stay in the area.

After they decide the type referring to their building material, they start inserting the structures into the holes. Depending on the desired structural strength up to eight structural studs might get tied together and serve as one structural part. After fitting all the structural studs, they start refilling the holes with soil and stones for much strength. Following they add on horizontal studs and tie them together. Finally, they add the envelope layered in the desired angel considering later modification in addition they decide on the location of the door. They clean the interior and organize their furniture’s accordingly.

5.4.4. DATA PRESENTATION AND DISCUSSION FROM OBSERVATION

Data Presentation: As described in chapter four of the methods of research the data collected through the researcher's observation were conducted to identify characteristics of Afar nomadic

vernacular architecture by physical mapping. The physical observation was done to identify the type, existing condition and current use of afar nomadic vernacular architectures. Data collected by physical mapping were photographed and presented below. The observation was done at a different time of the day and included different types of character at different locations. The researcher has documented existing characteristics of Nomadic vernacular architecture and factors affecting the thermal comfort of interior spaces and the livelihood of the Afar nomads. The observation organized into three sections.

- Environments including factors affecting both animals and humans.
- The house (exterior and interior)
- People (activities and rituals that are related to thermal cooling)

The above subsections have brief descriptions and pictorial presentation for a better insight into the situation and variables. The observation by the researcher has started from a neighbourhood design and analyse the environmental factors as follows.

Environmental/ Surrounding observation

- Vegetations
- Landforms
- Size and space
- Water bodies
- Fences
- Barn

Dwelling observation

- Exterior
    - Building type (Single story)
    - Building material (light natural interwoven materials, plastics)
    - Plan (circular)
    - Fenestration (openings)
    - Structural detail
- Interior
    - Interior functions and furniture’s

People (activities and rituals that are related to thermal cooling)

Activities that are carried out

- Outside
- Inside

ENVIRONMENTAL/ SURROUNDING OBSERVATION

Regarding the environment, it's one of the important factors for the choice of a given place by the nomads. When the nomads chose a place to settle, they consider the following factors. Each has its point in the decision making of choosing a specific temporary settlement area.

- Access

Access is important in selecting a given area as a place to stay temporarily. Ease of access means they can hear their livestock smoothly, it's safe in a sense for their kids to play around, they can get transportation to urban areas and if the main road access is near, they can sell their milk just walking there and offering their products under the shade. As it can be seen from the picture below all location in both sits has good access to the main road.

Figure 5. 21: Figure showing Access pints of the study area

- Vegetations

Vegetation is also significant in providing shade. Most of the nomads search for at least a few vegetation it defines space, cool the environment filters dust, serves as a shade and gives more privacy for the place in general.

Figure 5. 22: Figure showing vegetation of the study area

- Landforms

Nomads carefully examine landforms before settling even its temporarily settlement. The difficulty of the construction depends on the landform because it involves digging. Privacy is

also influenced by the landforms because most confidentially private activities are carried out in outdoor environments.

Figure 5. 23: Figure showing Landforms of the study area

- Size and space

Most of the time when Afar travellers choose their neighbourhood, they consider its size especially if they have a lot of cattle like camel and goats. Since they also used the outdoor space for a lot of activities.

Figure 5. 24: Figure showing size and space of the plot area

- Water bodies

Another essential environmental element is water bodies they always prefer to stay around water for their animals and it cools down the area.

Figure 5. 25: Figure showing nearby water bodies of the study area

- Fences

Some of them use fences the others don't. it's a personal preference and the safety of the place also depends on how many animals they possess.

Figure 5. 26: Figure showing fences of the study area

- Barn

They build barns out of spiny branches both for the safety of the animals it also very effective in serving the purpose of guarding the animals against escaping.

Figure 5. 27: Figure showing barn of the study area

Dwelling observation

- Exterior
    - Building type (Single story)

All afar nomadic buildings are single-story buildings.

Figure 5. 28: Figure showing the exterior appearance of nomadic afar vernacular architecture

    - Building material (light natural interwoven materials, plastics)

As it can be seen from the picture the natural material is “selen” however the scarcity, the price and the time the material takes making them change to a plastic cover which reduces the efficiency of the material.

Figure 5. 29: Figure showing different envelope covers

- Plan (circular)

The interior plan is circular.

Figure 5. 30: Figure showing the geometrical

- Fenestration (openings)

as it can be seen in the picture the door is the opening the other is a temporary opening that can be opened the others are layers that can be opened 360^0.

Figure 5. 31: Figure showing the opening of Afar nomadic vernacular architecture

- Structural detail

The structures are built by supporting one another its lightweight and the spacing makes it ideal not to block airflow in the interior space of the building.

Figure 5. 32: Figure showing the structural elements of Afar vernacular architecture

- Interior
- Interior functions and furniture's

The interior space of nomadic vernacular architecture is a multi-functional space. It's a bedroom, Livingroom and storage.

People (activities and rituals that are related to thermal cooling)

Activities that are carried out

- Outside

Cooking, washing, milking camels and goats, socializing and kids also play outside.

- Inside

When it's midday they spend most of their times inside. It's a sleeping, storage, socializing space.

Figure 5. 33: Figure showing activities that are carried out inside and outside of the nomadic vernacular dwelling

5.4.5. DOCUMENTATION OF AFAR VERNACULAR ARCHITECTURE

Environment

Nomadic people do not orient themselves in a space according to the physical measures and cardinal points, but along the paths or directions in response to topographic features in the natural environment. Hence the characteristics of the environment they temporarily settle influence the probability of staying in that place or not. Different environments have different characteristics despite being located in the same country. nomadic afar communities usually prefer surrounding that has different spatial qualities. As it was discussed in the previous section's ease of site access vegetation, rocky area and sites with water bodies are preferred. For instance, the rocky areas will give them the privacy they need to do confidentially private activities, the water bodies serve the site as an AC. Following this will be demonstrated using site plans. The settlement organization once the site was selected depends on social hierarchy and personal preference. The houses can extend from two to numerous dwelling units again, this is influenced by the number of livestock they own.

Site plan/ mobility

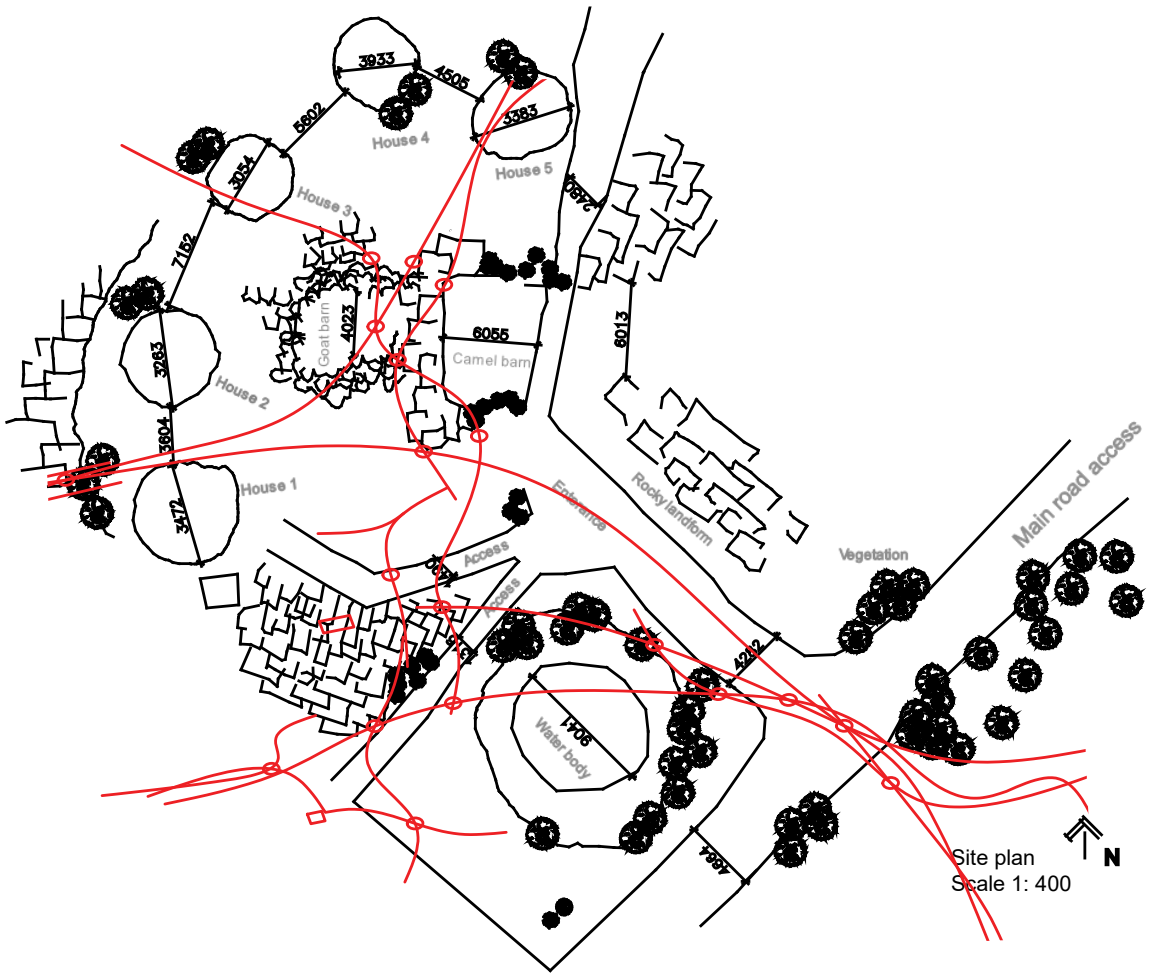


Figure 5. 34: Site plan of the selected study area

Zoomed in site plans

House_1 / Access

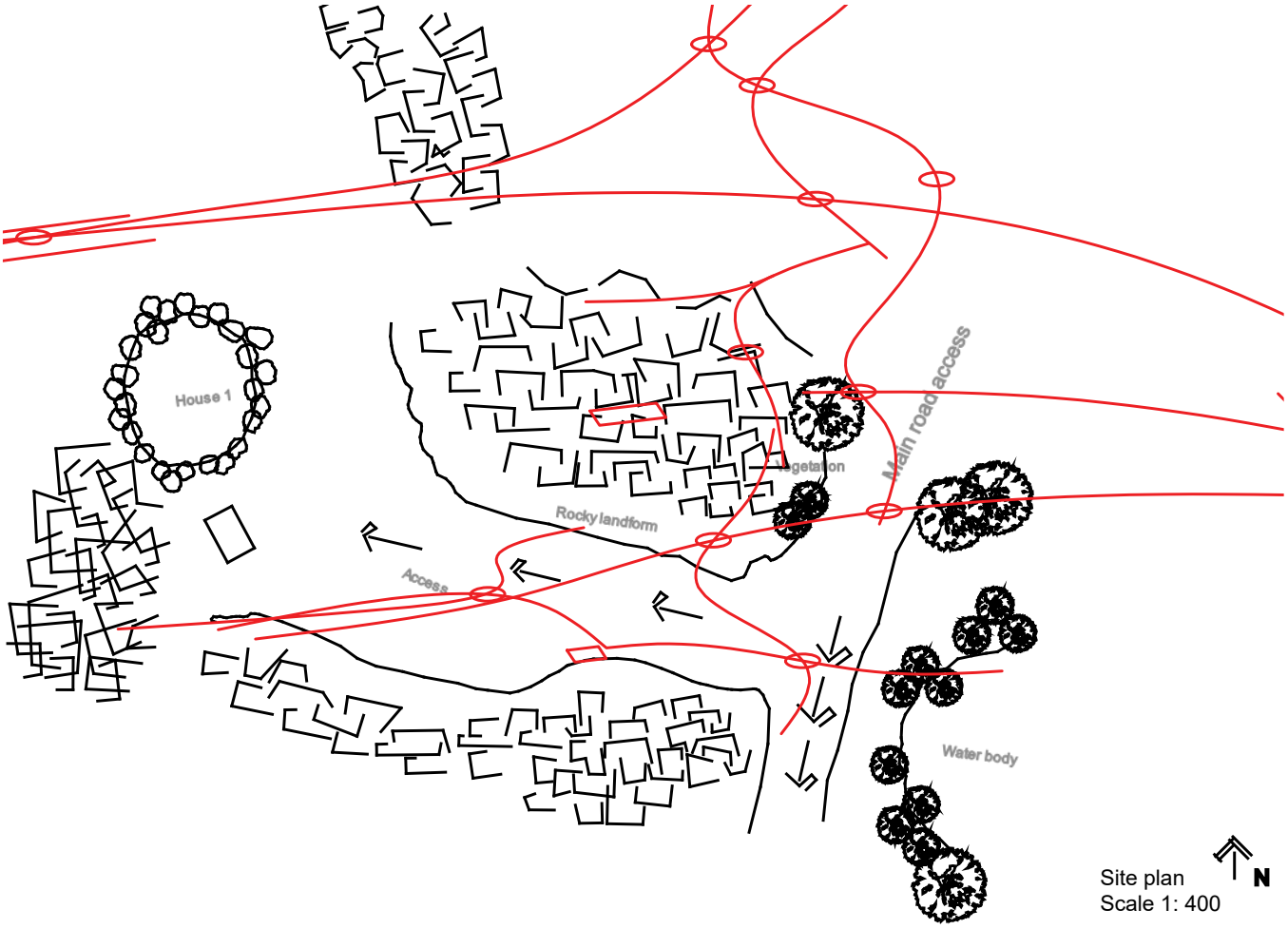
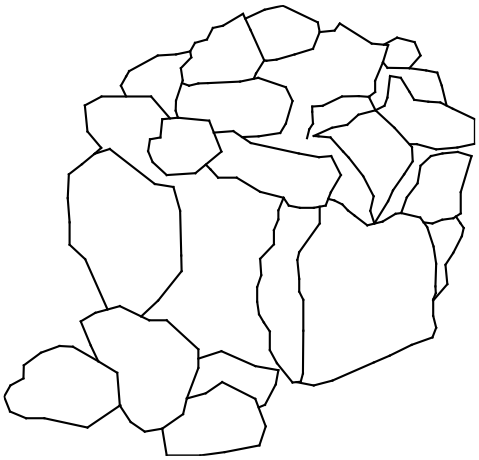


Figure 5. 35: Figure map showing access for house number 1

Site elements



"Gudataa": It's one element of the site that calves are kept to protect them from the harsh weather. Its usually located around the house to keep eye on the calve also develop the connection with their mother. The proximity helps to transport and take care of the calves. It's constructed using rocks the bottom structures have bigger and heavy stones on top smaller stones were placed packed to create a shade as well have a hole for cooling air circulation.

Figure 5. 36: Figure showing site elements of the site

House_1,2,3_ Barn _ Spaces designated for social activities

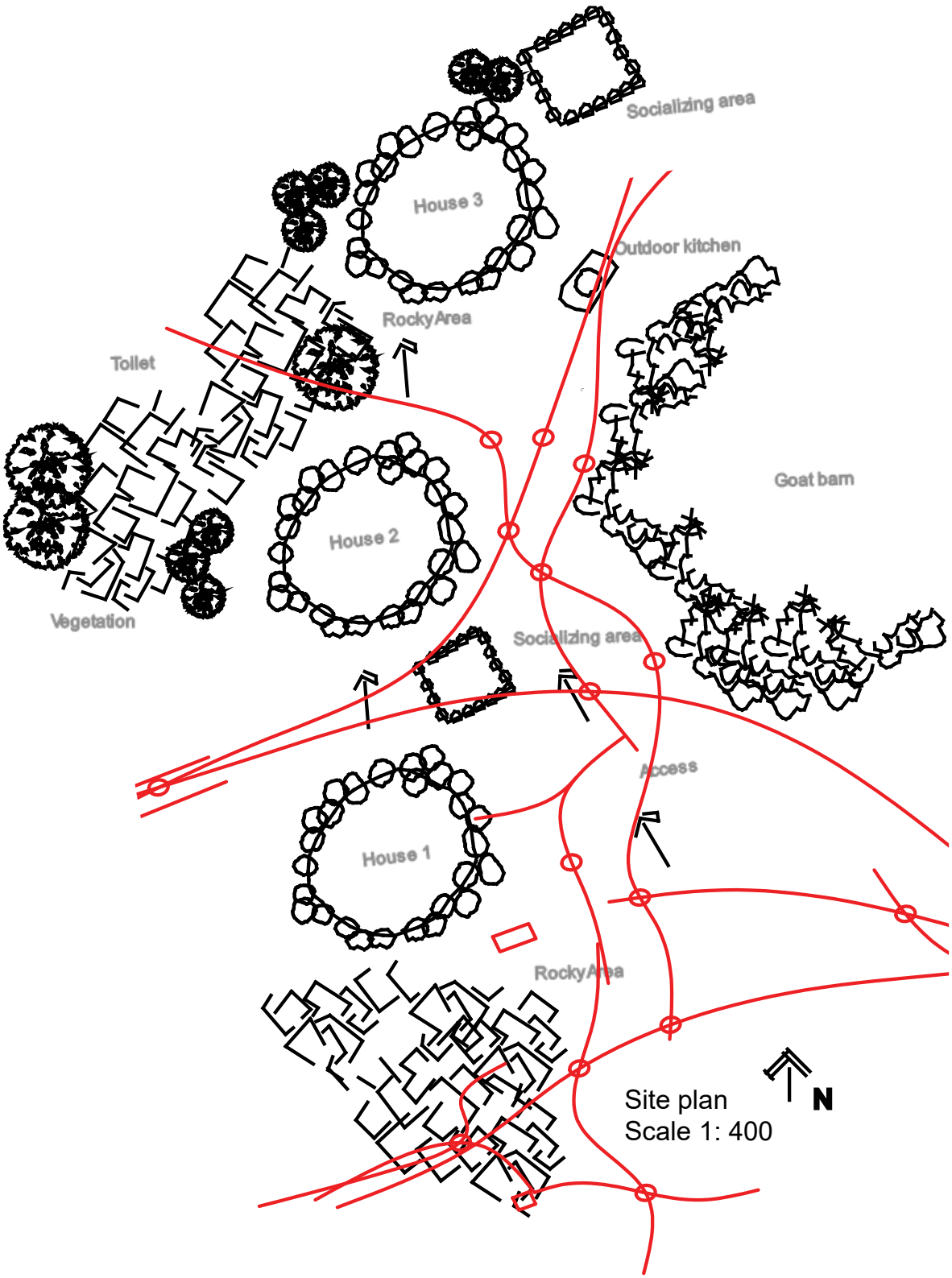


Figure 5. 37: Figure showing a map for activities for house number 1,2,3

House 4,5_ Barn _ Spaces outdoor activities

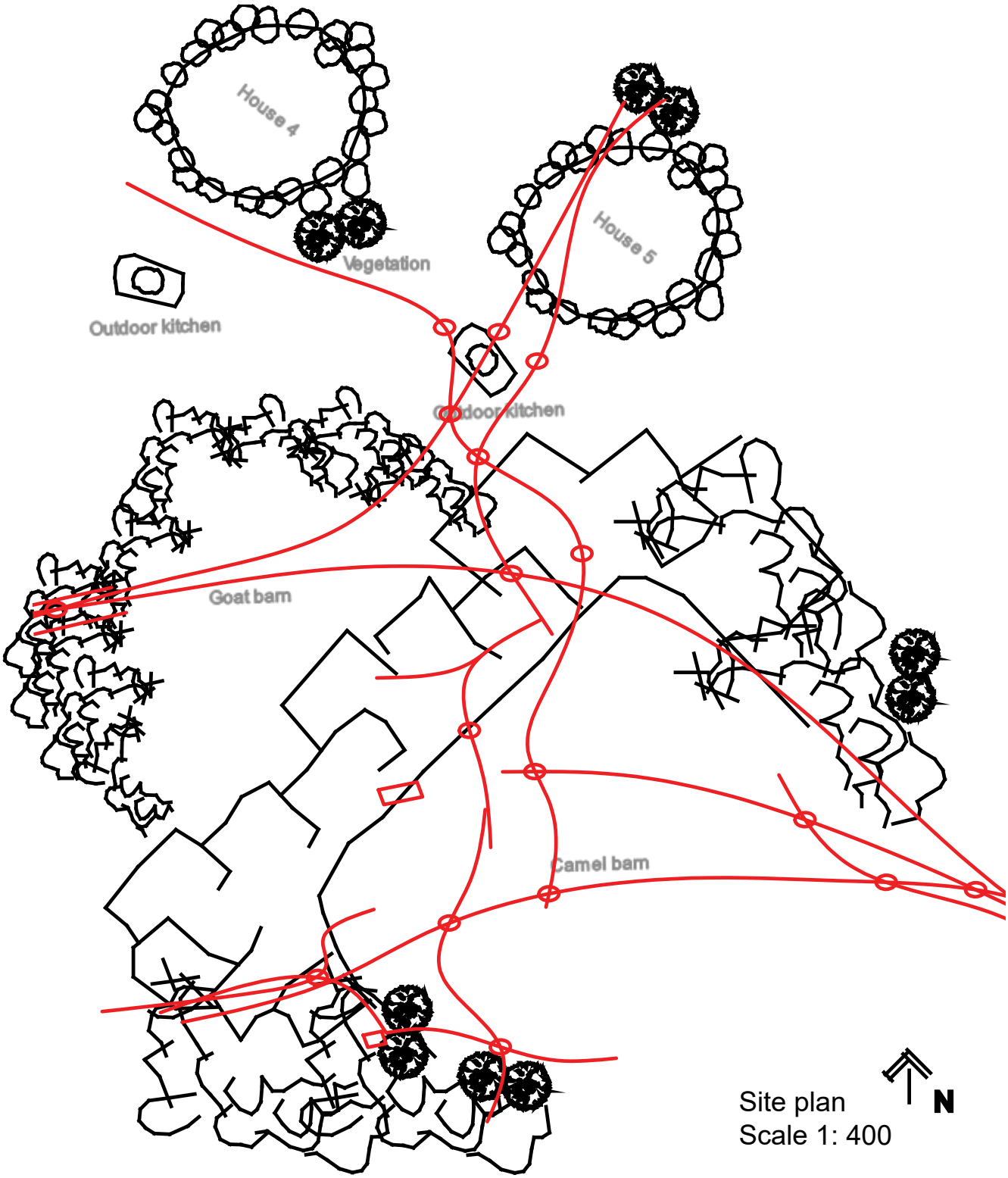
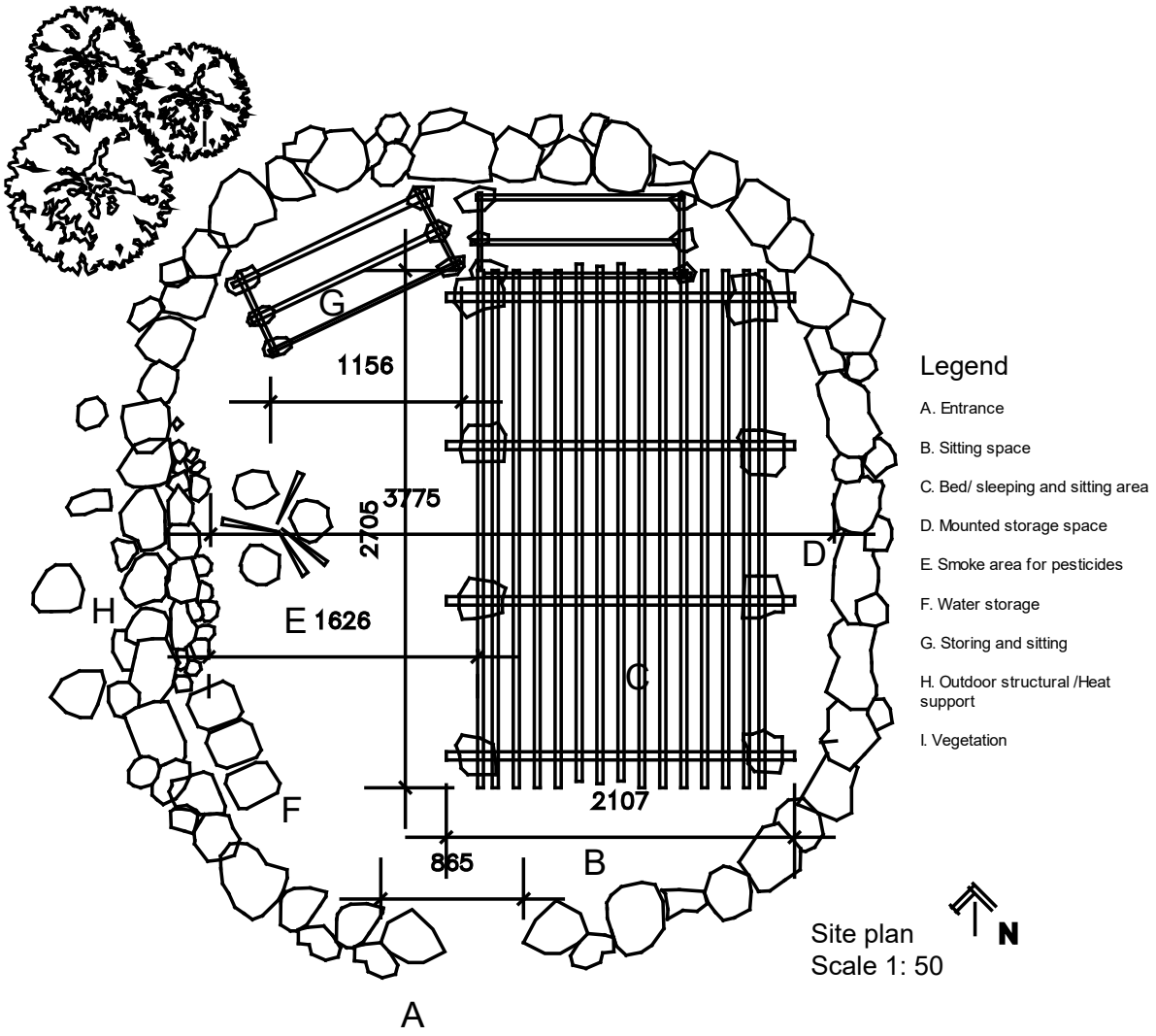


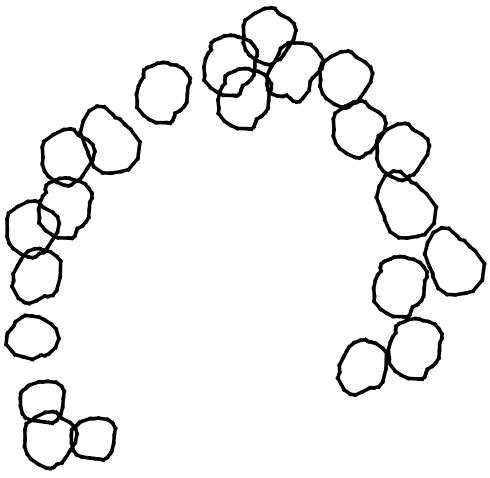
Figure 5. 38: Figure showing a map for activities for house number 4,5

The house **(Q'ari)**

- Plan/ measurement and space tagging



Outdooor milking space



Smaller tent for social gathering

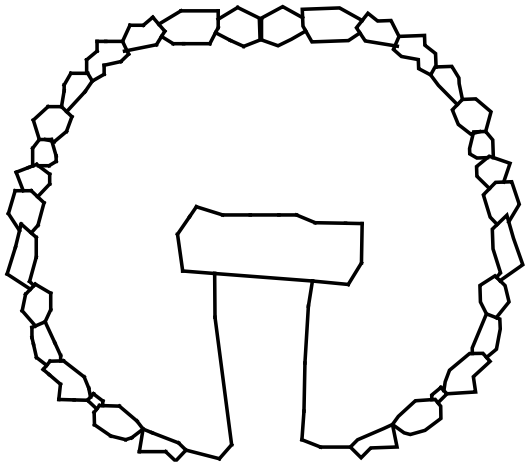


Figure 5. 39: Figure showing a plan of afar vernacular architecture

- Elevation

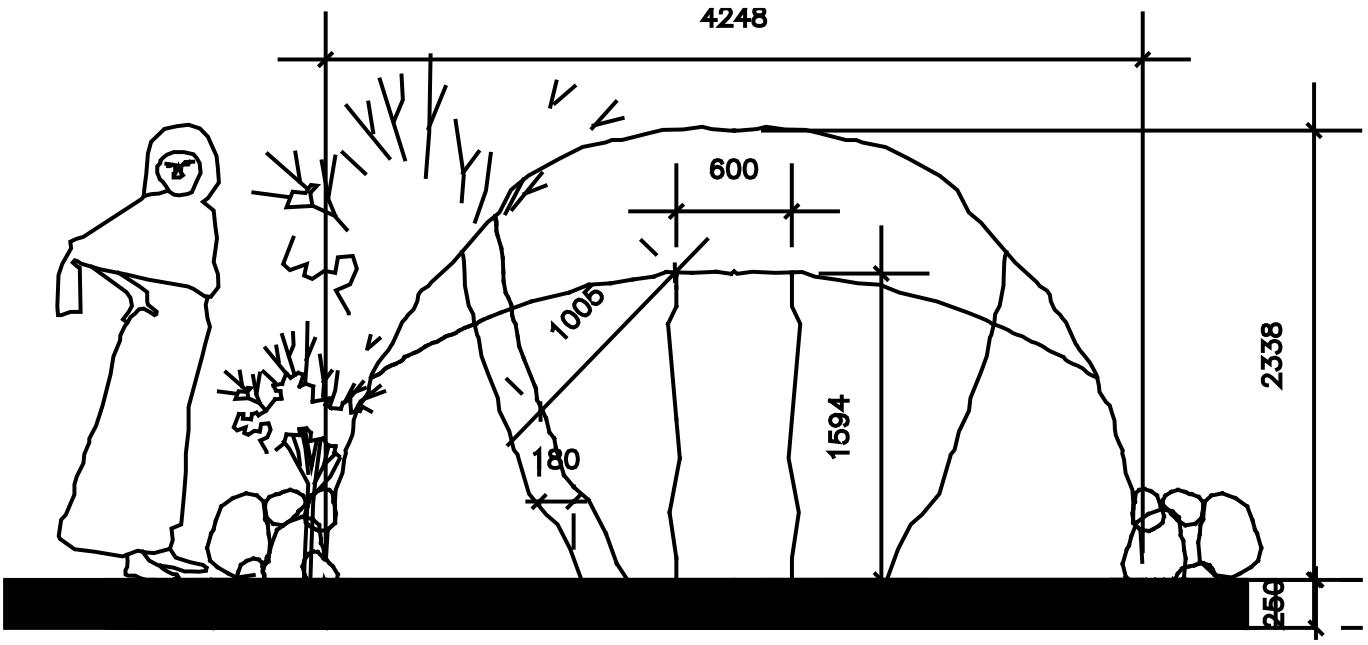


Figure 5. 40: Figure showing elevation of nomadic Afar vernacular architecture

- Structure/ Detail

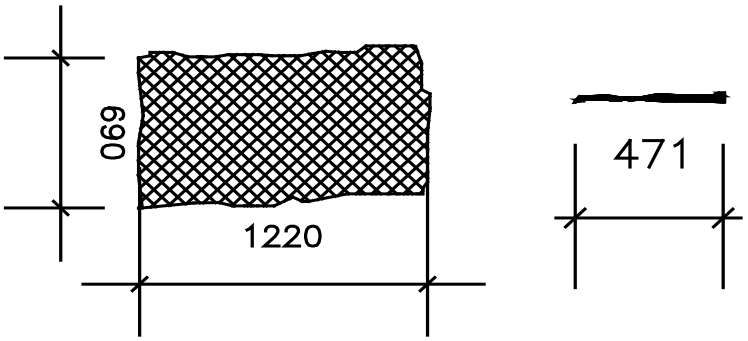


Figure 5. 41: Figure showing the material used to build their dwelling envelope

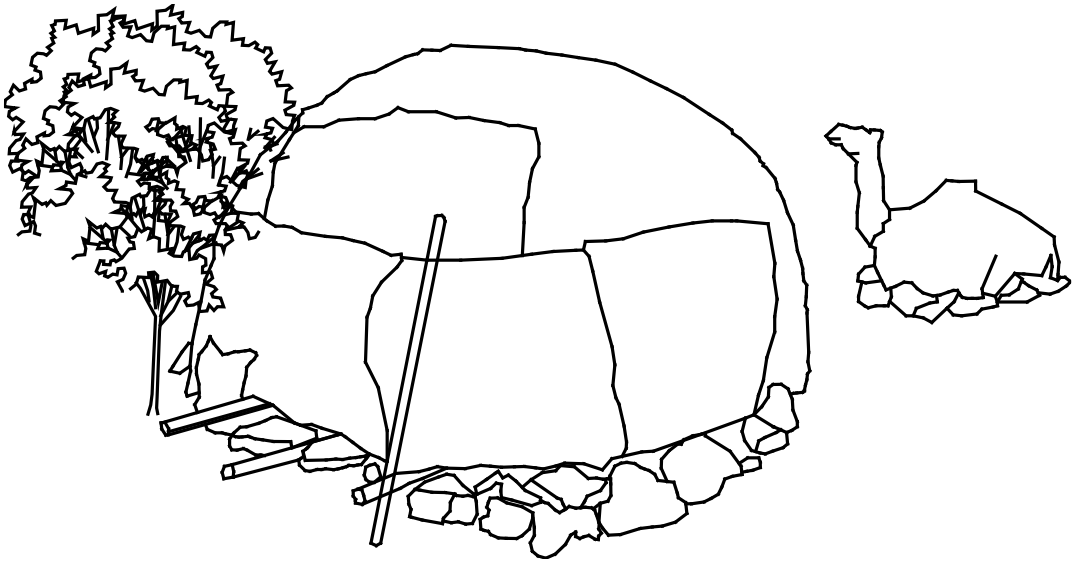


Figure 5. 42: Figure showing illustration of “Qari” the dwelling of Afar vernacular architecture

- Structural illustration of the Afar dwelling unit

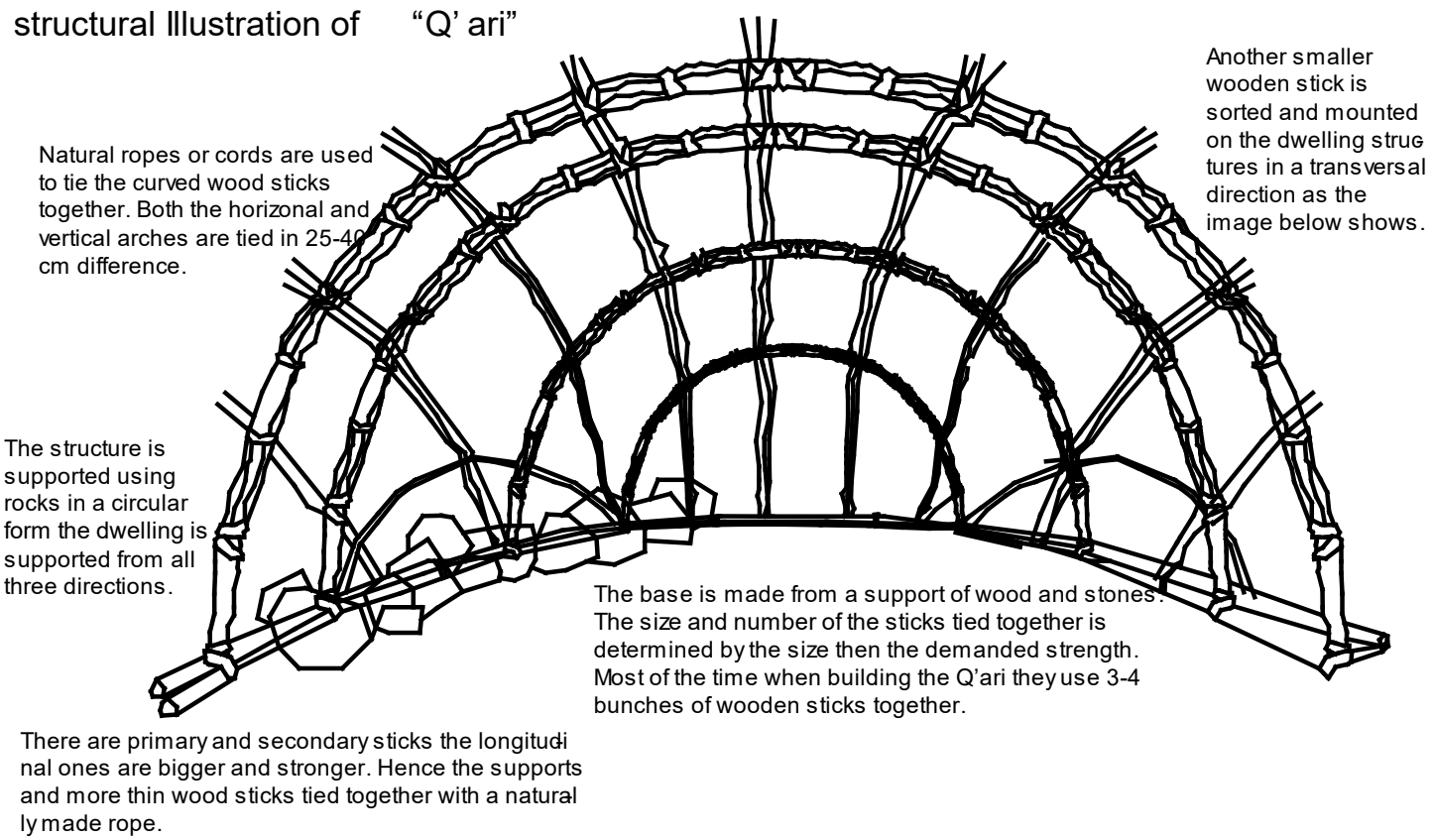
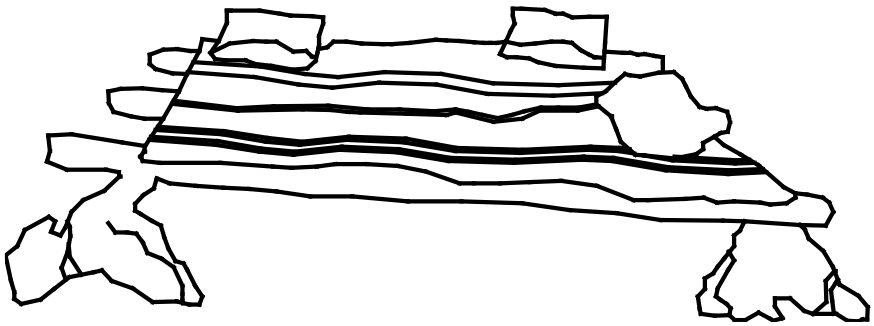


Figure 5. 43: Figure showing an illustration of structural elements of "Qari"

- Furniture/ Activities
    - Outdoor cooking /Socializing space

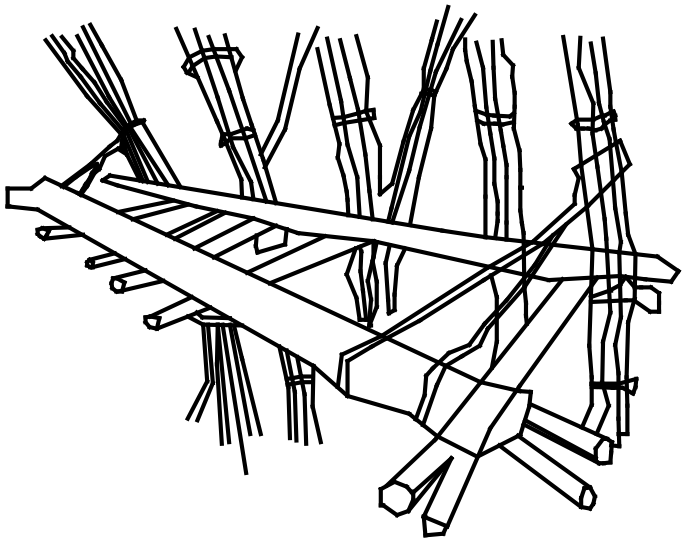
Sleeping and sitting



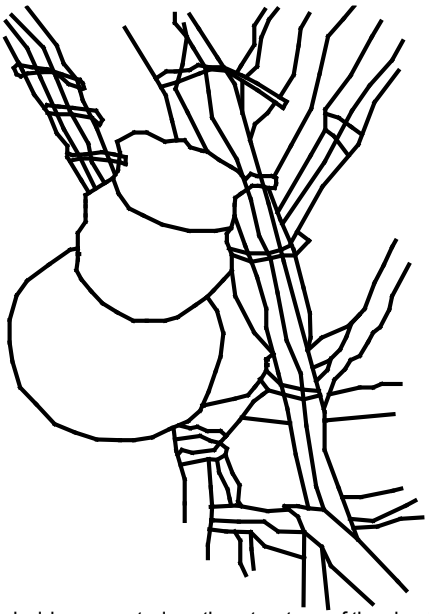
Most of the furniture's consists of mobile components. The furniture's are built using local materials found on the site for example the bed is built from a log or stone stands and layered vertically oriented wood panels that can be used as structural support. Then they put a foldable structure that is made from a very thin stick. The bed is multifunctional in the day time they used the bed as sitting place in addition to sleeping.

Figure 5. 44: Figure illustrating sleeping and sitting area

Store



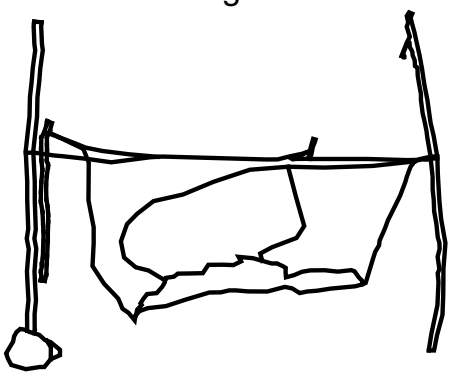
Hand crafted suspended interlocking wooden framed used as a drawer that can be used to store different things.



Leather holder mounted on the structure of the dwelling. Its usually mounted higher where children couldn't reach it. Th nomads used this for placing and hiding their weapon.

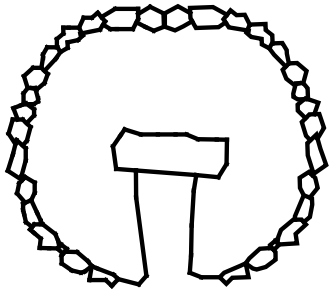
Figure 5. 45: Drawing showing the storage technique of the Afar pastoral nomadic community

Outdoor socializing area



In the afternoon when the sun cools down afar, nomads like to relax and socialize in outdoor spaces. They usually put transparent fabric over it to make the space even more relaxing. Above it can be Cleary seen how the space is constructed.

Indoor socializing area

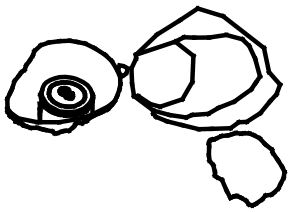


When it's a day time they also socialize however, not in the outdoors they have a special place constructed and designated for this purpose. As it can be seen above it relatively smaller space but comfortable to socialize and relax in day time.

Figure 5. 46: Drawing showing Afar people socializing space

Outdoor cooking and food preparation

Afar nomads carry out their kitchen duties in the outdoors in the morning and in the afternoon when the weather is cool. Cook ing outdoors protects the indoor environ ment from extra heat. They also have a special stove that is built underneath the ground level this will also keep the heat far from reach and affects the environment.



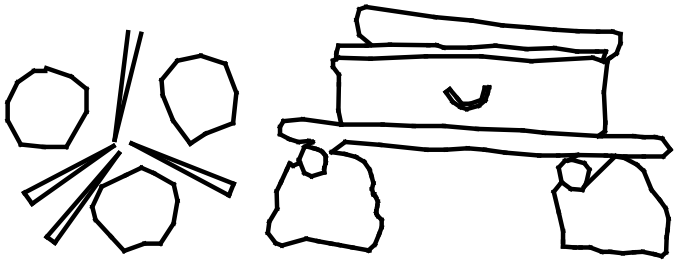
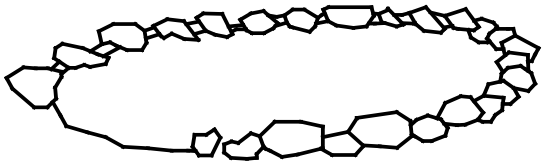


Figure 5. 47: Figure showing Afar cooling utensils and space

- Construction process

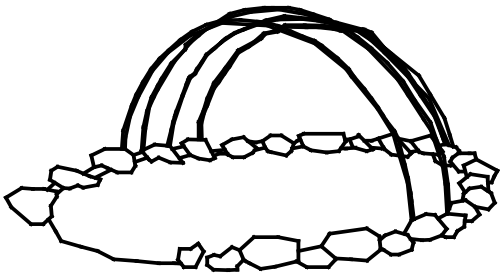
Construction process

The construction process is based on guide and assemblage process of fitting different elements of the dwelling together. In the construction process from 2-6 people might participate depending on the size of the dwelling. This process of construction a dwelling together is important for connecting community members. The different phases of construction are discussed as flows.



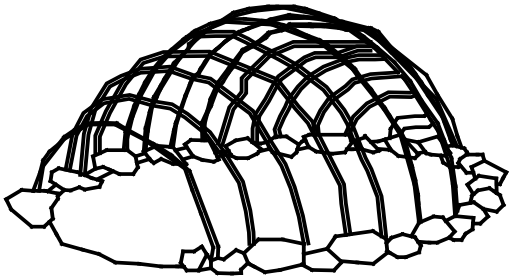
Phase 1

Locating space, cleaning and marking of the actual dwelling plot area. Then transport the materials to the site mainly unloading the materials fro the camel. Following holes will be marked and dug approximately 20-25 cm.



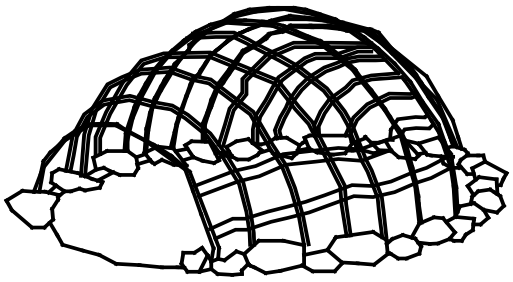
Phase 2

Tying 2-5 sticks together depending on the strength of the sticks and demanded strength. Using these sticks two or more women will start wor ing on the structures. These simple arched wooden sticks will be connect ed together and start forming the semicircle arched structural section in th transversal direction.



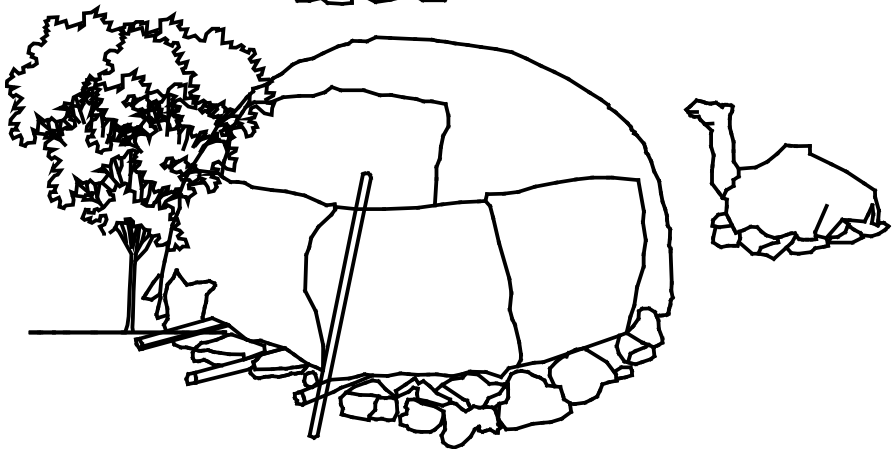
Phase 3

Setting all the main structural sections and defining the form of the dwell ing. This might take from 10-20 minutes depending on the number of individuals participating in the construction process and the size of the dwelling. The gaps between the stick bundles depends on the size and size of the family additionally on the required thermal comfort.



Phase 4

For more structural stability and strength including resistance to wind force they add a horizontal longitudinal arch and bundles accordingly. This will give the structure additional sturdiness. This will be performed by tying wit a cord on the crossing points of the wooden sticks.



Phase 5

Finally, they will put the envelope and opening on top. This process also requires lot of trying to avoid uncovering of the envelope from the structural part. It's performed both from the inside and outside of the dwelling. Approxi mately they use 8-12 average size covers which are naturally woven. They clean the floor of the dwelling and fix their furniture's before inhabiting them.

Figure 5. 48: Figure showing the construction phases of the Afar "Qari"

- Openings/ Ventilation technique _ Animal's barn

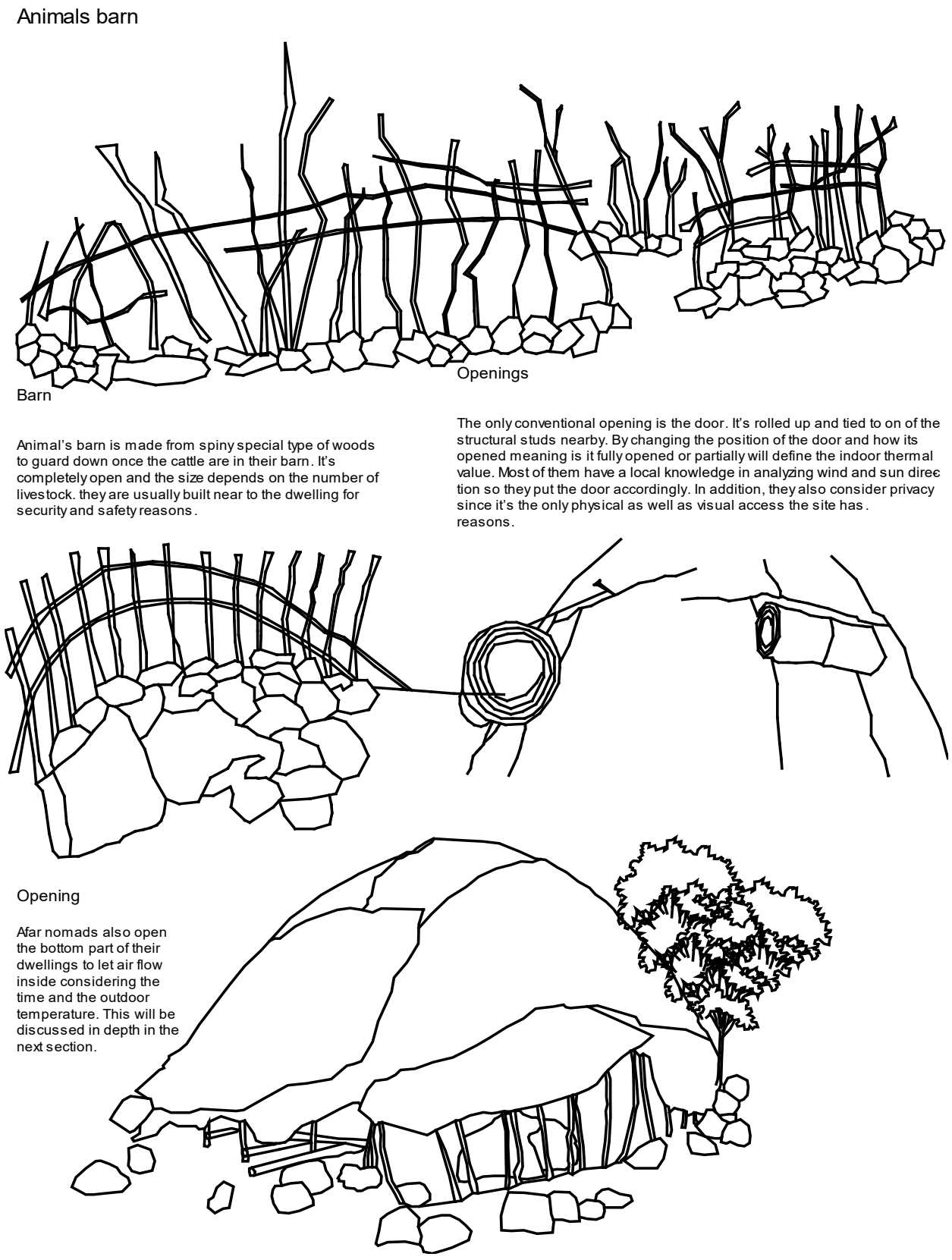


Figure 5. 49: Openings/ Ventilation technique _ Animal's barn

5.5. DATA PRESENTATION AND DISCUSSION ON THE STRATEGIES USED FOR SUSTAINABLE THERMAL COOLING FEATURES OF VERNACULAR ARCHITECTURE OF AFAR PASTORAL NOMADS

Site plan/ Sunlight and wind analysis

Sun path and wind analysis are some of the important local knowledge that the pastoral nomads of Afar apply to their vernacular architecture . Starting from site selection to mounting and building the dwelling all need the knowledge of how the sun moves through and the speed and direction of the wind. These variables play a crucial role both in: Daylighting /Ventilation

For instance, the position of the door is decided considering these factors. This will affect indirectly privacy and social interaction as well. Since the only access to the dwelling is the door. In an interview conducted asking them from where they got this knowledge, it's a knowledge that passes from generation to generation they said. the nomads said it's easily identified if we pay attention to our environment around us. For instance, to understand the wind direction they will see the leaves blowing directions etc. Below there is a site plan analysis regarding the sun path and wind directions and intensity.

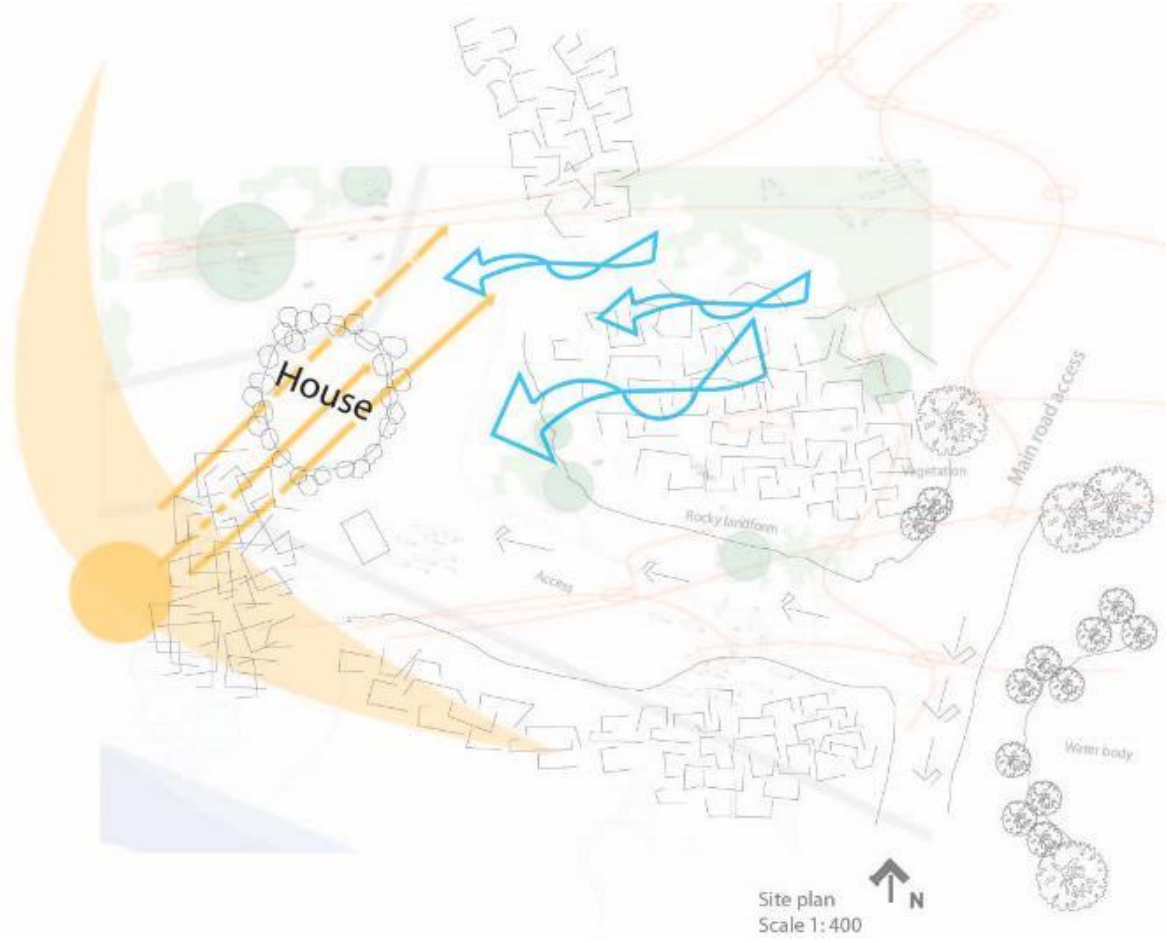


Figure 5. 50: Map showing sun path and wind direction

Airflow diagram

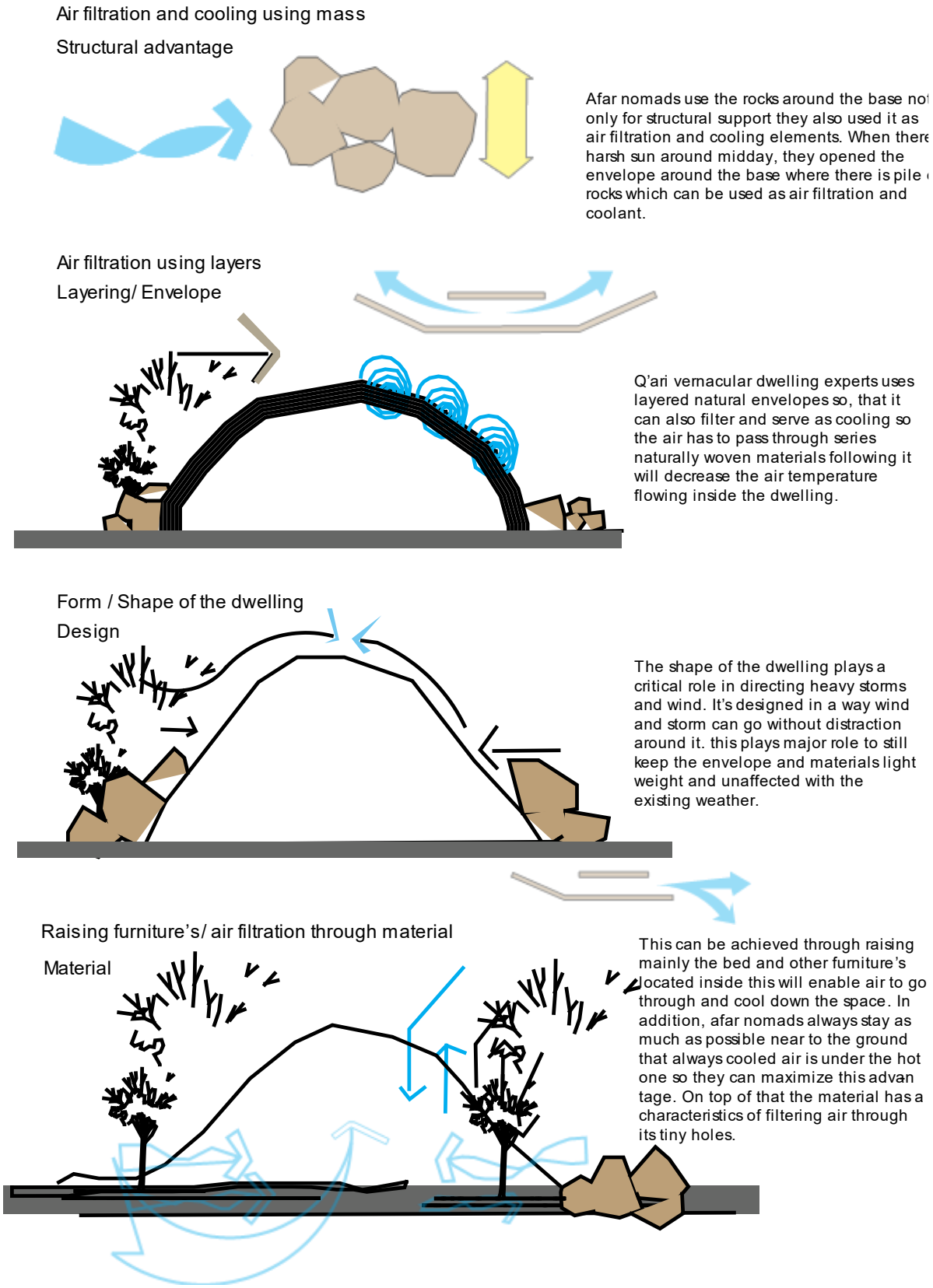


Figure 5. 51: Diagram showing Airflow technique and strategies of Afar pastoral nomads

Daylighting

Daylighting

Daylighting and ventilation depend on the adaptability and flexibility of the dwelling. This can be achieved thro changing the envelope opening pattern of the units. This alone makes afar nomadic houses very adaptable to th existing weather and environment. Below there is a diagram that show how much light and air they will let in du different time of the day. The yellow arches with different sizes show the intensity and shape they will open their door and envelope to maintain acceptable daylighting and ventilation.

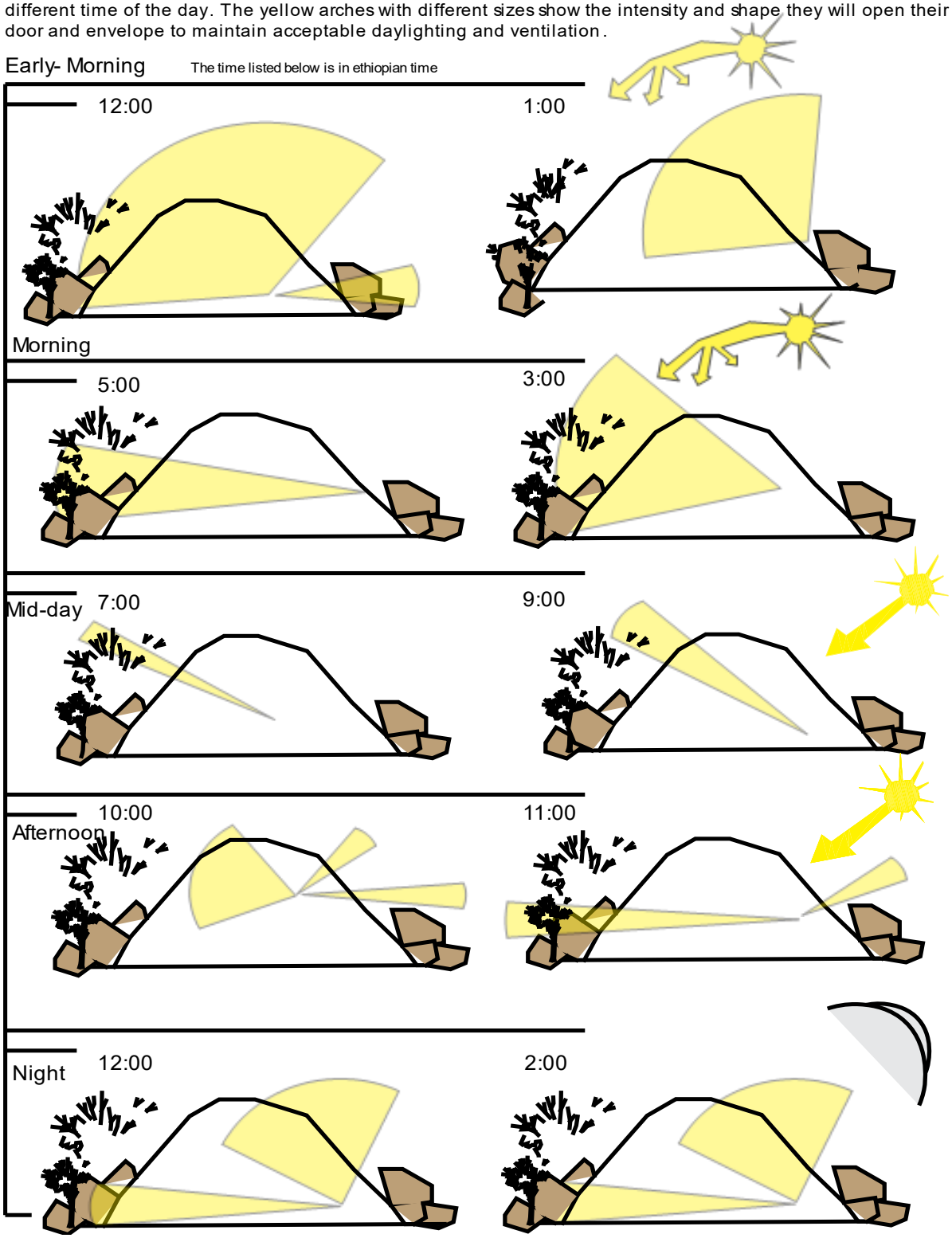


Figure 5. 52: Diagram showing daylighting strategy of dwellings of Afar pastoral nomads.

6. RECOMMENDATION AND CONCLUSION

6.1. CONCLUSION

The purpose of this paper is to analyse and contribute to the development of modern vernacular building in hot and arid climate through the analysis and documentation of lessons from the afar nomadic vernacular architecture that is highly associated with national identity, and utilize the design in strengthening a community. This can be achieved by re-interpreting (understanding) rather than re-using (copying) the technology'. Vernacular dwellings conserve great amounts of energy in a building only by optimization and employing passive strategies in architectural design. In Afar, this can be learned from the existing vernacular design and strategy. The proposed Architectural design was designed considering the extracted principles that will be discussed below. The principles consider socio-cultural factors and traditional passive strategies found in Nomadic afar vernacular architecture. All architectural principles were interdisciplinary and work together for instance minimizing the energy use of the building will promote climatic responsive design and environmentally friendly approaches which promotes the utilization of local material, knowledge and technique following the construction process and design inputs later strengthen the social interaction, identity and cultural significance of the place.

The concept of passive design was employed to decrease the heating, cooling and lighting demands of the building and meet the inhabitant's comfort based on their experience and acceptance that is explored in the analysis section. Strategies used in this thesis, such as optimizing natural ventilation by making the envelope flexible and adaptive throughout the day to define the daylighting and ventilation, environmental design inputs and analysis of unchanged factors like sun path and wind direction analysis, cross ventilation, orientation, shape, and suitable material chosen are mainly inherited from traditional and vernacular architecture. From the above-listed results and solution, principles are extracted that have a different approach in solving problems that are extracted from the nomadic lifestyle. Hence even we who sedentarized community somehow have a temporary need and life. So, the solutions extracted from the nomadic vernacular architecture can be adapted to a sedentarized community problems both to understand and to solve them. As a result, the proposed building shows great promise for lowering energy use by three major sectors i.e., heating, cooling, and lighting through understanding the social structure and spatial mobility of nomadic community. Although the preliminary results from this thesis can be improved by adding exact and refined schedule-use for energy consumption sectors, strategies of energy conservation and energy

efficiency can be applied to all residential buildings in the hot and arid climate of Afar and worldwide.

6.2. USEFUL PRINCIPLES EXTRACTED FROM THE VERNACULAR ARCHITECTURE OF AFAR PASTORAL NOMADS

Knowledge transfer, maintenance of well-being and cultural integration of nomadic pastoralist communities are much stronger than our sedentary architecture because it's so integrated with rituals and culture. In addition, it's a skill that's needed for survival and to continue life. Afar nomadic pastoralist architecture is responsive to the underlying needs of the inhabitants expressed through practical and experience of creativity practiced in every individual of the community. This makes the architecture engaging.

Understanding locale

As it is discussed in the data presentation and analysis section nomadic people orient themselves in a space according to paths and directions responding to the natural environment, topographic features in general the characteristics of the environment. This gave them the ability to analyse the environment whether it is suitable for settlement to not.

Such constant movement through space makes them able to connect and understand their environment better. As a result, they develop better surveying skills than us sedentary people. This shows us to better visualize and understand spaces and the representation of objects in them it's important to analyse and experience different environmental qualities that can be integrated into space. Mobility helps them to orient themselves, objects and unchanging factors and variables like a sunshade, wind direction, vegetation and landforms including how they affect the architecture and indoor comfort. A cross-cultural study has argued that for an ecological hypothesis, the nomadic people, regardless of the degree of nomadism they have more accurate spatial abilities than sedentary people.

Every human being defines and experiences spaces and boundaries through movement. Human movement, in turn, links the concept of space to the natural environment- from the sun, stars, moon, clouds, wind direction and topography- as well as the built environment and time. On the other hand, there is individuality to their understanding of space.

Individuality/ Responsibility/ Improvement

Understanding and interpretation of an environment are equally dependent on the position and individual ability as well as knowledge/ experience of the observer. This means there is more than one way of viewing space, and it will hardly be the same as the next person, this is also

known as Hodological Mapping. This will also promote responsibility for individual choice open-mindedness for immediate improvement that results in spatial discomfort.

Travel Pattern _ Space definition

Afar nomads understand dwelling units as movement and travel regardless of their distance meaning could be in their neighbourhood or long travels from place to place. Space is defined by movement well designed and understood movement. The thesis focuses on understanding why the Afar nomadic community travel for what purpose and when they are travelling as it was mentioned above regardless of the range and interval of the movement. Grouping and study activities in a space with certain qualities certain patterns started showing. For instance, understanding of the cultural connections as well as integrations. This makes us understand the activities create new paths as a design guideline to integrate them with modern and city lifestyle.

Light, Sun, Shade and Shadows

The patterns of shade and shadow affect all of us in our day-to-day activities. In a hot and arid climate, the effects become more critical likewise most of the design concepts and strategies arose from managing light, sun, shade and shadow. This also influences the Afar pastoralist nomad's settlement and territorial organization. Most of our daily activities respond to these patterns. Accordingly, it's important to understand the variance of these factors in our environment.

As it can be recalled from the mobility map from analysis sections programs are arranged refereeing the northern and western direction. Afar nomadic communities are very dependent on the sun, light, shade and shadows. They protect themselves using different techniques that are integrated with the site, activities and the actual dwelling due to the harsh temperatures found in Afar.

Proper utilization of natural resources Vegetation

Afar nomadic existence depends on vegetation and natural resources found nearby. It's also one of their reasons for traveling from place to place. Vegetation not only affects the way light is reflected off a surface on earth, but it is also the means of their architecture and food. It plays an important role in the sustainability of their entire existence, from their lively hood to the lively hood of their livestock. Traveling and moving from place to place for a search of vegetation makes them understand the importance of it in addition it provides continuity of their culture, their strength in self-sustainability and their strong connection to nature.

Social and cultural integration Ritual and Celebration

Rituals take place in the central place of the settlement. Ceremonies like marriage and funeral ceremonies. Dwellings are constructed solely by women the architecture is experienced by societies of women. Men can only look on. This shows the power the community gave to women and defines gender equality. The architectural expertise succession in a family or generation depends on the birth and rebirth of a girl.

Nomadic concepts eliminate the idea of the monumental station that an entire city can be built and disassembled for a specific purpose. Architecture can be a ritual passed down from generation to generation, without it having to be a physical form striving for immortality with no space for change and development. Afar nomadic practice can be raised as an example of this.

Borders and Boundaries

Afar pastoralist nomads usually don't have any fences or other physical entity the sense of boundary is not expressed physically but rather it's behavioural. This means respecting other privacy and values. Most of the time enclosed boundaries and fences doesn't exist in these relatively small temporal sites. But the nomad's boundary is not always physical, their boundaries can be explored in three categories: Behavioural/Social boundary Transient territory Temporary campsite. These boundaries are well respected and understood within the community.

Understanding of measurement _ Ergonometric

Nomadic architecture and ergonometric measurements. The language of Nomadic architecture continues to express itself through anthropometry e.g. The decision of the length of straw or envelope size that surrounds the structure always comes from the proper know-how of the size of the body concerning space and activities.

Anthropometry deals with the measurements and proportions of the human body, and anthropometrics is the comparative study of these measurements. The use of these practices in architecture means that the designs must fit the human body, rather than the people fitting the building. The females consider how much space she needs to comfortably move around with her family in the temporal house. This includes from gathering of materials for the putting together of the settlement.

Adaptation of standards for activities alone is not enough. Architects should also understand the ergonometric of the human body in movement. This is one of the basic principles in defining measurement of the body concerning activities and movement of the body. For this reason, developing an understanding of the site ergonometric and functional ergonometric is essential.

Indeed, this shows the level of attention given by afar nomadic communities to design their surroundings appropriately that suits their activities and movement.

Settlement vs unsettlement

Assembly and disassembly

The permeance of Afar nomadic architecture is held through their cultural approach and the value of identity its behavioural trait. Identity and individuality are expressed through the weaving patterns and duplication of specific structural requirements. Integration of these individual patterns into the total design gives a personal touch to the dwellings. This speaks for the personalization and individuality of their homes. Afar nomadic communities waving practice not only gave the dwellings natural aesthetics but also make the space flexible and adaptable to let optimal air circulation and light into space.

Some of the reasons they can change their homes so easily are because the structural part and the envelope of the dwelling, are always two separate things. This allows for optimum flexibility. This construction method of building changes and also adapts to different climates and seasons and times as well.

Flexibility and Adaptability

Afar nomadic dwellings can adapt to new activities, increase and decreased in size and rand of family and livestock. In the same manner that afar nomadic communities are not limited to a place or space their architectural forms reflect the same character that it always reflects the settlement needs at a specific point in time. The dwellings can transform themselves for example to the number of inhabitants at the same place and time.

The adaptability as well flexibility characteristics of nomadic vernacular architecture is essential for adaptation of any change that is coming ahead. In today's world where everything changes constantly the architectural approach of Afar nomadic architecture is important. Afar nomadic architecture adapts, rather than being static; transform, rather than Limit, interacts with its users, rather than inhibits. Because of its positive adaptability traits, it will take advantage of technological innovation more readily. Additionally, multifunctionality is also its advantage that helps to express social and cultural issues.

6.3. RECOMMENDATION _ DESIGN GUIDELINES

A number of useful lessons from the vernacular architecture of the pastoral nomads of Afar can be taken for future designs in hot and arid climates. One can consider the following general principles extracted from lessons learned from the vernacular architecture of the Afar, as a guideline in future designs for these communities in these and similar areas. .

- **Adaptation of proper local material for better daylight and natural ventilation.**

Proper adaptation of local material in essential for providing sustainable thermal comfort of for modern and contemporary buildings. Adaptation of local materials can also be expressed through how actually the materials are made. The original afar pastorals dwelling units are made to breath and ventilate they are also very light which made them easy to expand and modify to provide more shading. So, through proper adaptation of materials, we can improve ventilation and daylighting of modern buildings in hot and arid climates.

- **Proper design and utilization of openings for natural ventilation.**

Design plays vital role in providing and utilizing openings to provide natural ventilation for buildings. Afar pastoral dwellings designs are made to flexibly utilize openings to provide sustainable thermal cooling's and ventilation for their dwellings. Modern buildings in the area could learn a lot from the local pastoral dwellings designs regarding openings. For instance, providing window modules and panels that are made with different materials that can be easily rotated to cover at the same time let cooled air to buildings.

- **adaptive skins to deliver flexibility and multifunctionality of a space.**

Adaptation is key in performing sustainably in hot and arid climate like Afar. Pastoral dwellings of the area master adaptive skins to provide multifunctionality and flexibility in the process of providing acceptable thermal cooling for the area. Modern buildings designs can be made to be flexible and provide multifunctional spaces. This can be addressed through modular design for each building elements like openings and wall modules. Also using light material for construction is essential for adaptation and modification of existing dwellings.

- **Participation and control for inhabitants so that they can transform the space according to their need.**

The current trend regarding participation of inhabitants in the area is weak. In an area with unique culture understanding the social as well physical structure is crucial. This can be done through understanding of the social structure and giving options and room of modification of dwellings. For example, extending roof covers, flexible building elements and panels and well-designed modular special arrangement with the proper landscape design will give inhabitants control to transform the space according to their need.

- **Reflection of outdoor temperature in the indoors through proper connections.**

Reflection of outdoor temperature to the indoors through proper connections using different building elements like openings and breathing façades. This will let the inhabitants to get used to the outdoor temperature and give their metabolism and body adjust accordingly.

- **Promotion of local knowledge development and local building material manufacturing industries to minimize transportation cost.**

Promotion of local industries to produce local materials that can be used in the area will ensure sustainability in different aspects. Medium to small local enterprise producing local materials promotes the skill and ingenuity of the locals. This will promote the documentation understanding and improvement of the skills.

- **Adapting to local cultures and identities through applying traditional patterns.**

Recalling traditional patterns through embedding cultural patterns through the design will promote the culture and preserve it as well. We can see examples of Islamic patterns embedded in the architecture promotes and preserves the architecture.

- **Improved design considerations of neighbourhood design including mobility and movement.**

The travel and mobility culture of the pastoral communities of Afar must be imbedded in the design sections. This can be done by integrating well designed landscape for the neighbourhood design as well for the immediate space of unit buildings. This will still preserve mobility and inhabiting different section of the area in differ time and place.

- **more robust buildings that are less vulnerable to catastrophic thermal failure ceasing to be dependent upon electrical energy to remain habitable.**

Applying different natural systems and strategies to adapt for the unit building so that they can provide passive cooling for the indoor spaces. This will make the buildings independent of electric source to provide acceptable thermal comfort for their inhabitants.

- **fewer greenhouse gas emissions as energy use are reduced both embodied in materials and operational.**

The right material choice and strategies will decrease the amount of greenhouse gas emission as released energy as well embedded energy. This will contribute positively to our environment.

Finally,

In the future, I have an interest in exploring and experimenting with the vernacular architecture of the nomadic pastoralist communities of Afar and integrate useful and innovative ideas in contemporary architectural design. I believe more study and experiment can enrich the discourse and be used as an input for future design guidelines. Appling, these general principles to different sites is essential in proving the hypothesis and integration of principles of nomadic architecture to a sedentary one. This is not an end product it can be considered an entity of the process in recalling and learning from vernacular architecture to create a modern vernacular architecture that can accommodate current living styles and an architecture that we can learn and adapt the solutions and local knowledge that our ancestors have developed for centuries. This opens room for as much future change and transformation as possible. I conclude my argument with a quote from Afar pastoral nomads:

“He who does not look back at where he came from will never reach his destination.”

Afar people

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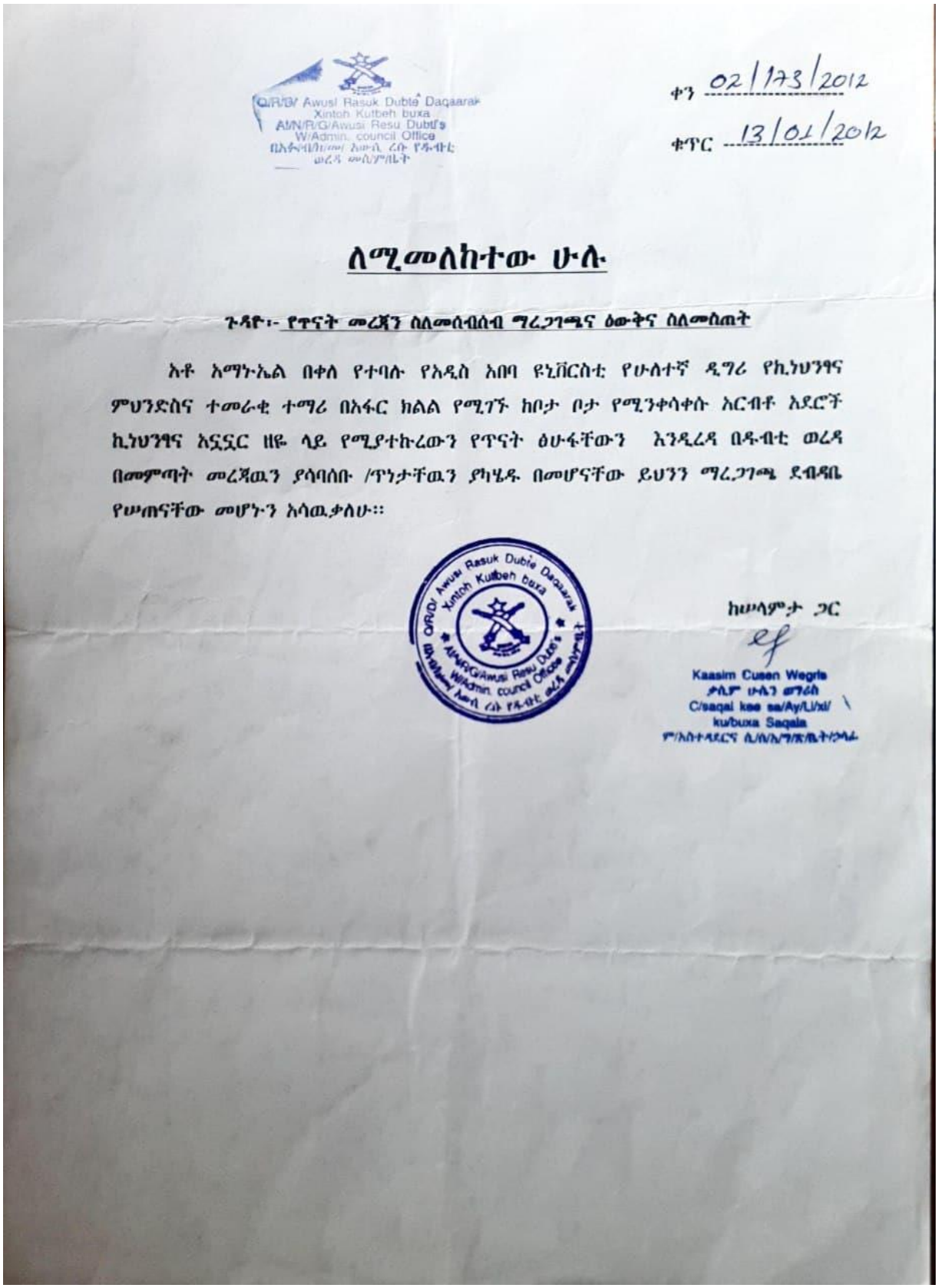
8. ANNEX-1



OARO/ Awusi Rasuk Dubte Daqaarar
Xintoh Kutbeh buxa
AI/N/R/G/Awusi Resu Dubti's
W/Admin. council Office
በአሉላቤ/ክ/መ/ አውሲ ረሱ የዱብቲ
ወረዳ መስሪያቤት

ቀን 02/173/2012
ቁጥር 13/01/2012

ለሚመለከተው ሁሉ

ጉዳዮ፡- የጥናት መረጃን ስለመሰብሰብ ማረጋገጫና ፅውቅና ስለመስጠት

አቶ አማኑኤል በቀለ የተባሉ የአዲስ አበባ ዩኒቨርስቲ የሁለተኛ ዲግሪ የኪነህንፃና ምህንድስና ተመራቂ ተማሪ በአፋር ክልል የሚገኙ ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች ኪነህንፃና አኗኗር ዘዬ ላይ የሚያተኩረውን የጥናት ፅሁፋቸውን እንዲረዳ በዱብቲ ወረዳ በመምጣት መረጃዉን ያሳባሰቡ /ጥነታቸዉን ያካሄዱ በመሆናቸው ይህንን ማረጋገጫ ደብዳቤ የሠጠናቸው መሆኑን አሳዉቃለሁ።

OARO/ Awusi Rasuk Dubte Daqaarar Xintoh Kutbeh buxa AI/N/R/G/Awusi Resu Dubti's W/Admin. council Office በአሉላቤ/ክ/መ/ አውሲ ረሱ የዱብቲ ወረዳ መስሪያቤት

ከሠላምታ ጋር

Kaasim Cusen Wegris
ቃሲም ሁሴን መገሪስ
C/saqai kee sa/Ay/Li/xi/
ku/buxa Saqala
ም/አስተዳደርና ሲ/ሰ/ኢ/ማ/ጽ/ቤት/ኃላፊ

መረጃ ማሰባሰቢያ መጠይቅ

የኢትዮጵያ የአርኪቴክቸር ፣ ህንፃ ግንባታ እና የከተማ ልማት ኢንስቲትዩት [EiABC]

አማኑኤል በቀለ [የአርኪቴክቸራል ምህንድስና ሁለተኛ ዲግሪ አጩ ተመራቂ]

በመጀመሪያ በዚህ መጠይቅ ላይ በመሳተፍ በመተባበርዎ እናመሰግናለን። በዚህ መጠይቅ የእርስዎን አስተያየት ለማግኘት ከ 5 እስከ 6 ደቂቃዎችን እወስዳለሁ እና ሁሉም መልሶች በሚስጢር የተጠበቁ ይሆናሉ። ከዚህ በታች የሚገኙት ጥያቄዎች ዘላቂ በሆኑ የቤት ውስጥ ሙቀት ማቀዝቀዣ መንገዶችን ብሎም መጤ የኤሌክትሪክ ኃይልን የሚወስዱ ማቀዝቀዣ መንገዶች በሚጠቀሙ የኪነ ህንፃ አሰራሮች እና ስለ አፋር ባህላዊ የኪነ ህንፃ አሰራር ጥበቦች ላይ የከተማ ነዋሪዎችን አስተያየት ለማሰባሰብ ነው።

መጠይቅ 1

1.የአፋር ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች አኗኗርና ኪነ ህንፃ የአፋርን ባህል ይወክላል ብለው ያስባሉ?

☐አዎ ☐አይ

- አይ ከሆነ መልሱ እንዴት?

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2.የአፋር ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች አኗኗርና ኪነ ህንፃ አሰራር የከባቢን ብክለት ይቀንሳል እንዲሁም ይከላከላል ብለው ያስባሉ?

☐አዎ ☐አይ

- አይ ከሆነ መልሱ እንዴት?

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3.የአፋር ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች ተነቃቃይ ቤት ሲገነባ አይተው ያውቃሉ?

☐አዎ ☐አይ

- አዎ ከሆነ መልሱ የት ?

☐ሰመራ ☐ዱብቲ ☐ሌላ

4.ከዚህ በፊት በሆነ አጋጣሚ የአፋር ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች ቤት የመግባት አጋጣሚ አግኝተው ያቃሉ?

☐አዎ ☐አይ

- አዎ ከሆነ መልስዎ ውስጥ አየር የሙቀት ሁኔታ እንዴት አገኙት?

☐ይሞቃል ☐ይቀዘቅዛል ☐ምንም አይልም

5.የት አካባቢ ነው ተወልደው ያደጉት?

☐ሰመራ ☐ዱብቲ ☐ሌላ

- በአካባቢዎ ከአፋር ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች ጋር ተነራብተው ኑረው ያውቃሉ ?

☐አዎ ☐አይ

6.ልጅ እያሉ የአፋር ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች መኖሪያ በብዛት አይተው ያውቃሉ?

☐አዎ ☐አይ

- አዎ ከሆነ መልሱ አሁን ጨምሯል ወይንስ ቀንሷል ?

☐ጨምሯል ☐ ቀንሷል ☐ለውጥ የለም

7.የአፋር ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች ተገጣሚ እና ተነቃቃይ ቤት መገንባት ይችላሉ?

☐አዎ ☐አይ

8.የአፋር ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች የኪነ ህንፃ ጥበብ እና አኗኗር ዘዬ ተጠብቆና ተመዝግቦ ወደ ቀጣይ ትውልድ እንዲተላለፍና እንዲሻሻል ያስባሉ?

☐አዎ አስባለሁ ☐አይ አላስብም

- አዎ ከሆነ መልስዎ እንዴት?

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9. የአፋር የወደፊት የከተማ ዲዛይንና ፕላን ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች አኗኗር ላይ ተመስርቶ እና ተሻሽሎ የሚሰራ ይመስልዎታል?

☐አዎ ይመስለኛል ☐አይ አይመስለኝም

10. የአፋር ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች አኗኗር ዘዴ እና ኪነ ህንፃ ያለው ጥቅምና ጉዳት ምን ይመስልዎታል?

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11. ለአፋር ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች የመሰረታዊ ልማት ግንባታና ተደራሽነት ማሳለጥ የሚቻል ይመስልዎታል?

☐አዎ ይመስለኛል ☐አይ አይመስለኝም

- አዎ ከሆነ መልስዎ እንዴት?

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12. የአፋር ዘላኖች ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች ተነቃቃይ ቤታቸውን ለመስራት የሚጠቀሙበት የግንባታ ግብአት እና የአሰራር ዘዴያቸው የአፋርን ከፍተኛ ሙቀት ለመቋቋም ይችላል ብለው ያስባሉ?

☐አዎ አስባለሁ ☐አይ አላስብም

- አዎ ከሆነ መልስዎ እንዴት?

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13. የትኛው (አሁን በየቦታው የምናየው የህንፃ ግብዓት እና የግንባታ ዘዴ ወይስ ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች) እዚህ ከባድ ሙቀት ያለበት ከባቢ አየር ጋር ተስማሙ መዝለቅ የሚችል ይመስልዎታል?

☐አሁን በየቦታው የምናየው የህንፃ ግብዓት እና የግንባታ ዘዴ ☐ ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች

- ለምን?

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14. የትኛው የአፋሮች የአኗኗር ዘዴ እና ኪነ ህንፃ ሲሻሻል የተሻለ እና የሚመች ዘላቂ የሆነ ችግራቸውን መቅረፍ ይችላሉ ብለው ያስባሉ?

☐አሁን በየቦታው የምናየው የህንፃ ግብዓት እና የግንባታ ዘዴ ☐ ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች

15. የአፋር ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች የቀን ተቀን ኑሮ እና ድርጊት መጥቀስ ይችላሉ?

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16. በአፋር ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች ቤት ኖረው ያቃሉ?

☐አዎ ☐አይ

- አዎ ከሆነ መልስዎ እንዴት ይገልፁታል?

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17. ምን ዓይነት የኢኮኖሚ እና የባህል ተፅዕኖ አላቸው ብለው ያስባሉ? (የአፋር ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች)

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18. የአፋር ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች የአኗኗር ዘዴ እንደ ኋላቀር ልምድ አድርገው ይመለከቱታል?

☐አዎ ☐አይ

- አዎ ከሆነ መልስዎ ለምን?

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19. አሁን ያለው ዘመናዊ ግንባታ እንዴት ይመለከቱታል? ለአፋር ከባቢ አየር ተስማሚ ግንባታ ነው ብለው ያስባሉ?

☐አዎ ☐አይ

- አዎ ከሆነ መልስዎ እንዴት?

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20. አፋሮች ባህላዊ የሆነ ከፍተኛ ሙቀት በቤታቸው የሚከላከሉበት ዘዴ አለ?

☐አዎ ☐አይ

- አዎ ከሆነ መልስዎ ምንድን ነው?

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21. አፋር ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች ሲንቀሳቀሱና ሲጓዙ አጋጥሞት ያቃል?

☐አዎ ☐አይ

- አዎ ከሆነ መልስዎ የት እና ስንት ጊዜ ?

☐ሰመራ ☐ዱብቲ ☐ሌላ

☐1-10 ☐10-20 ☐ከ20 በላይ

22.መንግስት ለአፋር ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች የአኗኗር ዘዴአቸው ሳይቀየር ድጋፍ ሊያደርግላቸው ይችላል ብለው ያምናሉ?

☐አዎ አምናለሁ ☐አይ አላምንም

- አዎ ከሆነ መልስዎ እንዴት?

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23. የአፋር ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች የአኗኗር ዘዴአቸው መቀየር ይጠቅማቸዋል ብለው ያስባሉ?

☐አዎ አስባለሁ ☐አይ አላስብም

- አዎ ከሆነ መልስዎ እንዴት?

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24. የአፋር ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች ምን ዓይነት መሰረታዊ ለውጥ የአኗኗር ሁኔታቸውን ያቀለዋል ብለው ያስባሉ?

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25. የአፋር ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች ዋና ዋና የኪነ ህንፃ መለያዎች እና ብልሀቶች ወደ ዘመናዊ ህንፃ ዲዛይንና ግንባታ ቢተላለፍ ጠቃሚ ይመስልዎታል?

☐አዎ ይመስለኛል ☐አይ አይመስለኝም

- አዎ ከሆነ መልስዎ እንዴት?

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- ከዚህ በታች የሚገኙት የሚሞሉት በተመራማሪው ብቻ ነው።

ቀን፡-_____/_____/_____

- ይህ መጠይቅ የተሞላበት ቦታ

☐ሰመራ ☐ዱብቲ ☐ሌላ

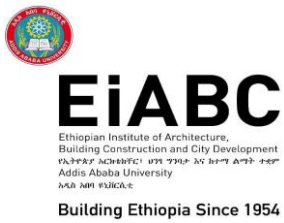
- ምን ያህል ተሞልቷል

☐25% ☐50% ☐75% ☐ 100% ☐ሌላ

ሌላ፡-_____%

- በማን ተሞላ

☐ቋሚ የግል ስራ(የንግድ ማህበረሰብ) ☐ቋሚ የቅጥር ስራ(የግል ወይም መንግስት መስሪያ ቤት)



በመጀመሪያ በዚህ መጠይቅ ላይ በመሳተፍ በመተባበርዎ እናመሰግናለን። በዚህ መጠይቅ የእርስዎን አስተያየት ለማግኘት ከ 5 እስከ 6 ደቂቃዎችን እወስዳለሁ እና ሁሉም መልሶች በሚስጢር የተጠበቁ ይሆናሉ። ከዚህ በታች የሚገኙት ጥያቄዎች ዘላቂ በሆኑ የቤት ውስጥ ሙቀት ማቀዝቀዣ መንገዶችን ብሎም መጤ የኤሌክትሪክ ታይልን የሚወስዱ ማቀዝቀዣ መንገዶች በሚጠቀሙ የኪነ ህንፃ አሰራሮች እና ስለ አፋር ባህላዊ የኪነ ህንፃ አሰራር ጥበቦች ላይ የከተማ ነዋሪዎችን አስተያየት ለማሰባሰብ ነው።

መጠይቅ 2

1. ከዚህ በፊት በአፋር ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች የአኗኗር ዘዴ ተወስዶ የተሰራ ኪነ ህንፃ አጋጥሞት ያቃል?

☐ አዎ ☐አይ

- አዎ ከሆነ መልስዎ የት?

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2. ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች አኗኗር የሚዘግብ ሰነድ አይተው ያቃሉ?

☐ አዎ ☐አይ

- አዎ ከሆነ መልስዎ ምን አይነት እና የት?

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3. ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች የኪነ ህንፃና የአኗኗር ዘዴ ለውጥ አስተውለው ያቃሉ?

☐ አዎ ☐አይ

- አዎ ከሆነ መልስዎ እንዴት?

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4. የወደፊት የአፋር ከተማ ፕላን እና ኪነ ህንፃ ግንባታ በአፋር ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮችጥሩ እሴት ላይ ተመስርቶ የሚስፋፋ ይመስልዎታል?

☐ አዎ ☐አይ

- አዎ ከሆነ መልስዎ የአፋር ዘላኖች ጥሩ እሴት ይዘርዝሩ።

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5. የአፋር ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች አጋጥሞት ያውቃል ?

☐ አዎ ☐አይ

- አዎ ከሆነ መልስዎ የት?

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6. የአፋር ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች ከምንም ዓይነት ታይል ሰጪ ጉልበት ውጪ የሆነ የአየር ንብረት ጥበቃ የአፋር የወደፊት መካተት የሚችል ልምድ ይመስልዎታል?

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7. አሁን ያለው የመሰረተ ልማት ተደራሽነት በአፋር ከቦታ ቦታ ለሚንቀሳቀሱ አርብቶ አደሮች ምን ይመስላል?

☐ ተደራሽ ነው ☐ተደራሽ አይደለም ☐ሌላ

- ሌላ ከሆነ መልስዎ እንዴት?

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8. ሀንፃ ግንባታ እና ዲዛይን ፈቃድ የከባቢ አየር ሁኔታ መስፈርቶች ማካተት ይኖርበታል ብለው ያስባሉ?

☐ አዎ አስባለሁ ☐አይ አላስብም

- አዎ ከሆነ መልስዎ እንዴት?

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9. አሁን ያለውን የአፋር የዘመናዊ ግንባታ እንዴት ይመለከቱታል?

☐ጥሩ ነው ☐አይ ጥሩ አይደለም ☐ሌላ

- ሌላ ከሆነ መልስዎ ምን?

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10. የአፋር ከቦታ ቦታ የሚንቀሳቀሱ አርብቶ አደሮች የአፋርን ማህበረሰብ ጥምረት ያጠናክራል ብለው ያስባሉ?

☐አዎ አስባለሁ ☐አይ አላስብም

- አይ ከሆነ መልሱ እንዴት?

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- ከዚህ በታች የሚገኙት የሚሞሉት በተመራማሪው ብቻ ነው።

ቀን፡-_____/_____/_____

- ይህ መጠይቅ የተሞላበት ቦታ

☐ሰመራ ☐ዱብቲ ☐ሌላ

- ምን ያህል ተሞልቷል

☐25% ☐50% ☐75% ☐ 100% ☐ሌላ

ሌላ፡-_____%

- በማን ተሞላ

☐አነስተኛ ንግድ ☐ትራንስፖርት ዘርፍ

Ethiopian Institute of Architecture building construction and city development

Emmanuel Bekele (Master's student of Architectural engineering)

The following is an outdoor and indoor temperature data of Nomadic afar vernacular architecture collected on the above-mentioned date.

- Site location and code:

Semera:

☐S1 ☐S2 ☐S3

Dubti:

☐D1 ☐D2

- Dwelling envelope type

☐Made from natural materials ☐Made from other plastic material

_____

_____

_____

- Shade and other nearby vegetation and water bodies

☐Yes ☐No

- Size of the dwelling units

☐Big ☐Medium ☐Small

_____

_____

_____

- Openings (Fenestration) at the time of temperature measurement. (Envelopes/Window)

☐Fully open ☐ Partially open ☐ closed/ minimum opening

- Activity inside the dwelling units/heating related

☐Cooking food ☐Preparing Food ☐resting/ socializing/ sleeping

- Number of individuals living or being present at the time of data collection

☐>2 people ☐<2 people ☐ <5 people

Date: _____	Morning 12:00-5:00		Mid-day 5:00-9:00		Afternoon 10:00-12:00		Night 1:00-4:00	
Monday	Outdoor ^{0}C	indoor ^{0}C	Outdoor ^{0}C	indoor ^{0}C	Outdoor ^{0}C	indoor ^{0}C	Outdoor ^{0}C	indoor ^{0}C
Tuesday								
Wednesday								
Thursdays								
Friday								
Saturday								

Ethiopian Institute of Architecture building construction and city development

Emmanuel Bekele (Master's student of Architectural engineering)

The following semi-structured questionary is collected to analyse and evaluate the thermal sensation and overall thermal comfort of individuals living in a nomadic vernacular dwelling.

- How do you rate the thermal comfort of the dwelling units?

☐Very hot ☐ Hot ☐Slightly hot ☐Neutral

- For how long do you stay inside the dwelling in a day?

☐> 3hrs ☐< 3hrs ☐ < 6hrs

- What activity do you engage in every day?

☐Intensive ☐ Moderate ☐ low

- What time of the day is the hottest?

☐Morning ☐Mid-day ☐Afternoon ☐Night time

- What kind of clothing do you usually wear and how does it affect your thermal comfort?

☐Layered ☐Not fully covered

☐Fully covered ***Type of cloth***

☐Single layered ☐Cotton cloth ☐polyester that can breathe

- What indoor activities do you usually do in indoor environments?

☐Cooking ☐Socializing

☐Food preparing ☐Eating

☐Sleeping/ rest

- What is the number of individuals in one household?

☐1-2 people ☐2-4 people ☐4-6 people

- Size of the household you living in?

_____

_____

_____

- What material used to construct the dwellings?

☐Natural Materials ☐Plastic/ Modified materials

Questionnaire
Ethiopian Institute of architecture, building construction and city development Addis Ababa university
Emmanuel Bekele (Architectural Engineering postgraduate student)

First of all, thank you for participating in this questionnaire. It will take 5 to 6 minutes to record your opinion and all answers will be kept confidential.

The following semi-structured questionary is collected to analyse and evaluate the thermal sensation and overall thermal comfort living in a nomadic vernacular dwelling.

Questionnaire interview for the random pastoral individual

1. First name_____

   Father's name_____

   Grandfather's name_____

2. Number of families

   ☐4-6 ☐8-10

   ☐6-8 ☐Above 10

3. For how long did you lead a nomadic lifestyle?

   ☐All my life ☐5-10 years ☐10-20 years ☐Above 20 years

4. Are you the first generation of the pastoral community?

   ☐Yes ☐No

   - If no

   ☐My parents ☐My grandparents ☐Before my grandparents

5. Do you know how to construct these houses?

   ☐Yes ☐No

   - If yes, how did you learn the skills to construct these houses? And have you passed the knowledge to anyone?

_____

_____

6. How do you store it when you are on the move?

_____

_____

7. Do you think the “Qari” are effective in performing the spatial cooling system?

☐Yes ☐No

- If yes how?

_____

_____

8. Why do you move from place to place? What kind of resources are you looking for? How do you locate these resources?

_____

_____

9. What are the advantages and disadvantages of being a nomad?

- Advantages

_____

_____

- Disadvantages

_____

_____

10. Where do you find the materials and furniture to make these homes?

_____

_____

11. Did you have access to public facilities like schools, hospitals, religious places, etc.?

☐Yes ☐No ☐Partial access ☐Other

- If other

_____

_____

Ethiopian Institute of Architecture building construction and city development

Emmanuel Bekele (Master's student of Architectural engineering)

The following data collected to analyse and evaluate socio-cultural structure by recording activities taking place in a given time.

Grouping and activity description

ACTIVITY	**DAILY ACTIVITIES**		**RITUALS**	
	Individual		Group	
	Indoor	Outdoor	Indoor	Outdoor
SPACE (NAME TAG OF THE PLACE)	Main house		Other spaces	
	• Living room • Bedroom • Store			• Outdoor kitchen • Outdoor toilet shade • Washing and hygienic • Small animal barn • Big animal barn • Outdoor sleeping and sitting area • Kids playing space • Kid's bedroom • Selling milk • Leisure activity
PROXIMITY TO THE MAIN HOUSE	Near (3-8 Meters)		Not too far (8-12 Meters)	Far (More than 12 Meters)
PRIVACY	Confidential privacy		Normal privacy	Transitional privacy / No privacy
LIGHTING	Natural Sufficient/available		Artificial Sufficient/available	
DOES IT ALLOW MOBILITY	Yes		No	
ZONING	Fenced		Not fenced	

Time and activity recording table

Time	Activity	Individual/group	Indoor/outdoor	Proximity	Privacy	Zoning
Night 3:00-11:30						
Morning 12:00-12:30						
Morning 11:30-12:00						
Morning 1:00-1:30						
Morning 2:00-2:30						
Morning 2:00-11:30						
Morning 2:00-11:30						
Mid-day 5:30-7:30						
Mid-day 5:30-7:30						
Afternoon 2:00-10:30						
Afternoon 9:00-10:30						
Afternoon 11:00-12:30						
Afternoon 10:00-10:30						
Afternoon 10:00-10:30						
Night time 5:30-7:30						

Ethiopian Institute of Architecture building construction and city development

Emmanuel Bekele (Master's student of Architectural engineering)

The following data is collected to provide S.W.O.T analysis and evaluation of the surroundings of Afar nomadic vernacular architecture.

Site code

Semera

☐S1 ☐S2 ☐ S3

Dubti

☐D1 ☐D2

Features: Access, Vegetation, Land forms, size and space

- Directly related with Existing condition

☐ Dwellings ☐ Affects ☐ Promotes

☐ Mobility Future conditions

☐ Climate ☐ Opportunity ☐ Treats

☐ Infrastructure _____

☐ Finance _____

- Data collected using

☐Sample ☐ Picture ☐ Video ☐ Drawing ☐Interview

Features: Water bodies, Fences, Barn

- Directly related with Existing condition

☐ Dwellings ☐ Affects ☐ Promotes

☐ Mobility Future conditions

☐ Climate ☐ Opportunity ☐ Treats

☐ Infrastructure _____

☐ Finance _____

- Data collected using

☐Sample ☐ Picture ☐ Video ☐ Drawing ☐Interview

Ethiopian Institute of Architecture building construction and city development

Emmanuel Bekele (Master's student of Architectural engineering)

The following data is collected by interviewing a group of women who build nomadic Afar vernacular architecture to compile focused group discussion.

Material_ in the making

- How the materials are made to construct the dwellings

- What is the name of the materials and where is it found?

- How long it will take to make the materials?

- How it's stored maintained and cleaned?

- How long it will last?

Construction

- How many individuals will participate to build the dwelling units?

- How long it will take to unfold and build the dwelling units?

- What other available materials are used from the site?

How other temporary structures are built like barns and outdoor shades?

How do you rate the strength and performance of the dwelling?

Describe the construction process in detail?

THE VERNACULAR ARCHITECTURE AND THERMAL COMFORT STANDARDS OF THE PASTORAL AFAR IN ETHIOPIA, LESSONS FOR CONTEMPORARY BUILDINGS

In the case of surrounding areas Dubti and Semera towns, Afar, Ethiopia.

EMMANUEL BEKELE FULEA, IMAM MAHMOUD HUSSEN

Abstract

Keywords: *Sustainable Architecture, Passive strategy, Thermal Comfort, Socio-cultural structures, contemporary architecture, Vernacular architecture, Nomadic vernacular architecture, Adaptive vernacular architecture study approach*

This thesis aimed to study and take lessons from sustainable thermal cooling features of nomadic Afar vernacular architecture and extract principles that can be applied to the current architectural and construction sector in Afar. Current modern architectural practice in the area has suffered from harsh indoor environments forcing people to use mechanical ventilation which has its drawbacks concerning sustainability and expression and integration of culture and identity through architectural spaces and activities accommodated. The study focused on socio-cultural structure and its integration with the nomadic vernacular dwelling, their indoor environment, nearby open spaces and their mobility pattern surrounding the emerging cities of Afar, Semera and Dubti. The research ranged from evaluating the performance of Afar nomadic vernacular dwelling to studying their socio-cultural structure and documentation of the physical structure of the dwelling plus mapping of the surrounding, construction technique and furniture. The assessment was conducted using methodologies such as subjective evaluation, observation and physical measurement. Both the survey, questioner and physical measurement results showed that afar nomadic people were able to provide sustainable thermal cooling features in a space that represent their culture that provides comfortable and productive space. These results finally discussed and interpreted into guidelines that offer basic considerations during Architectural design of hot and arid climates particularly spatial management, building material selection and adaptation of strategies.

Introduction

According to the world bank, Ethiopia population is more than 112 million people in 2019, which ranks the country as the second-most populated nation in Africa after Nigeria. (World Bank, 2016). In the case of Ethiopia, though only 20% of the total population lives in cities, the current urbanization rate is much higher than the current national average population growth (Yonas Soressa, Imam Mahmoud, Alemayehu, et al., 2018). Planning and understanding sustainable construction are important following rapid urbanization, fast-unmonitored construction will have an impact on our cities. For the hot and arid climate conditions like Afar, the effect will be even more. Afar is a regional state in north-eastern Ethiopia and the homeland of the Afar people. Its capital is a city of Semera. The temperature varies from 25^0C during the wet season to 48^0C during the dry season. Afar can be classified as one of the places with extreme climatic conditions. Afar is home to a considerable number of nomadic pastoral communities. Climate was approached as a starting point for Afar nomadic vernacular building design. The Nomads of afar moves from place to place in a search of water and food for their cattle as the main reason. Their temporary dwelling is designed considering their mobility culture and social values. The temporary dwelling is considered as the vernacular architecture and identity of the Afar people.

The problem of the statement

Buildings contribute directly and substantially to manufactured risk because of the number of raw materials, energy, and capital they devour as well as the pollutants that they emit. This problem even magnified following rapid urbanization and design standardization. This growth in urbanization will increase the demands for housing and infrastructure in cities. Afar is of the most growing cities in Ethiopia with a harsh climate and unique cultural values that demands proper adaptation of already proven vernacular practices for its modern design and construction sector. current contemporary Afar architecture suffers from harsh indoor environments because the current trend did not consider the context including climate conditions, materials, and the socio-cultural structure of the community.

Research questions

1. How do Afar nomadic communities around Semera and Dubti interact and relates with the other inner urbanized zones of the Afar region?

2. What level of thermal comfort and thermal sensation Afar vernacular dwellings around Semera and Dubti provides without any mechanical ventilation?
3. What are the features of the existing Afar nomadic socio-cultural structure and physical structure of vernacular dwelling units around Semera and Dubti to efficiently operates in these harsh environments?
4. What are the strategies used to provide sustainable thermal cooling for indoor environments in Afar nomadic vernacular architecture near the capital Semera and Dubti?
5. What design principles can be extracted from Afar nomadic vernacular Architecture that can be adapted to the modern architectural practice?

Significance of the study

A study of the thermal cooling system of Afar nomadic vernacular architecture near the capital Semera and Dubti areas assists for the deep understanding of the nomadic socio-cultural structure and physical structure of the existing nomadic dwellings. Lessons from this vernacular architecture can effectively improve energy efficiency in contemporary buildings as well as contribute to a sustainable approach through the reduction of emission and carbon footprint.

The specific objective of the study

The specific objective of the study is first to examine the interaction of afar nomadic communities with sedentarized communities living in inner urban zones of the Afar region. Then Measuring and examining the thermal comfort of nomadic afar vernacular architecture near Semera and Dubti. Thereafter Documentation of Nomadic Afar vernacular architecture and the socio-cultural structure near Semera and Dubti. Following this Identifying the sustainable thermal cooling features and strategies of Afar nomadic vernacular architecture near Semera and Dubti will be explored. Finally, extracting design principles for contemporary architecture from the nomadic Afar vernacular architecture near Semera and Dubti.

Scope and limitation

The research paper has both thematic and spatial scope. The focus on vernacular dwellings of Afar sustainable thermal cooling features is the thematic scope of the paper on the other hand, the sample size for the study will be limited to the nomads living in 10 Km proximity to the capital Semera and a nearby city called Dubti will be geographical scope. Limitation

encountered while conducting the thesis are Sample size, Lack of available and reliable data, Access: Geographical, location and Language and cultural. Even though the above-listed limitation exists using secondary credible sources the gaps have been filled. Also, the limitations can open a way for future researches and studies.

Methods

This paper based on the description, evaluation and correlation of Nomadic afar vernacular architecture intended to suggest that contemporary design could take a lesson from the principle of vernacular architecture.

Data type

Primary and secondary were used for this research. The primary data was gathered from measurement, interviews, questionaries, focus group questionaries and interviews and on-site observation. The secondary data was gathered from books written about Afar and maps produced by regional offices from the region. Qualitative and Quantitative data is collected to conduct the research. Temperature measurements, actual dwelling measurement for documentation and studying passive features and strategies are quantitative data. Whereby, interviews assessing socio-cultural interactions, thermals sensations of the inhabitants and interrelations and impacts of urban settlements on nomadic vernacular architecture are qualitative data.

Source of data

Primary data which are interviews and questionaries sources are listed as follows: Interviews: Residents (Inhabitants of afar Nomadic vernacular architecture) the informants are grouped by Age, Gender position in the group and Questionaries, On-site measurement**.**

For secondary data, the researcher gathered from researches conducted in the Afar area and books written regarding the study area. Book published by the regional government can be listed as an example.

Data collection technique

The study mainly used tools like questionaries, in-depth interview, focused group discussion and direct observation to collect the data. Additionally, it employed sketches, mappings (to study settlement and mobility pattern), pictures, video and audio and on-site measurement (Temperature and as-built) for documentation as data collection techniques.

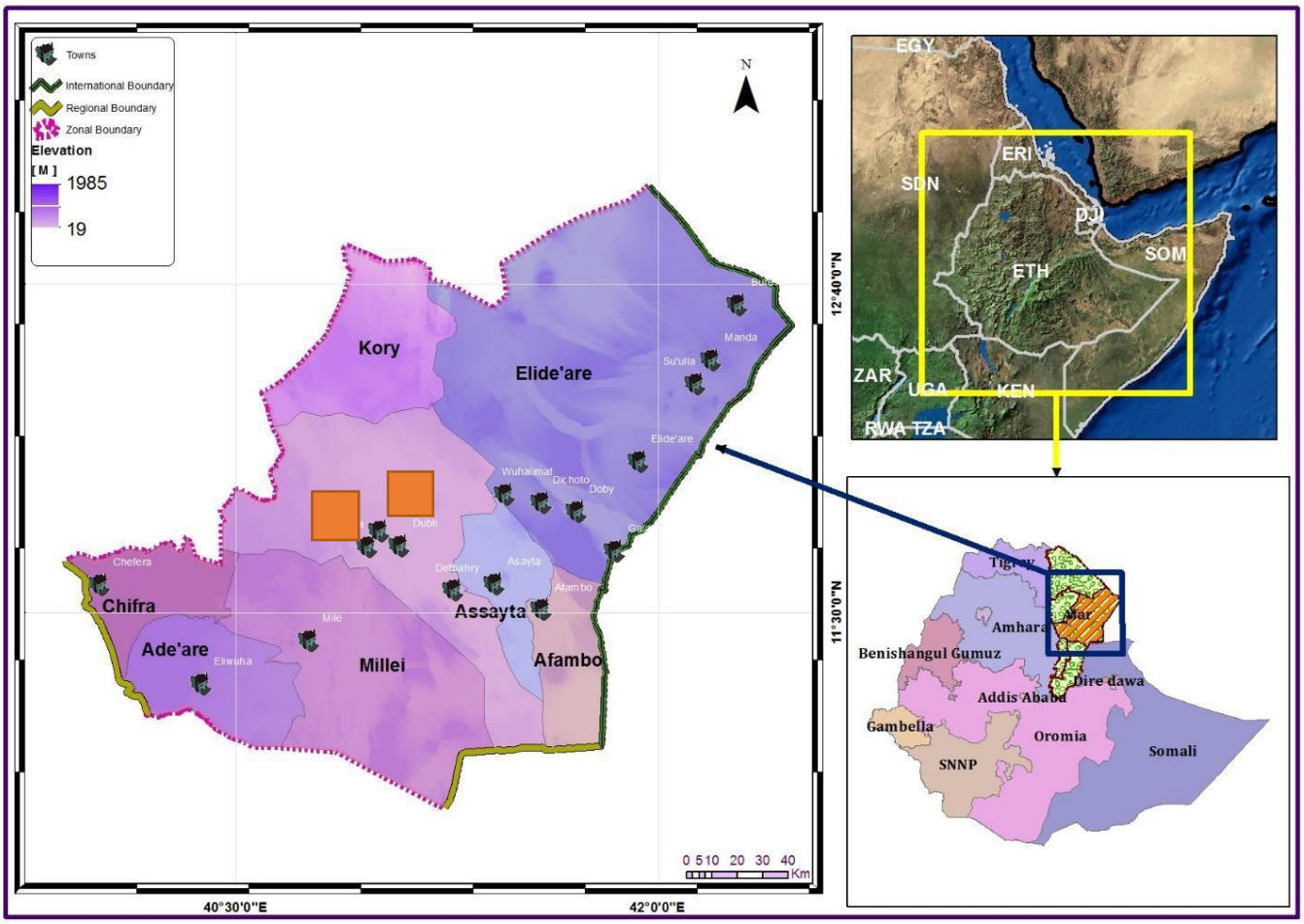
Selection of cases

According to Yin (Yin, 2009), the researcher has the right to select cases straight forward or using certain techniques based on the researcher's prior knowledge or complexity level of the cases. Therefore, two clustered case areas are selected which are known by the Woreda Administration. One of the Clusters is closer to the capital Semera which is in a 10 Km radius while the second cluster is near to the Zonal town Dubti which is also in a 10 Km radius.

Methods of data analysis

The data gathered for the study was first presented and then analysed using pictures, drawings, maps, sketches and tables. A thermal sensation of the inhabitants of Nomadic afar vernacular architecture will be analysed through Graphs and charts, statical analysis (Keitsch, 2012)(Kuru & Calis, 2017). Socio-cultural structure through daily activities and mobility pattern of inhabitants living in afar nomadic vernacular dwellings analysed by: Activity, Space, Meaning and Spatial configuration

Study area



Location map of Study region_ Afar region report_ (Afar Regional Atlas, 2018)

RESULTS AND DISCUSSION

DISCUSSION: RESULT AND ANALYSIS OF QUESTIONARIES COLLECTED FROM INFORMANTS FROM THE RESPECTIVE CITIES

From the above discussion and data presentation, it can be summarized with the following main three topics where the questionaries are grouped. The main three groups are listed below:

- Awareness and knowledge of nomadic Afar vernacular architecture
- Identity and tradition representation of the Afar people through its nomadic vernacular dwelling and lifestyle
- The thermal performance of Afar nomadic vernacular dwellings
- Environmental impacts of contemporary material and construction

The following result is derived from a total of 80 participants living in Dubti and Semera. These informants are divided into two subgroups professionals and non-professionals. The non-

professionals group has a subgroup of frequent travellers and non-travels. As well the professional group is categorized into business professionals and professionals working in government and non-government offices.

Questionaries collected from professional respondents

	Professional business owners	Government, and international organization officers	Total Number of Respondents
Number of Respondents	**21**	**19**	**40**
Semera	**15**	**13**	**28**
Dubti	**6**	**6**	**12**

Total number of professional respondents

Professionals (40 respondents in total)

From the total 40 respondents 65% of them has high awareness and knowledge about afar nomadic vernacular architecture on the contrary 20% has very limited knowledge about the vernacular dwellings the other 15 % has medium level awareness. The same informants were asked a group of questions to understand their opinion on representation of their culture and identity through the Afar nomadic culture, following 98% of the informant's belief 100% that afar culture, traditions and values can be expressed through the vernacular dwellings the other 2% said the main cultural values are a combination of other rituals and practices. Coming to the thermal performance of the vernacular dwellings 75% of the informants said that it has a great thermal performance the other 10% said it can still be hot inside in mid days whereas the other 20% have an opinion that it can deliver acceptable thermal comfort for the indoor environments. The informants are also asked about the environmental impacts of contemporary materials 86% of the informants said that they understand it has an impact on the environment the others said they have no clue that it has an impact on the environment.

Questionaries collected from Non-professional respondents

	Frequently traveller	Non- traveller	Total Number of Respondents
Number of Respondents	**20**	**20**	**40**
Semera	**10**	**10**	**20**
Dubti	**10**	**10**	**20**

Table 5. 24: Total number of non-professional respondents

Non - Professionals (40 respondents in total)

From the total 40 respondents 75% of them has high awareness and knowledge about afar nomadic vernacular architecture on the contrary 10% has very limited knowledge about the vernacular dwellings the other 15% has medium level awareness. Question on representation of their culture and identity through the Afar nomadic culture, following 99% said it represents 1% didn't agree in the fact. Coming to the thermal performance of the vernacular dwellings 70% of the informants said that it has a great thermal performance the other 10% said it can still be hot inside in mid days whereas the other 20% have an opinion that it can deliver acceptable thermal comfort for the indoor environments. The informants are also asked about the environmental impacts of contemporary materials 75% of the informants said that they understand it has an impact on the environment the others said they have no clue that it has an impact on the environment.

DISCUSSION: THERMAL COMFORT AND THERMAL SENSATION RESULT

Thermal measurement and comfort survey were conducted in addition to the documentation and study of the vernacular architecture and the techniques in detail. Altogether, 6 sets of measured environmental quantities and 16 thermal sensation responses from 16 residents were obtained. The major findings are as follows:

- According to the comparison of the indoor globe and operative temperatures with the outdoor air temperature, and also from the response gathered from the residents, natural ventilation of a well-constructed unit housing of Afar nomadic hut performed relatively well.

- Approximately three-quarters of the residents participating in the survey were comfortable under similar indoor and outdoor shaded environments; this is probably because of natural ventilation.
    - Under given conditions.

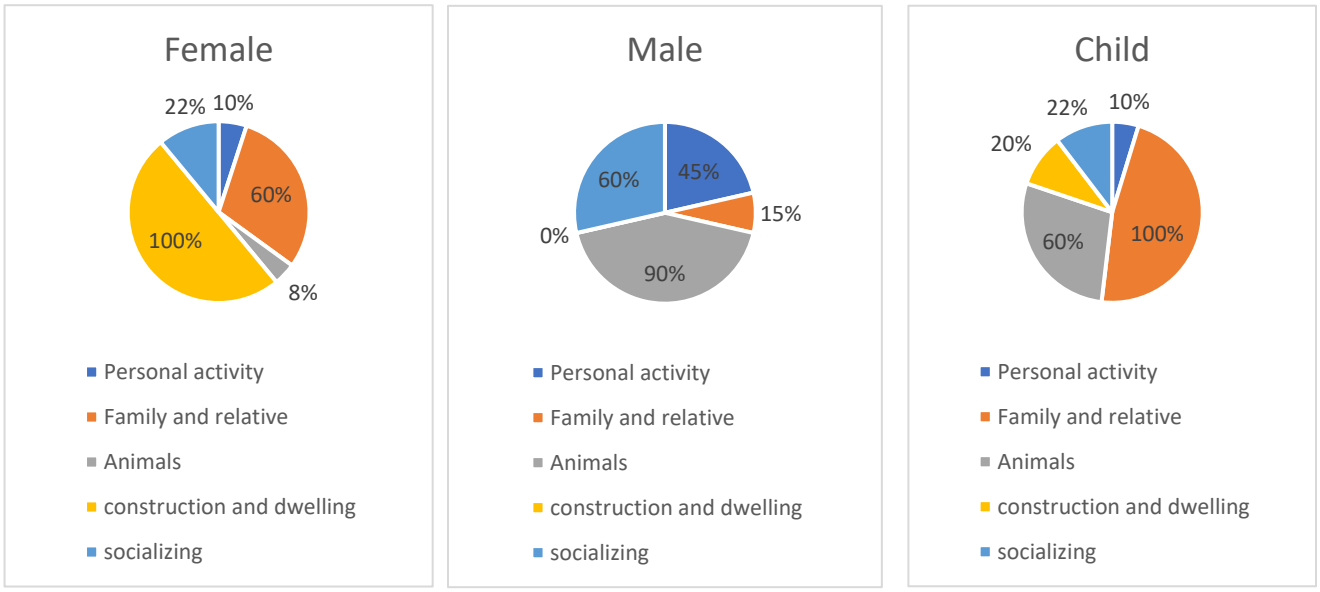
- The discomfort was due to the higher temperature caused by the thermally poor characteristics of the building envelopes, such as poor construction and poor material or building envelope.

- The average indoor temperature estimated from the data was **37 °C.**
    - The comfort temperature of the residents living in moderately big and well-constructed unit buildings was lower than that of small and poorly constructed ones.
    - Female residents had higher comfort temperatures than male residents. The residents with comfort temperature beyond the temperature limits prescribed by ASHRAE showed a tendency to adapt to their indoor thermal environment.

- Differences in clothing insulation and comfort temperature in terms of gender and housing type were observed. The clothing adaptive behaviour was an additional factor for the increased thermal comfort values with the outdoor environment. This study showed that most of the residents adapted and felt comfortable under the condition of an indoor natural thermal environment. The comfort temperature for male and female residents is different owing to clothing insulation.

DISCUSSION: RECORDING ACTIVITIES IN A GIVEN TIME

From the above in-depth analysis and life story narrations, we can summarize the spatial usage of inhabitants in a given space. This spatial usage is influenced by age and gender since the activities differ according to gender and age. The same with the analysis sections the activities are grouped in five groups that define the livelihood afar nomads. The following is the grouping of the activities: Personal activity, Family and relative, Animals, Construction of the dwelling, Socializing. These activities also define the spaces where the activates occur. To elaborate personal activities are activities related to intimate privacy like taking a shower and using a toilet etc. as it can be shown in the pie chart there is a fair time allocation and distribution of these activities. The activity is carried out in a private outdoor space. Most of the time small children are accompanied by their mother to take the activity. On the other hand, family and relative activities are carried both in the indoor spaces as well in outdoor space. Women do spend most of the time in these activities. These activities are cooking, preparing food, cleaning the household and taking care of the kids. Next activities that relate with animals such activity is related with taking care of the animals and protecting them. More men and kids are involved in this activity. Construction of dwelling is carried out by the women. Following socializing with other relatives and with each other has a fair distribution among the families but it's a bit strong with the women. Most of the socializing activities are carried out in outdoor space.

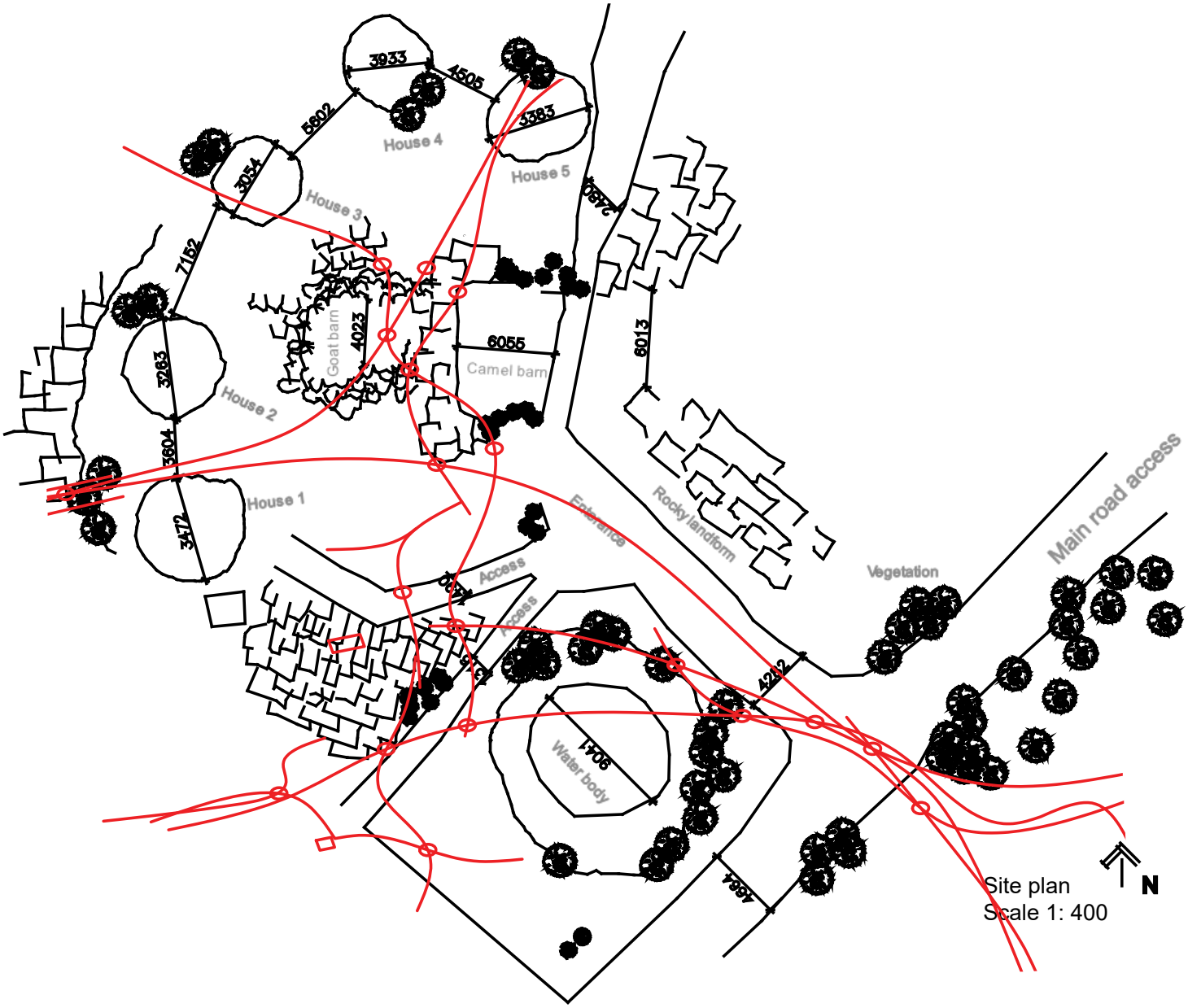


Activity distribution and allocation of Female, Male and a child

DISCUSSION: DOCUMENTATION OF NOMADIC AFAR VERNACULAR ARCHITECTURE

Nomadic people do not orient themselves in a space according to the physical measures and cardinal points, but along the paths or directions in response to topographic features in the natural environment.

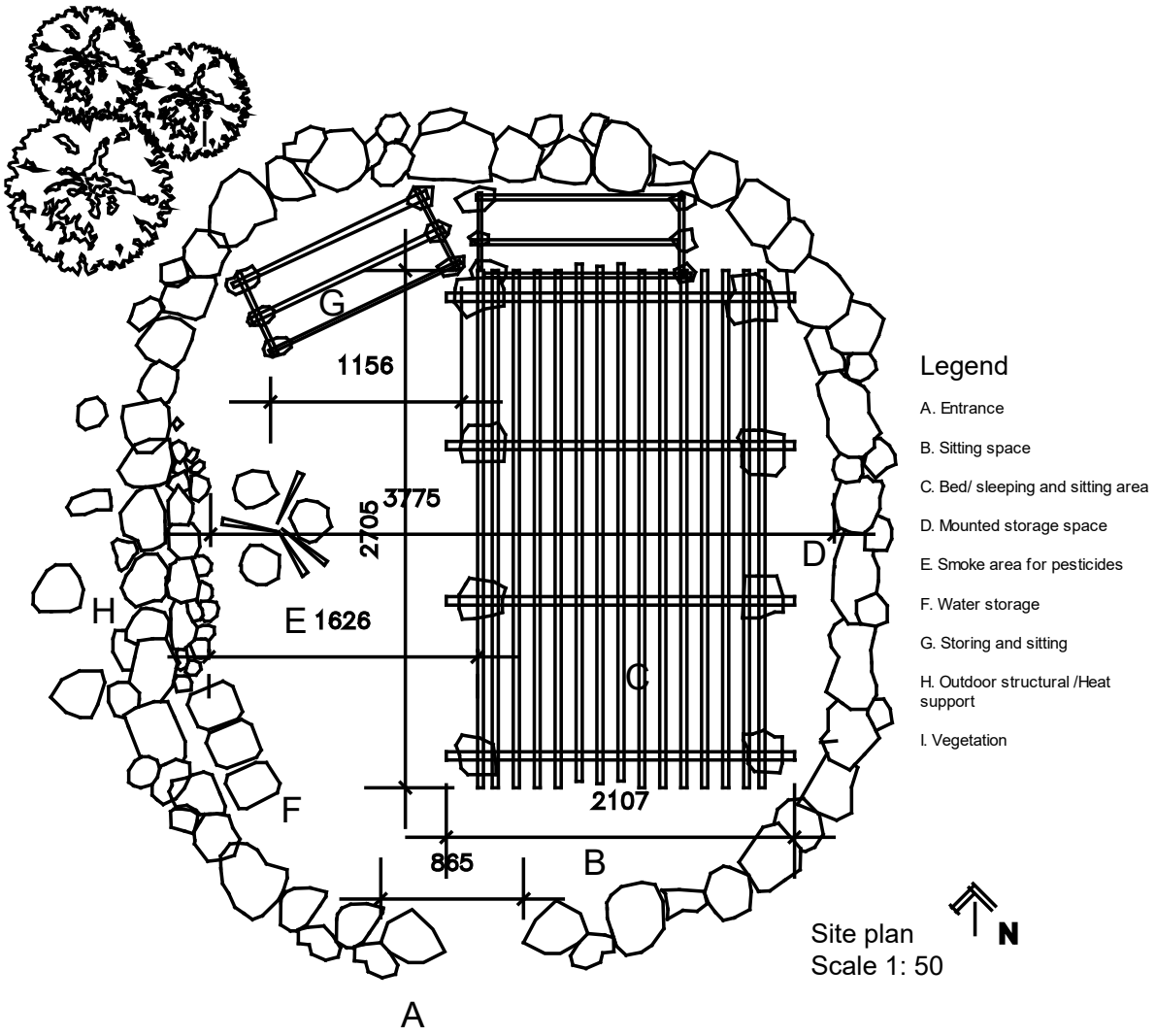
Site plan/ mobility



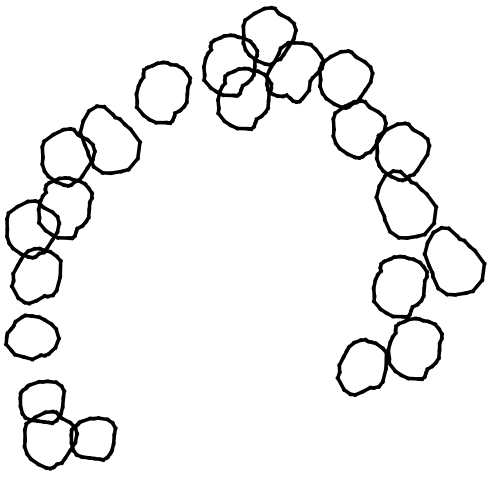
Site plan of the selected study area

The house **(Q'ari)**

- Plan/ measurement and space tagging



Outdooor milking space



Smaller tent for social gathering

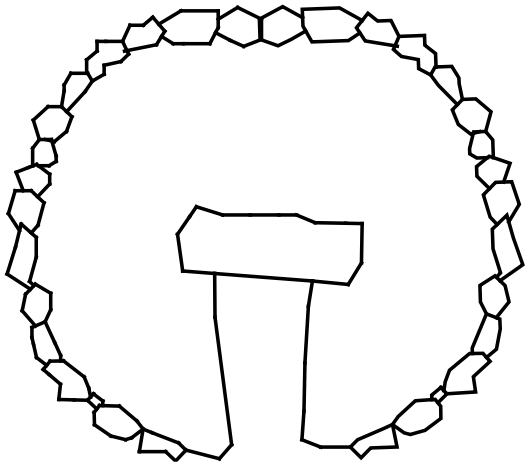


Figure showing a plan of afar vernacular architecture

- Elevation

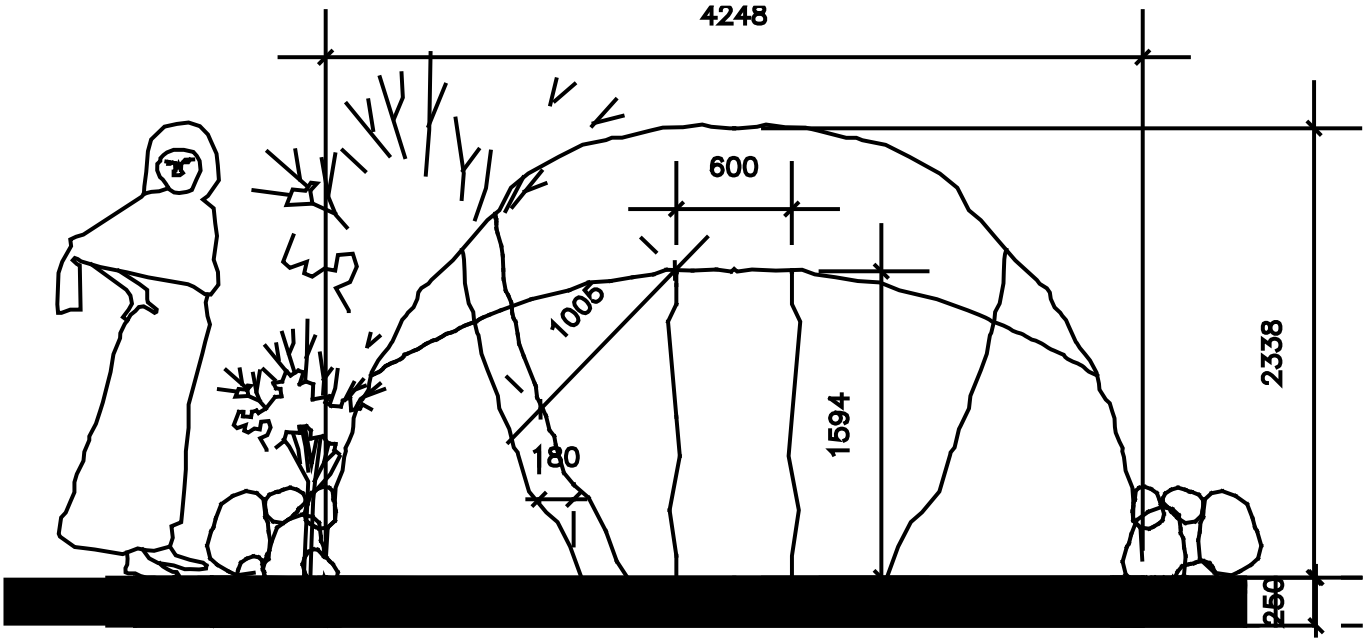


Figure showing elevation of nomadic Afar vernacular architecture

- Structure/ Detail

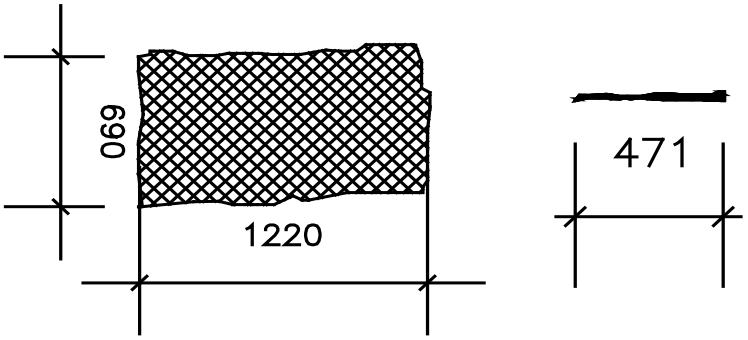


Figure showing the material used to build their dwelling envelope

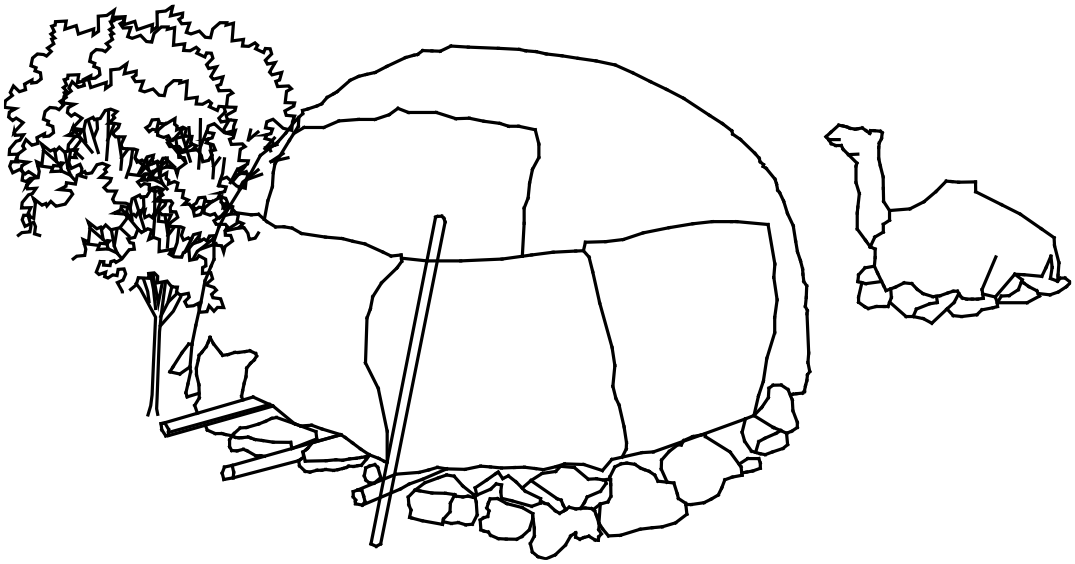
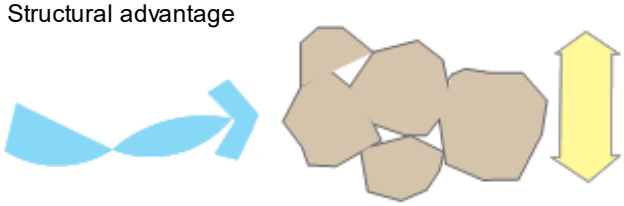


Figure showing illustration of “Qari” the dwelling of Afar vernacular architecture

Airflow diagram

Air filtration and cooling using mass

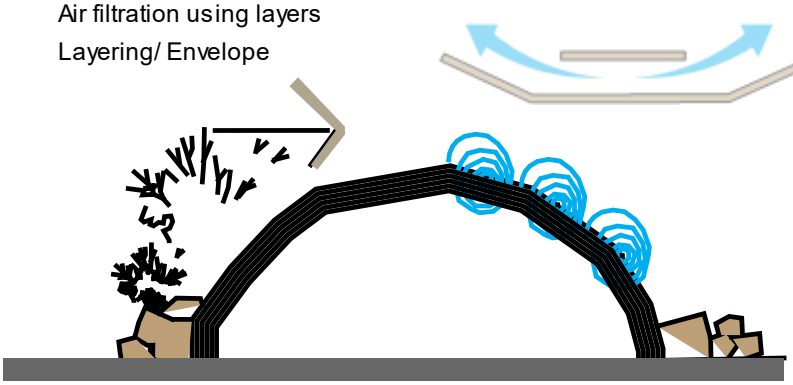
Structural advantage



Afar nomads use the rocks around the base not only for structural support they also used it as air filtration and cooling elements. When there harsh sun around midday, they opened the envelope around the base where there is pile rocks which can be used as air filtration and coolant.

Air filtration using layers

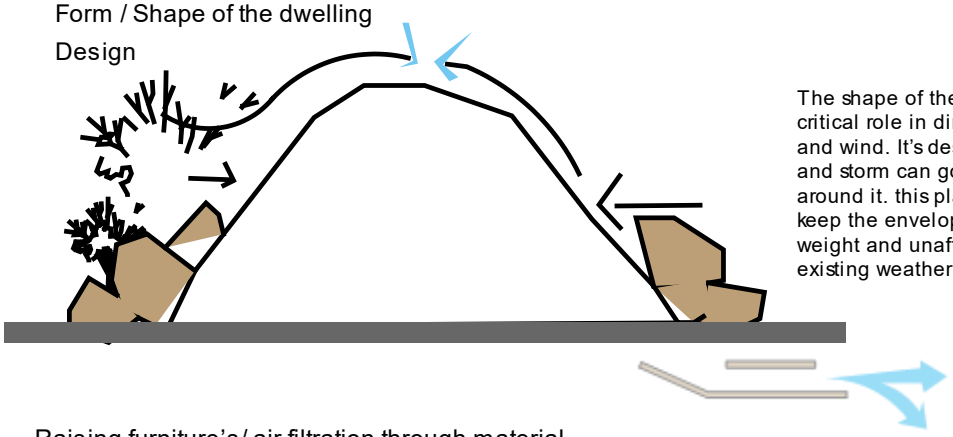
Layering/ Envelope



Q'ari vernacular dwelling experts uses layered natural envelopes so, that it can also filter and serve as cooling so the air has to pass through series naturally woven materials following it will decrease the air temperature flowing inside the dwelling.

Form / Shape of the dwelling

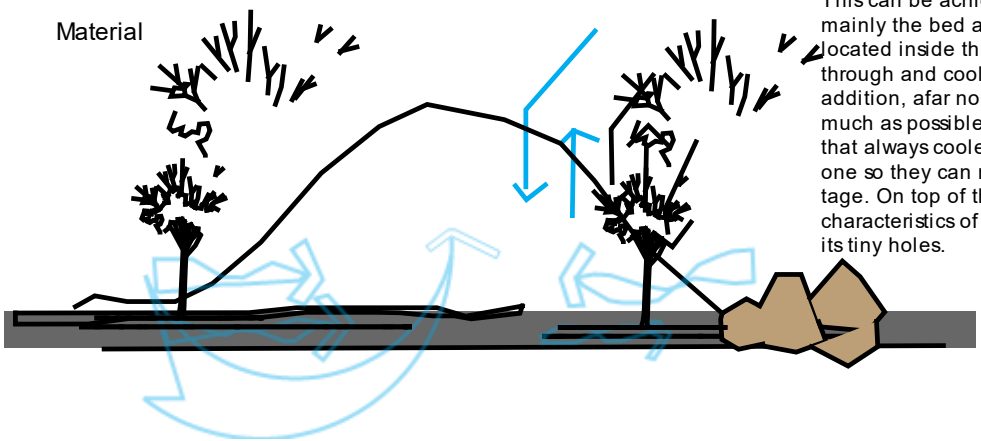
Design



The shape of the dwelling plays a critical role in directing heavy storms and wind. It's designed in a way wind and storm can go without distraction around it. this plays major role to still keep the envelope and materials light weight and unaffected with the existing weather.

Raising furniture's/ air filtration through material

Material



This can be achieved through raising mainly the bed and other furniture's located inside this will enable air to go through and cool down the space. In addition, afar nomads always stay as much as possible near to the ground that always cooled air is under the hot one so they can maximize this advan tage. On top of that the material has a characteristics of filtering air through its tiny holes.

Diagram showing Airflow technique and strategies of Afar nomads

Daylighting

Daylighting and ventilation depend on the adaptability and flexibility of the dwelling. This can be achieved thro changing the envelope opening pattern of the units. This alone makes afar nomadic houses very adaptable to th existing weather and environment. Below there is a diagram that show how much light and air they will let in du different time of the day. The yellow arches with different sizes show the intensity and shape they will open their door and envelope to maintain acceptable daylighting and ventilation.

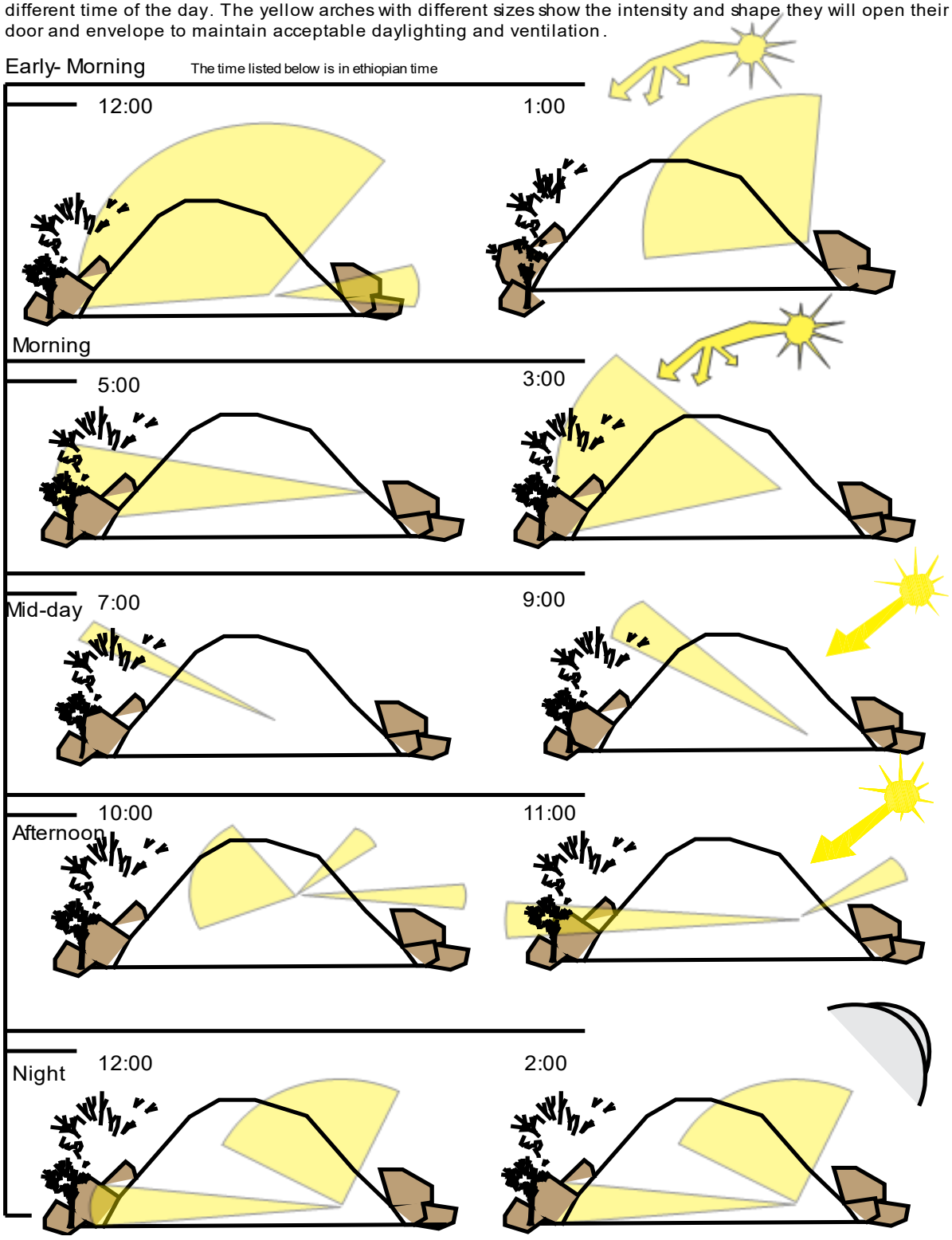


Diagram showing Afar nomadic dwelling Daylighting strategy

Recommendation and conclusion

In Afar, lessons can be learned from the existing vernacular design and strategy. The design guideline was developed considering the extracted principles that will be discussed below. The principles consider socio-cultural factors and traditional passive strategies found in Nomadic afar vernacular architecture. The concept of passive design was employed to decrease the heating, cooling and lighting demands of the building and meet the inhabitant's comfort based on their experience and acceptance that is explored in the analysis section. Strategies used in this thesis, such as optimizing natural ventilation by making the envelope flexible and adaptive throughout the day to define the daylighting and ventilation, environmental design inputs and analysis of unchanged factors like sun path and wind direction analysis, cross ventilation, orientation, shape, and suitable material chosen are mainly inherited from traditional and vernacular architecture. As a result, the proposed guideline shows great promise for lowering energy use by three major sectors i.e., heating, cooling, and lighting through understanding the social structure and spatial mobility of nomadic community.

Principles extracted from afar nomadic vernacular architecture

Knowledge transfer, maintenance of well-being and cultural integration of nomadic communities are much stronger than our sedentary architecture because it's so integrated with rituals and culture.

Understanding locale

As it is discussed in the data presentation and analysis section nomadic people orient themselves in a space according to paths and directions responding to the natural environment, topographic features in general the characteristics of the environment. This gave them the ability to analyse the environment whether it is suitable for settlement to not.

Individuality/ Responsibility/ Improvement

Understanding and interpretation of an environment are equally dependent on the position and individual ability as well as knowledge/ experience of the observer.

Travel Pattern _ Space definition

Afar nomads understand dwelling units as movement and travel regardless of their distance meaning could be in their neighbourhood or long travels from place to place.

Light, Sun, Shade and Shadows

The patterns of shade and shadow affect all of us in our day-to-day activities. In a hot and arid climate, the effects become more critical likewise most of the design concepts and strategies arose from managing light, sun, shade and shadow.

Proper utilization of natural resources Vegetation

Afar nomadic existence depends on vegetation and natural resources found nearby. It's also one of their reasons for traveling from place to place. It plays an important role in the sustainability of their entire existence, from their lively hood to the lively hood of their livestock.

Social and cultural integration Ritual and Celebration

Rituals take place in the central place of the settlement. Ceremonies like marriage and funeral ceremonies. Dwellings are constructed solely by women the architecture is experienced by societies of women.

Borders and Boundaries

Afar nomads usually don’t have any fences or other physical entity the sense of boundary is not expressed physically but rather it's behavioural. This means respecting other privacy and values.

Understanding of measurement _ Ergonometric

Nomadic architecture and ergonometric measurements. The language of Nomadic architecture continues to express itself through anthropometry e.g. The decision of the length of straw or envelope size that surrounds the structure always comes from the proper know-how of the size of the body concerning space and activities.

Settlement vs unsettlement

Assembly and disassembly

The permeance of Afar nomadic architecture is held through their cultural approach and the value of identity its behavioural trait. Identity and individuality are expressed through the weaving patterns and duplication of specific structural requirements. Integration of these individual patterns into the total design gives a personal touch to the dwellings.

Flexibility and Adaptability

The adaptability as well flexibility characteristics of nomadic vernacular architecture is essential for adaptation of any change that is coming ahead. In today's world where everything changes constantly the architectural approaches of Afar nomadic architecture is important.

Design guidelines

Transfer of Afar nomadic vernacular architecture to a future design in hot and arid climates. one can consider the following general principles as a guideline in adapting vernacular lessons from afar nomadic communities.

- Adaptation of proper local material for better daylight and natural ventilation;
- Proper design and utilization of openings for natural ventilation
- adaptive skins to deliver flexibility and multifunctionality of a space
- Participation and control for inhabitants so that they can transform the space according to their need.
- Reflection of outdoor temperature in the indoors through proper connections
- Promotion of local knowledge development and local building material manufacturing industries to minimize transportation cost.
- Adapting to local cultures and identities through applying traditional patterns.
- Improved design considerations of neighbourhood design including mobility and movement.
- more robust buildings that are less vulnerable to catastrophic thermal failure ceasing to be dependent upon electrical energy to remain habitable;
- fewer greenhouse gas emissions as energy use are reduced both embodied in materials and operational.

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