A house for nomads

Development of earth building technologies for the Afar Region: Implementation of a compound for education and culture

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Diplomarbeit

A house for nomads
Development of earth building technologies for the Afar Region: Implementation of a compound for education and culture

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Abstract (english)

This project encompasses the planning, design and the realisation of a construction project for educational purposes for the local development organisation “Afar Pastoral Development Association” (APDA) in the Afar region in Ethiopia. An educational centre consisting of a Kindergarten, a boarding school and a community space will be built in the course of this project. Access to education is limited in many areas of the Ethiopian multi-ethnic state, however particularly difficult in rural areas. Consequently, local populations from these areas are de facto excluded from political, economic and juridical participation and decision-making. The Afar region is inhabited by pastoral semi-nomads. Contemporary societal developments lead to changing settlement structures and alter architecture. Rapid economic growth and construction techniques, which are resource intensive, using wood which is rare, pose big architectural challenges in the country.

This project includes a theoretical analysis of ongoing developments, as well as it develops alternative construction techniques based on empirical research and design, and finally describes the implementation of the project on site. The actual architectural problems are encountered with a concept. Thereby the focus is on cost-efficient, ecological and locally adapted architecture. The materials used, building techniques and climatic conditions and social requirements are considered as being of central importance. Construction techniques using loam and adobes were used for the implementations. The buildings which are built using these innovative construction techniques should serve as examples of alternative building methods and should initiate impulses for new architectural developments. The implementation of the project was successfully initiated. A documentation of the building process is integrated as part of this report. The realisation of the whole education centre is in process but not yet completed. Empirical insights will be considered in further planning and implementation of the project. The construction process is ongoing. The completion of all planned buildings, a collection of resulting insights and the spreading of knowledge are the goals of this project.

Abstract (deutsch)

Das Projekt beinhaltet die Planung und Umsetzung eines Bildungs-Bauprojekts in der Afarregion in Äthiopien für die lokale Organisation „Afar Pastoral Development Association“ (APDA). Ein Bildungskomplex, bestehend aus Kindergarten, Schülerunterkunft und Gemeinschaftsräumen, wird im Rahmen dieser Arbeit entstehen. Der Zugang zu Schulbildung ist in vielen Gebieten des Vielvölkerstaats Äthiopiens sehr schwierig, besonders jedoch in ländlichen Regionen. Dies führt zu einer weitgehenden Exklusion der Bevölkerungsgruppen dieser Gebiete von politischen, ökonomischen und juristischen Entscheidungsprozessen. Die Afarregion wird von pastoralen Halbnomaden bewohnt. Gegenwärtige Entwicklungen führen zu einem Wandel der Siedlungsstruktur und der Architektur. Rasantes Wirtschaftswachstum und holzintensive Bauweisen stellen das Land vor eine große architektonische Herausforderung.

Diese Arbeit beinhaltet die theoretische Analyse der laufenden Entwicklungen, sowie die Entwicklung einer alternativen Bauweise basierend auf empirischer Forschung und Planung, und schließlich die Implementierung vor Ort. Auf die aktuelle architektonische Problematik wird in Form eines Entwurfs reagiert. Dieser legt den Fokus auf kostengünstige, ökologische und lokal angepasste Architektur. Die verwendeten Materialien, technischen Methoden, sowie die klimatischen Bedingungen und sozialen Bedürfnisse sind von primärer Bedeutung. Für die Umsetzung wurde die Lehmziegel Bauweise gewählt. Die für diese Region innovativen Gebäude sollen als Muster alternativer Bauweisen dienen sowie neue Impulse in der Entwicklung der Architektur setzen. Die Implementierung des Projekts wurde bereits erfolgreich initiiert. Der Prozesss ist in Form einer Dokumentation in die Arbeit integriert. Die Umsetzung des gesamten Bildungskomplexes ist in der Anfangsphase; gewonnene empirische Erkenntnisse werden für die zukünftige Vorgehensweise berücksichtigt. Der Bauprozess ist nach wie vor im Gange und die komplette Umsetzung aller geplanten Gebäude, die daraus gewonnen Erkenntnisse und deren Verbreitung sind das Ziel dieses Projekts.

Content of the diploma thesis

Introduction

The Afar region is known as one of the driest regions on earth. The landscape is covered with shrub lands, stone, and sand deserts. Despite these hostile environmental conditions people have been living there since ancient times. It is populated by semi-nomadic pastoralists named the "Afar". Their subsistence is based on livestock with which they travel in search of pastures and according to the seasons. This kind of lifestyle assumes a close relation to nature and an immense knowledge of the environmental processes.

The language of the Afar has been passed on orally until the 1970s when it has been transcribed into written form for the first time. Only few children in the Afar region have access to school education, whereby their nomadic lifestyle is a factor that has an impact on this. The lack of educational institutions and language barriers in class are other factors that contribute to the low education rates in the Afar region.

Currently the life of many Afar starts to change. Ongoing modernization processes within the country cause rapid changes in the environment conditions and living circumstances. Road construction, dams and large-scale plantations cause disruptions to the pastures and limit grazing land. Deforestation and unsuccessful reforestation with invasive plants further contribute to the newly developed problems also caused damage to the delicate ecosystem. A change in vegetation, pastoral territories and water balance occur. Increasing conflicts and impacts on the food security of the pastoral populations are some of the consequences.

But also the settlement structure is subjected to change: Immobile settlements are developed and the new cities grow rapidly. The lack of static architecture within the nomadic culture creates major challenges for the new urban requirements. Timber-pillar constructions with a high material consumption are imported from the once for-est-rich areas and endanger the seriously depleted tree population and the highly sensitive climate. To prevent further deforestation, an alternative way of construction has to be found. Currently the construction with steel and concrete is the solution the contractors offer, but these materials have a high energy consumption and are not affordable for the majority of the population. Increasing construction activity further rises the prices of these materials.

Earth construction techniques are known all over Ethiopia, but in many areas the clay is used only for plastering wooden constructions. In some areas the supporting structures are also made out of loam, but further spreading of this knowledge is needed. In Afar occasionally a slight scepticism regarding the stability and durability of loam constructions can be observed. By using modern earth construction techniques the properties of the construction can be optimized and the trust to the earth construction techniques can grow.

For the extension of the education program of the local organisation *Afar Pastoral Development Association (APDA)* new buildings are required in the town of Logya. An education complex consisting of a kindergarten, a student-accommodation, and communal facilities will be created in the context of this work. The "student hostels" will provide the possibility for 50 rural students to get a higher education and visit government schools in town. Assisted accommodation and food will be provided for the students. Preserving and developing the local culture and language as well as preparing the children for school education will be the focus of the education in the kindergarten, but also in additional lessons held for the hostel students. About 60 children will visit the kindergarten. Communal space, integration of public zones, and small-scale food production in gardens are part of the design. A newly defined Afar compound for children will be created. Operation and maintenance of the compound will be managed by the organisation APDA, which will be the owner of the education-compound.

The design process is focussed on finding an architecture which builds on traditional building construction, social aspects, ecological materials, and climatic challenges of this extreme region. Low costs and uncomplicated techniques are focused. The innovative buildings in this area should act as samples stimulating discussions and generating new impulses in the development of urban architecture. The construction of the houses will be done with loam adobes. Additionally other earth construction techniques such as rammed earth will be used for some elements. By using different techniques the advantages and problems regarding the implementation can be documented and the best solution for the region can be found. And the knowledge of different earth construction techniques can be shared by the local population.

This diploma thesis is divided into three parts: research, design an implementation. This division corresponds to the sequence the project was carried out and organized. The implementation is already started and an ongoing process. Actual information will be displayed on my homepage: *afarhouse.wordpress.com (english)*
afarhaus.wordpress.com (deutsch)

Acknowledgements

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I Research

Content - Research

1. Preface - Research

The first part of my work will provide some information necessary to understand the interactions of the design process.

Glossary

Addis Ababa	Capital of Ethiopia
Afar	Name of the region and inhabiting people of the north-estern lowlands of Ethiopia (Afar, Affar, Qafar)
Amharic	Official Language in Ethiopia
APDA	Afar Pastoral Development Association; The project is done in cooperation with APDA and they will be the owners of the compound for education and culture.
ARNS	Afar Regional National State in Ethiopia
CSA	Central Statistical Agency Ethiopia
EiABC	Ethiopian Institute of Architecture, Building Construction and City Development, Addis Ababa
Logya	Town in the center of the Afar Region, where the project is built.

1. Ethiopia

1.1 General Information

Geographical Position
Ethiopia is placed at the Horn of Africa, between 3°24` and 14°53` North; and 32°42` and 48°12` East. The country covers an area of about 1.1 million square kilometres. It stretches about 1,200 km from north to south and boarders on Djibouti, Eritrea, the Republic of the Sudan, the Republic of the Southern Sudan, Kenya, and Somalia. Ethiopia lies on the continental part of the East African Rift System. The population of Ethiopia was 87,952,000 people in 2014. (Ethiopia Demographic and Health Survey 2011; FAO: Country profile Ethiopia)

Topography
The topography ranges from 4,550 metres at the "Ras Dashen" peak in the highlands down to 110 metres below sea level in the "Afar Depression". (Ethiopia Demographic and Health Survey 2011)

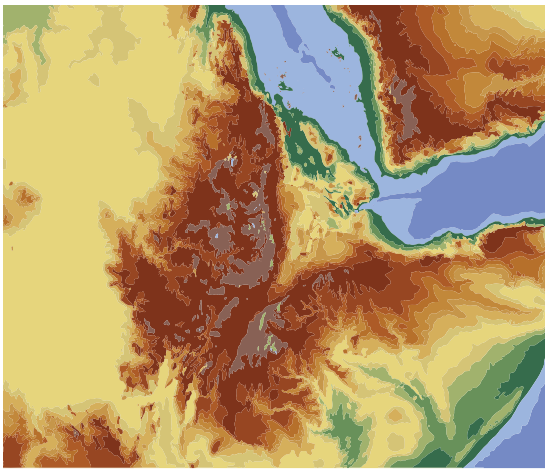
Climate
With the topography the climate changes distinctly. There can be up to 47 degrees Celsius in the depression areas and temperatures as low as 10 degrees in the mountains. The three climate zones are tropical rainy, dry and warm temperate. (Ethiopia Demographic and Health Survey 2011)They can be revealed on the satellite picture below.

Form of government
Ethiopia was ruled by emperors until 1974 when the Derg military-regime was overtaking power. In 1991 the Ethiopian Government introduced a policy of decentralisation and nine newly created regional states were determined. Since 1994 Ethiopia is a Federal Democratic Republic. First public elections were held in 1995.(Ethiopian Parliament Information; FAO: Government expenditure on forestry)


1.1

1.2

1.1 Political map of Africa and Arabian peninsula
1.2 Ethiopia with bordering countries
1.3 Topographical map of Ethiopia / Horn of Africa
1.4 Satellite picture of Afar / Ethiopia / Horn of Africa

1.3


1.4


1.2 Brief historical background

Based at the Horn of Africa, Ethiopia looks back to a long and eventful history. The boarders of Ethiopia have changed many times and also within the country relations between the cultures changed. Ethiopia is a multi-ethnic state with over 80 ethnicities with their own cultures, customs and languages. There are two main groups of people living in Ethiopia: the primarily settled people from the highlands and the agriculturalists, many of them pastoralists in the lowlands.

In the Rift Valley discoveries of hominid bone fragments date back 4.5 million years. Ethiopia is said to be the origin of humankind, although older findings in Chad had recently been discovered. The famous skeleton of "Lucy" (tralopithecus afarensis) was found in the Afar Region and dates back 2.9 to 3.4 million years. Since 975 B.C. there had been emperors ruling the country.

Ethiopia is said to be one of only two countries in Africa, that never had been colonized, although this is still subject to debate. But the relationships and distribution of power within Ethiopia´s cultures had often been unbalanced. Some authors see this as some kind of colonization of multiple cultures within the states boarders.

Ethiopia was the first country in Africa that embraced Christianity (340 A.D.) and also part of the early development of Islam (700 A.D.). The time of the emperors ended in the 1970´s when the socialist military-committee called Derg took over power. Ethiopia had political, economical and military cooperation with Great Britain, USA, Italy, Egypt, France, Cuba and the Soviet Union. The delivery of weapons and money for military purposes were an important part of this cooperation. Egypt occupied parts of Ethiopia, Italy tried to invade in 1935. Today Ethiopia is a democratic Republic. (Shinn, 2004; Omar, 2010, Last, 2010)

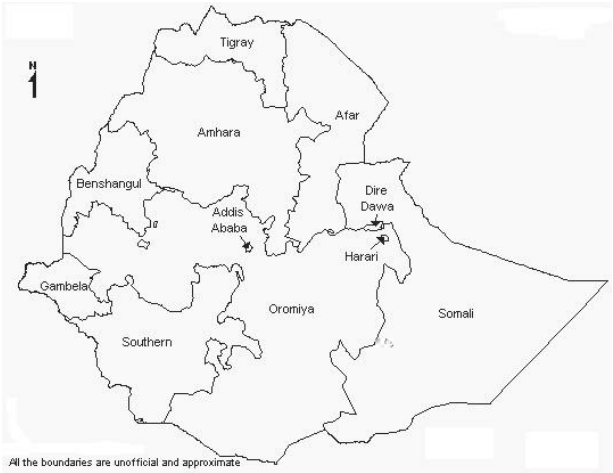
1.3 Demography

Ethnicities, cultures and languages

Ethiopia represents a heterogeneous mixture of linguistic, ethical and cultural types. Only about 17 % of the population lives in cities. The country is divided into nine newly created regional states (Fig. 1.5). Each state is built on different tribal settings. The Oromiya people make up the biggest population group with 36.6 %. The Afar are a minority with 1.89 %. (Shinn, 2004; CSA, 2007, FAO: Government expenditure on forestry)

The main religions are Orthodox (43.5%) Islam (33.9%) and Protestant (18.5%). Traditional religions constitute about 2.6%. (CSA: National Population and Housing Census 2007)

1.5



Population by age

The total population of Ethiopia in 2014 was 87,952,000 people according to the Central Statistic Agency (CSA). A study of the CSA with a number of 39,462 surveyed people suggest that 55.7 % of the population are aged younger than 20 years. The people from 20 - 39 years make up 26.7 %, and 11.4 % are 40 - 59 years old. Only 5.2 % are between 60 and 79, and 1 % is 80 or older. (CSA, Mini report 2014, own calculations)

Tab. 1

Geographical Region	POPULATION	%
Country Total	73,750,932	100
TIGRAY	4,316,988	5,85
AFFAR	1,390,273	1,89
AMHARA	17,221,976	23,35
OROMIA	26,993,933	36,60
SOMALI	4,445,219	6,03
BENISHANGUL-GUMUZ	784,345	1,06
S.N.N.P REGION	14,929,548	20,24
GAMBELLA	307,096	0,42
HARARI	183,415	0,25
ADDIS ABABA CITY	2,739,551	3,71
DIRE DAWA CITY	341,834	0,46
ESPECIAL ENUMERATION AREA	96,754	0,13

1.4 Economy

Economy and Agriculture
The Ethiopian economy is dominated by agriculture and the services sector. Each accounts for about 45 % of the Gross Domestic Product (GDP). About 10 % are earned by industry (2006/07).

Approximately 45 % of the landmass is arable. Agriculture is supplying domestic consumption and manufacturing industries and produces the primary export commodities. 86 % of the total foreign exchange earnings come from agriculture. With 60 % of total export income coffee is the most important product. In Ethiopia coffee is still widely produced by smallholders and the coffee is growing wild. Only few plantations exist so far. Currently 85 % of employment and 70 % of the raw material belong to this sector.

Most of the households earn their total income from crop and livestock. Up to 87% of this total household cash income is from livestock, depending on the part of the country. The higher the cash income, the higher the share of livestock. This can indicate that increased cash income comes primarily from livestock, especially in the pastoral areas. The Middle East countries have been a traditional export market for Ethiopia. Increasingly stringent health and quality control regulations led to declining official exports share, only partially substituted by illegal ones. This leads to over-capacities in livestock, depresses domestic market prices and reduces income. (FAO: Livestock marketing in Ethiopia, Ethiopian Government: Economy, Omar, 2010)

Livestock
Ethiopia has the largest livestock population in Africa. Over 80 million cattle, sheep, goats, equine and camels and 55 million chicken live in the country. The livestock sector contributes 12 % to the total Gross Domestic Product (GDP) and provides livelihood for 65 % of the population. 40 % of the cattle, 25 % of the sheep, 75 % of the goats and 100 % of the camels belong to the pastoral sector. (Getachew, 2001; FAO: Livestock marketing in Ethiopia)

Traditional agricultural systems
The independence of the agricultural production in Ethiopia is extremely high. Most of the farmers are smallholders producing mainly for their own consumption. The advantage of this system is an equal distribution of the capital stock and resources within traditional systems (like the Gada-system in Oromiya). In these systems the ownership of land and mutual help in emergency situations is clearly defined. They also have a smaller impacts on the ecosystem and environment compared to industrial farming and plantations. The lack of infrastructure like systems for irrigation, constructive interventions against erosion and reafforestation prevent optimized yields. And the lack of effective preservation, storage and distribution possibility lead to losses of the harvest. (Omar, 2010)

Refugees and forced displacement
In 2014 Ethiopia was on place five of the largest refugees-hosting countries worldwide. 659,500 people have fled their homes and came to Ethiopia. At the same time 86,861 people were fleeing from Ethiopia. The 30 countries with the largest number of refugees per 1 USD GDP (PPP) per capita were, all members of developing regions, including 18 of the Least Developed Countries. Hosting 440 refugees per 1 USD GDP (PPP) per capita, Ethiopia had the highest number of refugees relating to its national economy, followed by Pakistan, Chad, Uganda, Kenya and Afghanistan. These Least Developed Countries host 25%, the developing regions, in total 86 %, of the worldwide 59.5 million forcibly displaced people. (UNHCR Global Trends, 2014)

Poverty and economic development
The Ethiopian government portal sees the reasons for the limited change in the structure of the economy among other things in: "... the low levels of investment flows and the sluggish growth of the private sector, which was too little to affect its historically low share in labor-intensive manufactures." (Ethiopian Government: Economy, 2015) In contrast Musa Mohammad Omar claims in his book "Herrschaft und Armut in Äthiopien" the government and ruling classes themselves, as well as the foreign creditors, are responsible for the poverty. He sees the main reasons in unjust agrarian reforms that exploit small farmers and different ethnic groups, as well as in the war policy of the ruling classes with enormous expansions in military spending, as well as the fatal consequences of war on the population. In 1988 Ethiopia spent 563 US $m. (8.1 % of the GDP) on military purposes. 2001 the amount descended to 286 US $m. (Ethiopian Government: Economy; Omar, 2010; The Guardian: Military spending)

1.5 Living standard and public infrastructure

Wealth index
The wealth index is used to indicate inequalities in household characteristics in the use of health and other services, expenditure and income measures. The so-called Gini Coefficient amounts to 0.44 and the situation is better in urban areas (0.2) and worse in rural areas (0.31). The highest Gini Coefficient, which means the least equitable distribution of wealth, is observed in Afar (0.65). (CSA, Mini report 2014)

Drinking water
Referring to statistics of the CSA 56.9 % of the total population had access to an improved source of drinking water (in urban areas 94.3 % and in rural areas 46.4 %). This means 53.1 % of the rural population has only access to non-improved sources like unprotected wells and springs, tanker trucks or surface water. (CSA, Mini report 2014)

Sanitation facilities
Only 4 % of households have improved toilet facilities on their own (11 % in urban, 2 % in rural areas). About 8 % use shared toilets. And 88 % of the households in Ethiopia use non-improved toilet facilities (58 % in urban, 97 % in rural areas) including having no facility at all (11.3 % in urban, 39.8 % in rural areas). (CSA, Mini report 2014)

Famines
The high reliance on domestic agriculture combined with the missing infrastructure make the provision system unstable, especially in cases of droughts, pests, wars and other changes in the environment like large irrigation and plantation projects. The worst famine catastrophes since 1960 were in 1972-73 and 1984-86. (Rettberg, 2009)

1.6 Architecture and housing

Current development
The variety of architectural styles and building techniques in Ethiopia is rich, as all the cultures have their own building tradition. An overview of the different styles would go beyond the scope of this work. Below there is a comparison of three housing types and standards of living. The first figure (1.6) shows rural settlement, how the majority of the population lives. Water has to be carried and is kept in containers and there is no electricity. On the next figure (1.7) a typical informal settlement in rural areas is shown. Although the supply along the new road is built, these houses have no water supply. The third picture (1.8) shows a modern "Condominium", built by the state and inhabited by people with higher income.

The significance of traditional construction techniques
Traditional construction techniques are increasingly buried in oblivion. Modern is one of the significant words within this process. This word is often connected with improvement, especially in countries with developing economies. But modern does not necessarily mean improved. The traditional Ethiopian way to impregnate loam-roofs is a special cactus-mixture which makes them waterproof. With the appearance of modern materials on the local markets the traditional roof construction techniques fell into disuse and were left behind. After some time people were no longer able to repair their roofs and replaced them with corrugated metal sheets. These roofs, if correctly constructed, are less maintenance dependent. On the other hand the climate in the house suffers from the direct heat transfer through the metal. Further, high energy consumption of the metal production and the transport pollute the environment. Finally, metal is a cost-intensive material, which is not affordable for all. While constructing with corrugated iron might still be modern, its advantages might be overshadowed by its downsides. (Zegeye, 2012)

1.6

1.7

1.8

1.7 Education systems

History of education in Ethiopia

Cultural education

The awareness of an ethic group of the importance to educate the young generation and preserve the culture and mother tongue is influenced by the use of the mother tongue as a medium of instruction. Besides this, the classic school curriculum is based on the western scheme of education. The western model of education is often not adequately adapted and comprehensive for the local requirements. Basic education, international orientation, competitiveness and suitability for science are the goals of this "classic school education model" from the west. But beside this local adaption, culture and the immense knowledge about living in harmony with the environment should be greater valued, as these topics are increasingly important. For example the Afar Region is classified as "not suitable for human life" or "hostile environment" but still 1.4 million Afar live in this region in Ethiopia. It requires a special way of life, an immense knowledge about weather conditions, nature, animals and orientation to survive here. The connection between action an reaction within this environment are often very close, the impacts can have huge dimensions. This knowledge was the traditional way of education within these societies. The languages and mediums of transfer were often different using stories, songs, dances and practical task. The impact of neglecting this kind of education is often not sufficiently reflected in the western model of education. (Griefenow-Mewis, 2009)

Modern education

The history of modern education can be divided in four periods: Influences by religion, western school systems, socialist oriented education and current curriculum.

The early emergence of education is related to the emergence of Christianity. Christian missionaries preached their believes and began to found educational and medical institutions. The first modern state supported school was founded in 1908 in Addis Ababa. A proclamation declared to urge parents for sending their children to school, money was offered to attract students.

Pre-war education was focused on training translators, ambassadors and emissaries. At this time the education system was dominated by the French system, 20 schools were built during this period. By the invasion of the Italians the institutions were devastated and collapsed, school was permitted up to grade four. The major mother tongues were used for instruction on primary level. After the expulsion of the Italians in 1941 a shortage of money, materials and teachers characterized the situation and the government made agreements with Great Britain. This was the start of the British oriented education and English became the medium of instruction. The secondary education was introduced. In 1958 Amharic replaced English as the teaching language and more practical subjects like Agriculture, Health Education, Culture or Handicrafts were introduced by the Ministry of Education. After the conference held in 1961 of the heads of states of independent African countries a more Africanized education system was intended to create. Technical and vocational subjects were offered. Teachers guides, textbooks and instruction materials were developed and distributed. Despite all efforts the number of books was insufficient. The commercial training and vocational subjects and the duration up to grade twelve was extended. A reorganization and equipping of the secondary schools was done with assistance of the United States Agency for International Development. The new curriculum expanded rapidly. The number of students was reduced to thirty per teacher and the program was continued to the ninth and higher grades. A national committee was established by the Ministry. The reasons for low standards and failing of students should be established and strategies proposed.

In 1974 the period of the socialist oriented education started. The general principles were: Education for production, education for science, education for socialist consciousness. The former academic school system was continued and adapted to socialist ideologies. Polytechnic Education was introduced.

After the socialist period in 1991 the curriculum development process and its trend research conducted. Public discussions on poorly equipped, overcrowded and badly managed schools in different regions were held. The missing of societal, pedagogical and creative demands was also claimed and the ignorance of science and cultural components. New guidelines and general objectives were formed. The new education system, described on the following page, was introduced. (Griefenow-Mewis, 2009)

Current challenges

More than 55 % of the 87 million Ethiopians are younger than 20 years. The schools are already overcrowded and under-equipped. In Logya for example there are 29 teachers for 1710 students in primary school. There are 95 students in one class room. (TH Consulting, 2009) School books are rare and often the children do not have anything to write, because their parents can´t afford stationery.

Education system
In Ethiopia school education is divided into primary and secondary education in a 8-2-2 system. Primary education ranges from grade 1- 8. Grade 1-4 is for pupils from 7-10 years, grade 5-8 for 11-14 years. The secondary education is grade 9-10 (15-16 years) and ends with an final exam. If the children want to go to university they have to complete the preparation phase of grade 11-12 (17-18 years). After successfully completing these grades and the university entrance exam they are qualified to study at the university. (Griefenow-Mewis, 2009)

Subjects
Grades 1-4:
1. Languages: Mother Tongue, Amharic, English
2. Mathematics
3. Environmental sciences: Biology, Chemistry, Physics, Geography, History, Civics)
4. Aesthetics (Physical Education, Music, Arts)

Grades 5-8:
1. Languages: Mother Tongue, Amharic, English
2. Mathematics
3. Natural sciences: Science, Biology, Chemistry, Physics)
4. Social Science and Studies
5.Cultural Education: Arts, Music, Physical Education)

Education languages
The Oromo language played a special role, as it was the first language used as a medium of instruction in the 19th century. Amharic was used as a medium for instruction after 1945. There are 8 languages in primary schools in different regions of the country in use. The official language in schools is Amharic. (Griefenow-Mewis, 2009)

Percentage distribution of school graduation
The school attendance and graduation rates are significantly higher in urban than in rural areas and for males compared to females. About 47.9 % of females (26.9 % in urban, 52.8 % in rural areas) and 36.6 % of males (14.9 % urban, 41.1 % rural areas) have no school education at all. 3 % of the females finished primary, 0.7 % completed secondary and 2.4 % have higher education than secondary. Of the male students 4.2 % finished primary, 1 % completed secondary and 3.8 % have higher education than secondary. (CSA, Mini report 2014, own calculations)

Woman literacy
With 6 % the Afar Region has the smallest percentage of woman (aged 15-49) having a secondary or higher school education. The highest numbers are reached in Addis Ababa (44.1%), Dire Dawa (33.6 %), Harari (33.3 %), Tigray (19.9 %) and Amhara (13.2 %). The literacy rate is declared 22.9 % which includes every person from secondary school education to “can read a part of a sentence”. This rate is only lower in Oromiya with 16.6 %. (CSA, Mini report 2014)

Mobile school education in rural Afar
In areas where the access to school education is rare or relatively new, there are also children of different age groups and adults visiting classes. One of these areas is Afar. In the rural areas, there can be young children of 5 years and adults sitting in the same class, if the adults or older children had no chance to learn the treated subjects before. The mobile teachers educated by APDA often have a wide range of audience.

1.9 Private kindergarten in Logya town
1.10 School education with mobile teacher in rural Afar with mixed audience; the teacher (white shirt) in the back

1.9

1.10

1.8 Landscape and nature

In the highlands evergreen thicket, scrubs and forests, as well as high mountain vegetation dominate the landscape. Swamp formations are found around the lakes in the high- and lowlands. The lowlands are covered with desert and semi-desert vegetation like Savannah and Wadis. There is a rich wildlife in Ethiopia, although the population of especially big animals like Elephants or big cats was shrinking the last decades because of deforestation and hunting. (Rettberg, 2009; Westphal, 1974; Grabherr, 1997)

Deforestation
It is estimated that 3.4 million km^2 of forests in dry-land zones of Africa had become degraded through human activities. Agricultural expansion for crop and livestock production and deforestation for fuel-wood and construction are the causes. Ethiopia´s forests shrink rapidly and this is developing to a serious problem. About 92 % of the nations energy income are biomass resources. Wood makes up about 77 %. Forests covered 16 % of the land in the 1950s; this share decreased to 2.7 % in the early 1990´s. Land-use shifts have impacts on traditional resource management in arid and semi-arid areas, where the pastoral way of life is common. In northern Afar a reduction of woodland from 8.35 % to 0.28 % and grassland from 7.75 % to 0.91 % took place between 1972 and 2007. (Tsegaye, 2010; Bekele-Tesemma, 2007, FAO: Current status of the forestry sector)

Desertification
Human induced land degradation, or desertification, is caused by actions that have a negative impact on the functioning of the environment, or ecosystems. Drivers of desertification are improved grazing and domesticated crops, chemicals used for agriculture, pollution, deforestation and the increasing population. Under natural conditions hydrological and geomorphological processes are regulated by vegetation, ecosystem and soil. Under this condition there is little flooding, erosion and sediment transport. The change in the vegetation affects soil organisms, water and salt balances and other plants and can lead to a total collapse of the system. In dry areas the impacts can be less groundwater, dried springs and whole rivers or lakes can disappear. Once occurred, it is very difficult to reverse this process. To avoid desertification at a local level simple actions to restore soil quality can be done to raise fertility by improving micro-climate and water availability. The conservation of soil, water and vegetation and the restoration of degraded areas by constructive interventions and reforestation have to be done. (Imeson, 2012)

Interactions in ecosystems by the example of termites
Termites are colonizing insects that can be divided into wood-, dead plant material- and humus-eating feeding types. Living in warm areas all over the continents, they are mainly found in tropical and subtropical areas. They are known for their damaging conduct as wood pests, which brought them a bad reputation. Termites can cause serious damage to buildings, but their impact on their environment is much more extensive. Their constructions are crucial to stop desertification in semi-arid climates and in protecting these ecosystems. The subterranean tunnels enable water to penetrate the soil more effectively. The mounds store nutrients and function as a “safe site” for the germination process of plants, when they are abandoned. (Princeton, 2015; Grabherr, 1997)

1.11 Termite tower in semi-arid southern Ethiopia, near Turmi
1.12 Landscape in the dry Afar Region in north-east Ethiopia
1.13 High plateaus and valleys (Simien Mountains) in northern Ethiopia with higher rainfall and lower temperature

1.11

1.12

1.13

1.9 Geology

1.14 Volcanic pile in the highlands

1.15 Fissure in “Boina” opening in 3 weeks

Geology Ethiopia

The country is placed on the northern tip of the East African Rift. The Highlands in the west of Ethiopia are covered with voluminous piles of mainly Cenozoic volcanic rocks. At the eastern part Mesozoic and Cenozoic sediments occupy the landscape. The Rift Valley in the north-east is covered with relative young lacustrine sediments and volcanics. Afar is part of the Rift Valley. (Schlüter, 2008)

East African Rift System

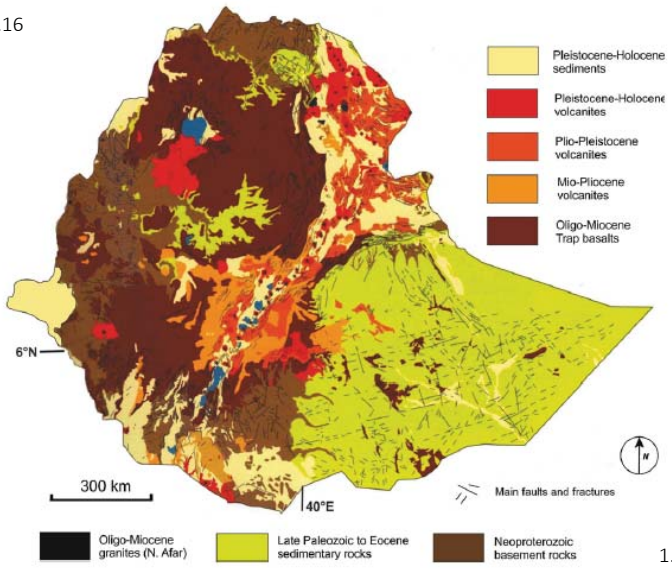
The East African Rift System stretches over 3000 km from the Afar depression in the north to the Okavango Delta in the south. Continental rifting processes are producing sediment-filled rift basins or form new ocean basins and are characterized by volcanic and seismic hazards and geo-thermal energy resources. The Eocene-Oligocene Afar volcanic province is covered with the earth´s youngest, up to 3 km thick layers of flood basalt and more minor rhyolites. The rift marks the boundary between the Somalia plate and the Nubian plate, which are drifting apart with an extensional velocity of 4-6 mm per year. The junction spreading between Nubian and the Somali plate current geodetic data predict that 23 km of sea-floor spreading had been produced during the past 11 million years near the Danakil Micorplate. The key processes of these spreading are “weakening of the lithosphere by mechanical stretching, intrusive heating and interactions with a dynamic asthenosphere.”(Yirgu, 2006) One impressive occurrence was the opening of the 60-kilometer-long an 4 meters wide fissure that opened up within three weeks after an earthquake in the region of “Boina”. (NBC, 2005)

Afar triple junction

Plate kinematics of the Nubia, Arabia and Somali plates develop the Afar rift triple junction, complicated by the presence of the Danakil and the Aisha microplates. The result is a complex plate boundary at the active plate separation and intense magmatic activity that stretches over a 250 km wide area. Most of Afar is covered with Plio-Quaternary volcanics and sediments. During the late Proterozoic the continental areas around the Afar Depression were stabilized. It retained as a stable platform until the Cenozoic continental break-up. The Cenozoic rift flanks were covered by sediments of Jurassic, Cretaceous and Palogene series, that were deposited by seawater spread inland from the Ocean. About 31-28 Ma ago 1-2 km basaltic flood volcanics covered a large area on the Ethiopian plateau. (Yirgu, 2006)

1.16 Geological Atlas of Ethiopia
1.17 East African Rift: movement and plate boarders

1.16



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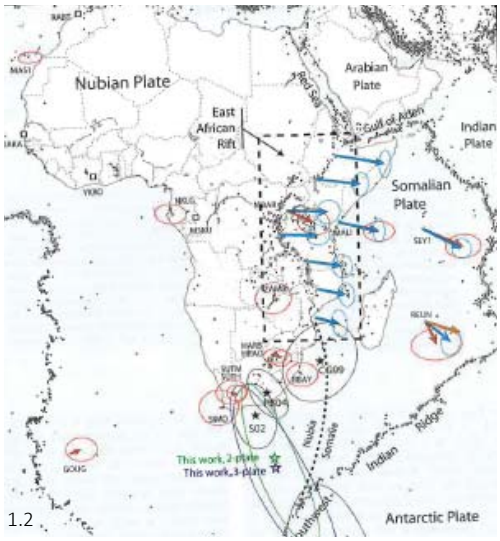


1.2

2. Afar

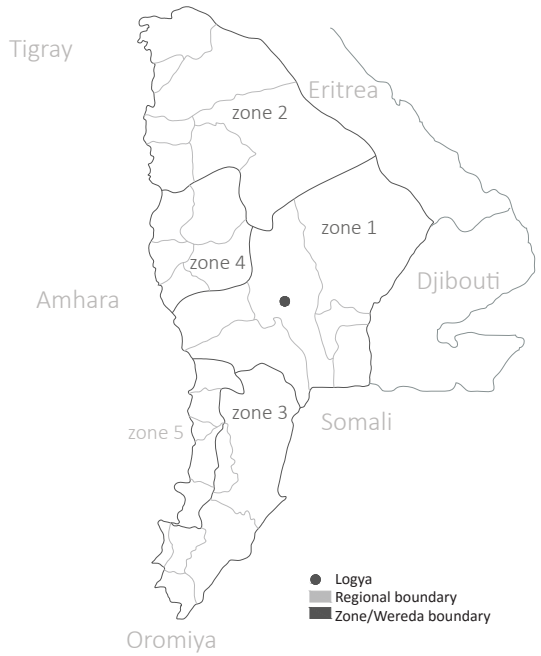
2.1 Geographic position and boarders

Cultural borders of Afar
The region inhabited by the people belonging to the ethnicity of Afar stretches from the North-East of Ethiopia to parts of Eritrea, Djibouti and Somalia. The land was divided by tribes and clans of Afar and neighbouring ethnicities long before the current political borders were defined.

Political borders of the Afar Region in Ethiopia
The Afar Regional National State (ARNS) of Ethiopia has regional borders to the Somali-, Oromiya-, Amhara- and Tigray -region and international borders to Eritrea and Djibouti. It is dived into five administrative zones and 32 regional administrative units called "Woreda". The new capital is Semera town, which was founded in 2002/03. Before this, Asayita was capital of the region. (TH Consulting, 2009; Rettberg, 2009)

Geographic position
The Afar Region is in the north-eastern part of Ethiopia. The geographic coordinates are ranging from 39°34' and 42°28' East Longitude and 8°49' and 14°30' North Latitude. It is part of the arid and semi-arid lowlands. Over one third is below 400 m sea level and more than half of the land is between 400 and 900 m. The lowest point is 157 m below sea level in the Danakil Depression. (TH Consulting, 2009, Rettberg, 2009)

Afar Regional National State (Ethiopia)



2.1

2.2 Climate

The Afar region is known as one of the hottest and driest places on earth with average temperatures ranging from 25 to 48 °C in the Danakil depression. The present landscape of the Region is a product of tectonic processes, episodes of wind and water erosion. Changes in temperature, rainfall and vegetation are closely connected to the topographic development. (TH Consulting, 2009; Rettberg, 2009) This is graphically illustrated in figure 2.12 to 2.14.

2.3 Pastoralism and nomadism at the Horn of Africa

Pastoralism means the raising of livestock on natural pasture, that is unimproved by human intervention. In fact the line between pastoral land and farm land may shift, as rotation systems or other human activities often shaped the landscapes. Nomadic and semi-nomadic pastoralists are found in areas, where the environmental conditions do not allow agriculture and settlement, such as the deserts of Afar. The people living in the arid lowlands at the Horn of Africa are pastoralists. Ethiopia has the biggest portion of lowland pastoralist zone in the area. This zone stretches from Eritrea in the northeast to Sudan in the west and parts of Djibouti, Somalia and Kenya. The pastoralist population of Ethiopia is roughly estimated to lie at 12 % of the total population. (Markakis, 2011; Salzman, 2004)

2.4 Population

Population facts
According to the population census 1,411,092 million people were living in Afar Regional National State in 2007. The Afar are Cushitic-speaking. (TH Consulting, 2009)

Pastoralism and Nomadism
"Some pastoralists depend entirely for their subsistence on livestock." (Getachew 2001, 9) Some have a combination with subsidiary cultivation, commerce and wage-employment. A combination of pasture with crop cultivation to produce fodder and food is done by the Agro-pastoralists. Mobility is a main principle of the herd management. In the dry seasons pastures takes palce along the rivers and during the floodings in the rainy seasons the pastures on higher elevations are used. (Salzman, 2004; Getachew, 2001)

Religion
Most of the people are Muslim (about 95 %) with animistic-traditional beliefs and practices. Early settlers from the Arabian Peninsula brought the faith of Islam to Afar. "In the Aussa Sultanates the principles of Islamic State (Sultanate) and Islamic Law (Shariyya) are implemented along with Afar customary law (maada) to a greater extend than among the pastoral clans." (Getachew 2001, 36) The influence of Islam is more present in urban areas. There are rural areas, where people do not follow Islam. (CSA: National Population and Housing Census 2007, Interview Valerie Browning, 2011)

Social structures
In Afar social organisation is based on descent and kinship. The smallest unit is the family (burra), which is part of the extended family (dahla). The extended family belongs to a lineage (gulub/dahla) and a clan (kedo). (Getachew, 2001)

Traditional Authority
Before 1971 the land-owning pastoral clans and the sultanates had loose agreements. The Sultan, clan-heads and lineage heads were responsible for internal affairs. The military government replaced the imperial offices with new offices having very similar functions, but clan elders continued to be important leaders and the link between government and the population. The Afar have a "...local sanction-executing institution, finaa/fimaa..." (Getachew 2001, 65). An important role is the peace-making (billu-arri), that is done by elders who are members of the "Finaa".

Economy
Most of the Afar live from subsistence pastoralism. Still "Pastoral values are a dominant feature of their social and cultural life." (Getachew 2001, 37) Occasionally an animal is sold to buy cereals and other goods. Subsidiary economic activities are regionally practiced. The trade with salt in the Danakil depression and the transport with caravans from the coasts to the highlands are regional economic branches. In some areas along the Awash river small-scale agriculture is practiced. (Getachew, 2001; Little, 2008; Rettberg, 2009)

Herd composition
The composition of the herds vary depending on natural environments and group. Usually they consist of camels, cattle, sheep, goats. In some areas donkeys, mules or horses are also kept. The stock of the population varies seasonally depending on natural resources. (Getachew, 2001)

Stock transfers
Stock transfers are done as gifts, loan or for exchange. They are an important part of social structures and effective herding and follow predetermined rules. In cases of food shortage they are central for survival. The milk stock transfer is called "Hantilla". (Getachew, 2001)

The Pastoralist way of life
The traditional way of life of the pastoralists was developed over thousands of years to find a sustainable way to survive in the harsh environment. A strong connection to the environment and extensive knowledge of the interaction within the ecosystems are fundamental. Many aspects have to be considered, like the density of people and livestock, when looking for a favourable combination of location and time. (Salzman, 2004; Getachew, 2001) The way of life is conformist to the difficult environmental conditions in deserts. "...customary resource management methods are used and have proven to be efficient." (Getachew 2001, 9)

The enforced change of pastoralist societies in Afar
A widespread opinion of settled Ethiopians is that: "...pastoralism is considered a backward way of life." (Getachew 2001, 9) Pastoralists are regarded to be inefficient land users or "lawless" wanderers. They are blamed for damaging lands through overgrazing. Since the 1950s the government started various schemes to promoted development of the lowlands. Irrigated cultivation was introduced, but there was no involvement of the local population. Local economies and cultural needs were widely overlooked. (Getachew, 2001; Little, 2008)

Impacts of the enforced development
The introduced development schemes did widely not achieve the intended goals. The alienation of land and resources deteriorated the economic situation of many inhabitants and increased group-conflicts. The middle Awash valley was mainly inhabited by semi-nomadic Afar. Irrigation schemes at Tendaho, Aussa and Amibara were established in the 1950s. The construction of the Addis Ababa-Assab motorway in the 1960s led to a rise of market towns in the 1970s. Sedentarization schemes in the 80s transformed production systems and lifestyle of many Afar. The appearance of urban centres, increasing involvement in trade and poorly paid wage employment were some of the results. (Getachew, 2001) Deforestation, unsuccessful reforestation with invasive plants, and large-scale plantations have impacts on food security.

2.2 Afars on the move

2.3

2.4

2.5

2.5 Environment

Geomorphology
The rift valley is covered with young lacustrine sediments and volcanics. The structural deformation of Mesozoic rocks was important in the early evolution of the East African Rift System. Subsiding troughs caused an excessive thickness of sediments. Down-warping of trough margins was accompanied by spilitic and basaltic volcanism. The basins filled with Mesozoic sediments. The lowest point of the Afar Region is 157 m below sealevel at the lake Assal in Djibouti. (Schlüter, 2008; Rettberg, 2009; Figure 2.12 shows altitudes in Afar)

Rainfall
Seasonal rainfall depends on a strong air flow from south-west to north-east Afar caused by deep low pressure zones over the Arabian sea and Indian ocean. There are three rainy seasons in Afar separated by two dry seasons. The Karma (big rainy season, about 60 % of the annual rainfall) lasts from mid July to the end of September followed by the Kayra (calming down rainfalls) until the end of November. The Gilaal (dry season) endures from November till March. Sugum (small rainy season, about 30 % of the annual rainfall) starts in mid march. Hagai (dry season) lasts from May to June. The highest amount of rain come down at the boarder regions to the highlands at higher elevations (Fig. 2.14). In these areas 600 - 900 mm/a rain can be expected. Most of the area of Afar has an annual rainfall of about 300 mm. The lowest rainfalls (< 100 mm) are found along the boarders to Eritrea and Djibouti.
(TH Consulting, 2009; Rettberg, 2009)

Drought
The amount of rain is subject to natural variability. Cyclic recurring droughts are the result and can be followed by famine catastrophes. The most extreme ones since 1960 were 1972-73 and 1984-86. After the big drought of 1972-73 it is estimated that 250,000 people died of hunger in Ethiopia, and that the population of the Afar was reduced by 20-30 % on account of this famine. (Rettberg, 2009)

Rivers
The most important river for the Afar Region is the Awash river. The river has its spring in 3,000 m altitude in the rainy highlands and is with a total length of 1,200 km the longest river in Ethiopia. The Awash has a drainage basin of 113,000 km^2, which is about 10 % of the Ethiopian territory. It ends up in a braided stream at the boarder of Djibouti. (Rettberg, 2009)

Fauna and Flora
Half of the landscape consists of sand and stone deserts and a third of the land is covered with desert shrublands. Grasslands make up 15 %, woodland and forests 2.4 %, water and wetland 2 % and cultivation 0.5 %. The plant "Prosopis juliflora" was introduced in the 1980s in Afar for reforestation purposes. The evergreen plant became a immense problem, as the local vegetation is suppressed. Also the big thorns cause injuries to animals and people. (Rettberg, 2009, Little, 2008)

Wetlands (Kallo)
Among the flooding areas of the river extended wetlands were formed. The fertile sediments lead to a large agricultural-economic importance. The Afar word "Kallo" means "a good place". They are used as pasture land during the dry seasons and droughts. (Rettberg, 2009)

Grassland (Alta)
During the rainy seasons the savanna is used to feed the livestock. The Afar word "Alta" means "high plane". (Rettberg, 2009)

2.3 Afar woman and children
2.4 Afar boy on the way with a camel ready for transportation
2.5 Afar girl with grazing donkey

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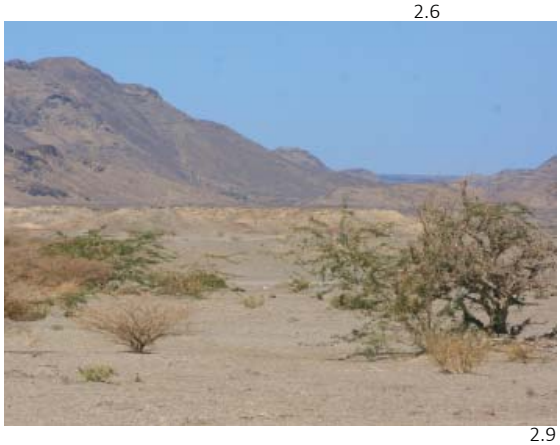

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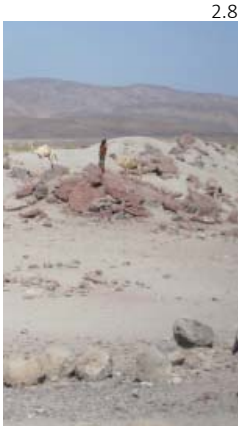
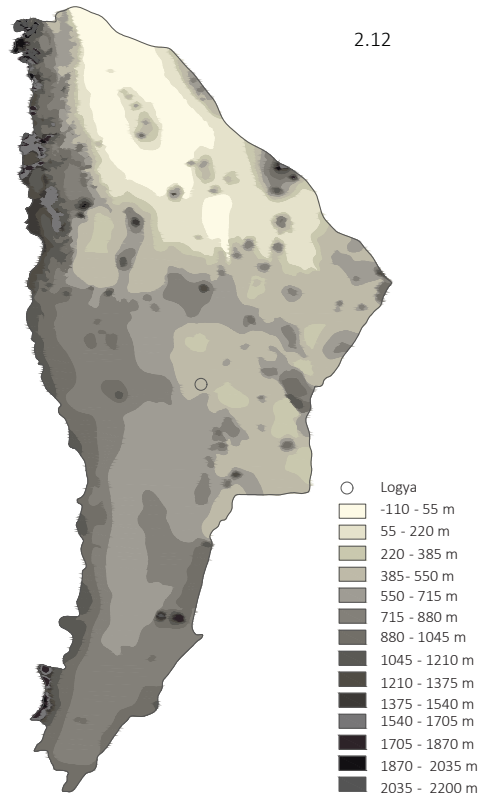


2.11

2.6- 2.8 Different types of livestock in Afar
2.9 The dry landscape in Afar around Logya town
2.10 Fertile flooding areas along the Awash River, Asayita: agriculture in the background
2.11 Woman walking through the stone-sand desert in Afar, near Asayita

Altitude



2.12

Temperature

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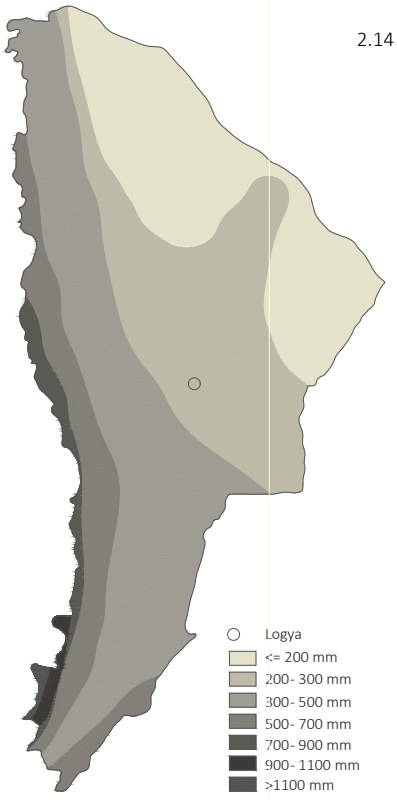
Rainfall



2.14

2.6 Settlement organisation

Clan land
The land of the Afar is divided in clan areas. The members of the clan have the usage rights and control over the land. This area belongs to the clan and cannot be claimed for individual purposes. (Getachew, 2001)

Co-operative settlement (Ganta)
Nuclear and extended families together form a co-operative settlement typical for rural Afar. These are different from urban settlements, that are connected with harmful influence and political domination. “The town (ketema/ katma) is considered as a home of outsiders. It is associated with commerce, modernity, prosperity and poverty.” (Getachew 2001; 58)

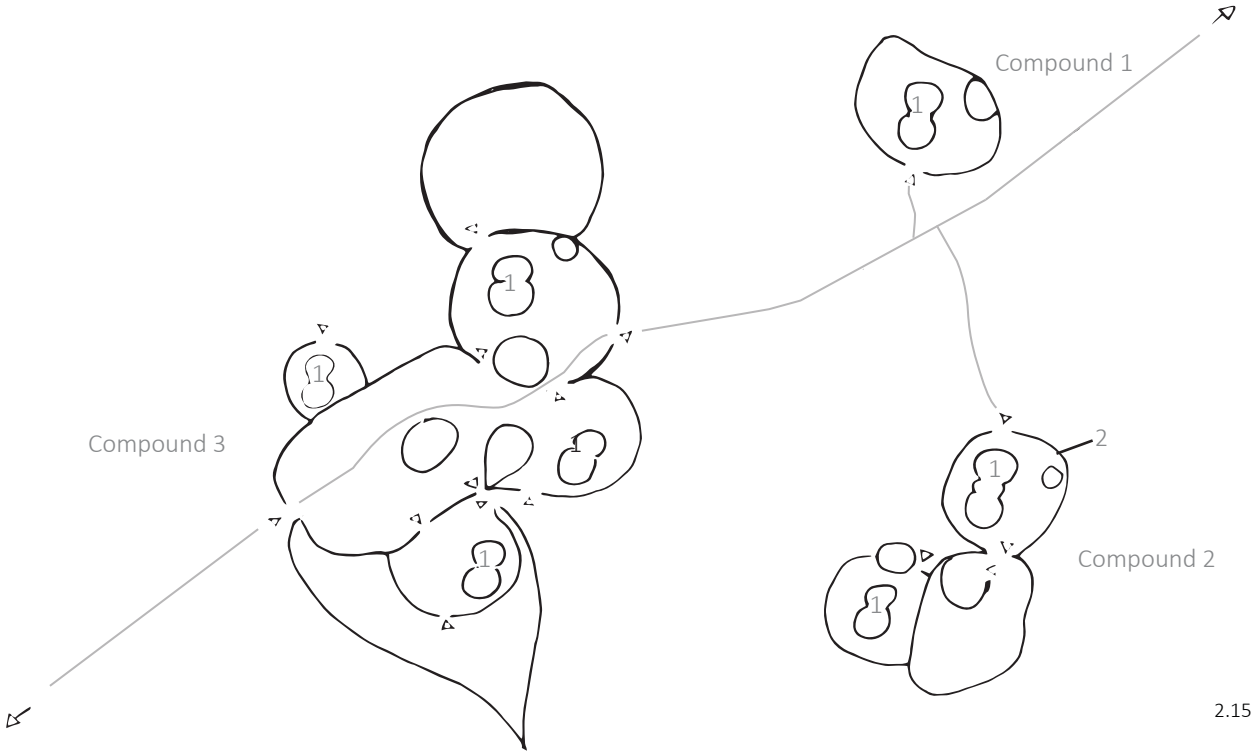
Compounds
Afar live traditionally in fenced compounds. They are pastoral nomads and this means the animals they keep are the most important source of food. The significant value of farm animals can be deduced from the way the compounds are built. These settlements are divided into the main settlement unit “Homa” and the satellite camps “Magida”. (Getachew, 2001; Rettberg, 2009)

Main settlement unit (Homa)
In these units lives the majority of the members, woman, children and the household heads. The head of the household is giving the instructions for the herd management, but is not actively involved. In this production unit the lactating herd is kept. Usually the “Homa” is close to the river or market-centres. (Getachew, 2001)

Dry-herd unit (Magida)
“During the weather periods, the households will move some distance from the River and send part of the family and the dry-herd to the wet season pastures...” (Getachew 2001, 39) The dry-herd are the not lactating and male animals. Armed young man are sent to these “Magidas”. A continuous exchange of animals, food, medicines and other products with the main settlement is going on. (Getachew, 2001)

Co-operative settlement (Ganta)
Nuclear and extended families together form a co-operative settlement inhabited by rural Afar. They are different from urban settlements, which are associated with bad influences and political domination. “The town (ketema/ katma) is considered as a home of outsiders. It is associated with commerce, modernity, prosperity and poverty.” (Getachew 2001; 58)

Schematic Illustration of compounds
The illustration below shows a part of a main settlement. The first unit named “compound 1” is the simplest way a compound can be build: One house for living (1) with a fence to lock up the lactating animals at night. A small fenced area within the fence is used to protect the young animals. The second unit named “compound 2” shows two housing units built together. The bigger compound has a separate fence for locking up the animals and a fenced area for praying (2) beside the houses of the family (1). The unit “Compound 3” shows an agglomerate of three compounds united to one unit.



2.15

Exemplary plan of a main settlement unit (Homa)

The map shows a rural main settlement unit called “Ragden” in the region of “Uwwa”. These kind of settlements are called “Homa” where most of the people of the household and the lactating herd lives. The settlement “Radgen” has already few modern influences. It has a hand-pump well built by an NGO. There is a mobile teacher educated by APDA, so the village has a n old house that is used as school. A small shop and a mosque exist. Valerie Browning explained in a interview in 2011: “The Muslim people use the ground to pray. They pray outside. Building mosques is a historically newish idea, although there are mosques all over Afar now...” These modern influences nevertheless, the structure of the village is representative for the traditional “Homa” unit and can be seen as a good example for the ongoing changes in the Afar society. (Interview Valerie Browning, 2011; Little, 2008)

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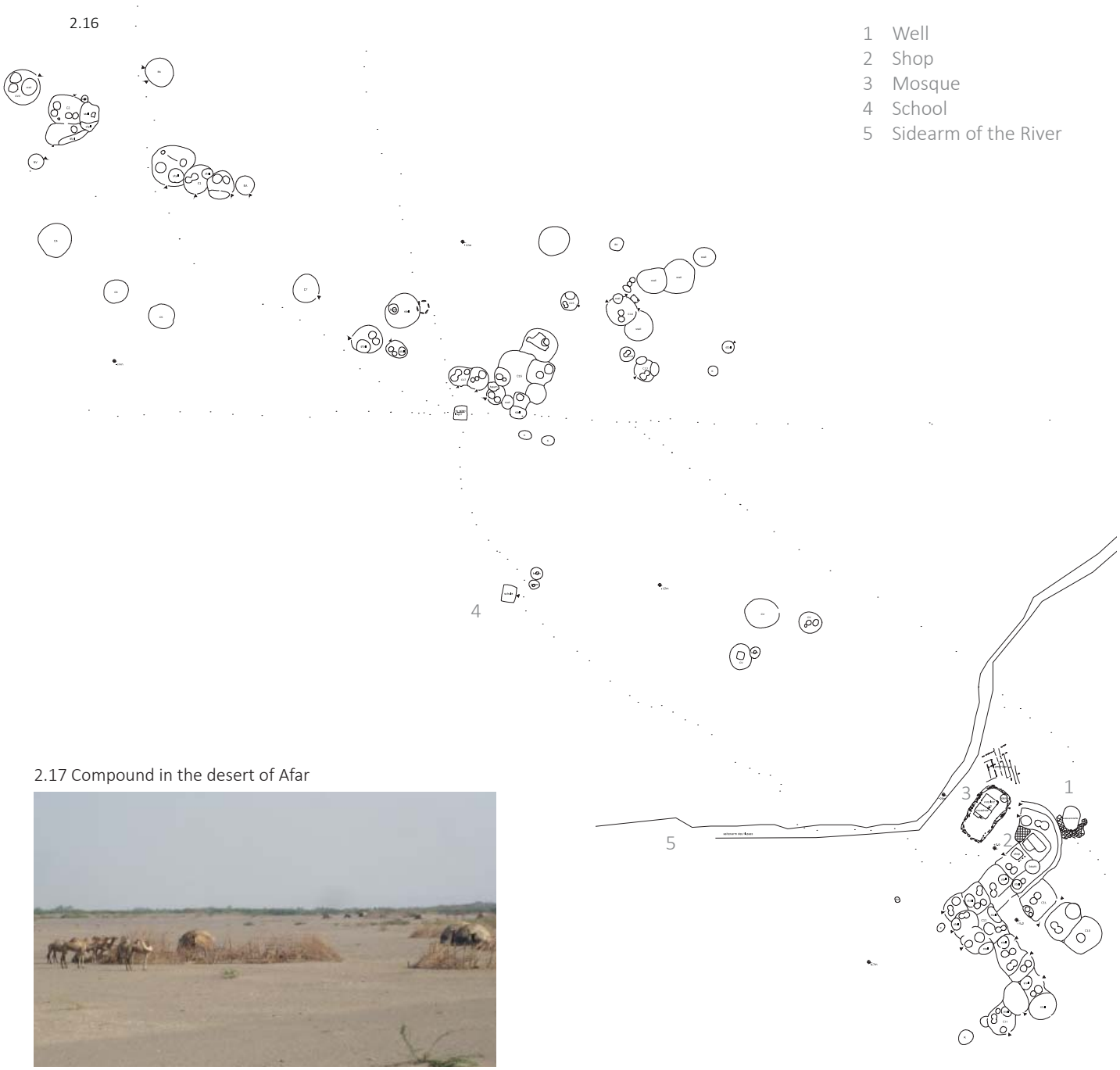

2.17 Compound in the desert of Afar

2.7 Traditional architecture

The Deboita (mobile family house)

A family house is called *Deboita* in Afar. In this house the family sleeps, cooks, works and welcomes guests. The material and form of the *Deboitas* vary depending on area and local resources. Mainly the supporting structure is made out of branches and covered with woven palm-mats. In some regions two tents are built together, in other regions there is only one tent. The from can vary from circular domes to elongated shapes. The *Deboitas* are portable and can be packed on the back of two camels, in case the family has to move. The construction of the tents is done by the woman. This is typical for African nomadic societies. (Prussin, 1998)

The armature tents are made out of wooden sticks. The poles are buried into the ground or stabilized with stones. For the construction branches, roots or collected sticks are used. The community of the Afar nomads do not fell whole trees. When a whole trunk of the tree is taken they believe the „soul of the land" is gone. (Interview Valerie Browning, 2011; Little 2009) The sticks are connected with lines, textile pieces, leather stripes or plant-fibre. The simplest way to construct a *Deboita* is to build a row of arcs and a second row rotated 90 degree. A very stable, armature dome is created. During our field research the region of "Uwwa" in 2011 I could document an interesting improvement of the stability of the basic structure. This stabilized structure is explained in the figures below.

2.18 "Deboita" with textile cover and the "Halowa" poles used for the supporting structure ready for transport on a camel
2.19 Supporting structure, basic system
2.20 Mobile "Deboita" with permanent "guest house"
2.21 Tents within a fenced compound

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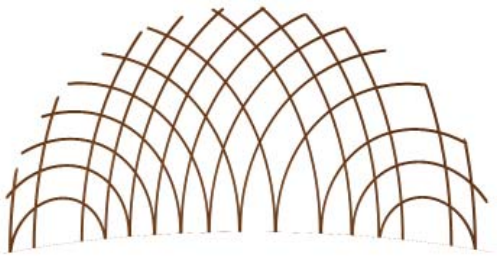
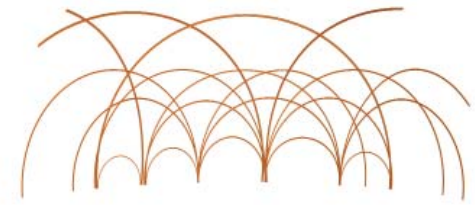


Supporting structure of a “Deboita”



1

The basic supporting structure exist of arcs strung in a line with different diameters. The second row is arranged in 90 degree rotation to stabilize (1).

As an improvement some of the tents in the village “Ragden” in the region of “Uwwa” had a second system of smaller arcs for additional stabilization (2).

2

The third system was made out of poles formed to a stiffening ring (3).

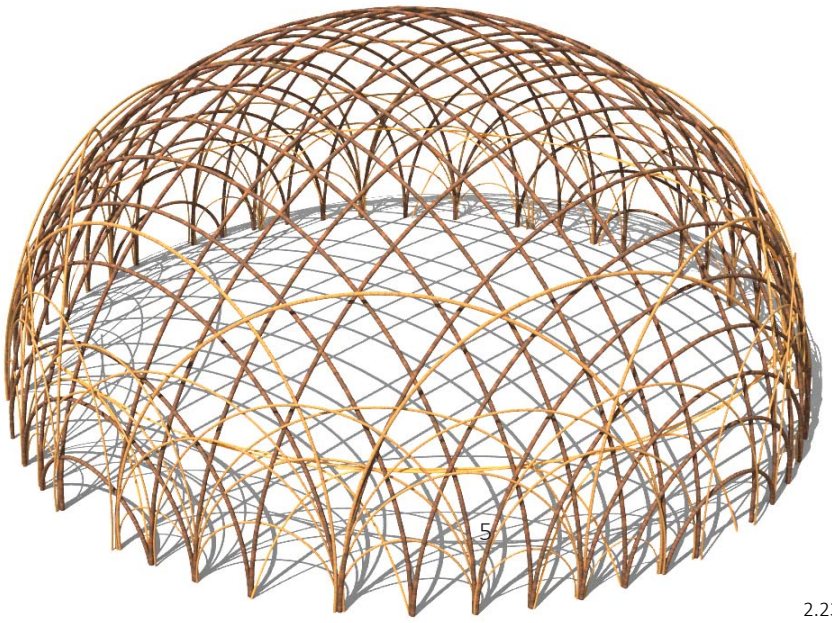
All these components together create a very effective statical system (4).

3

This example shows that the woman have a far developed traditional knowledge of construction techniques and a great understanding of leading forces (5).

4

2.22



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Elements of a compound

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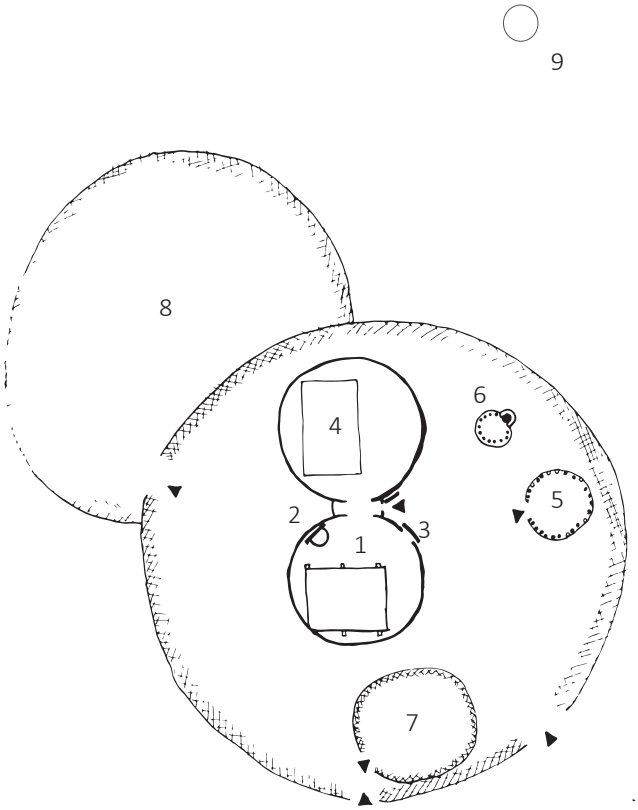
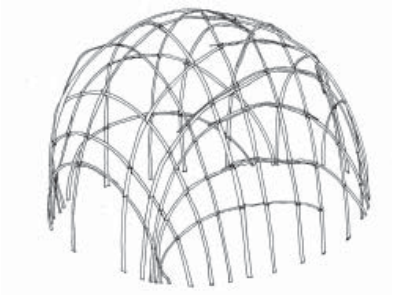


2.29

The sketch shows a compound with its elements. These elements are signed with numbers and explained in the text below and shown in the pictures.

1 family house “Deboita”
2 cooking place in the tent
3 window “Loita”
4 guest house
5 fenced area for praying
6 oven for smoke perfuming
7 young animal pen
8 lactating animal pen
9 bread oven
10 supporting structure sketch

10



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Exemplary compound of a main settlement unit
In the Region of "Uwwa" the houses consists of two tents (more or less the same size) with a smaller tent connecting them. One of the houses is permanently at this place and the so called „guest house". It is used to welcome visitors and as a sleeping place for the men if necessary. The other is the mobile „family tent". It contains the bed (used by the woman and children) and a fireplace. The „connecting tent" could be described as an entrance area and storage place. The household equipment is usually very basic.

The entrance tent
The „connecting tent" has a small door, about 30-40 cm wide and 80- 100 cm high. The door can be closed by a piece of wood or a something similar. Inside there are two doors with a similar size. One leading to the mobile private tent, the other one to the permanent guest house. As Valerie Browning says, the small doors are a sign to slow down and to enter with respect. Visitors are expected to stop outside and wait for response until they are invited to come in. (Interview Valerie Browning, 2011)

The mobile house (Deboita)
The mobile house can have a window called the *Loita* which is usually next to the ground and can be closed by a piece of wood, stone or mat. The supporting structure is built out of the *Halowa* sticks. These are the sticks which are used for the frame-work. They are packed together and loaded on camels when the people move to another place. In the mobile house there is also a fireplace where food can be cooked. In this place the walls are covered with soot as there is no chimney for the smoke to get out. This helps to keep pests away but the air quality is suffering from the smoke. For saving the wooden tent construction from burning down, a piece of metal or a big stone is put in front of the wall. (Interview Valerie Browning, 2011)

The bed
The bed is made out of a wooden construction which is mounted on a wooden column or a stone. This construction is covered by a slatted frame made out of sticks, sewed together by small threads of animal skin. This slatted frame is called the „Aloita" and it is made by the women. In Afar culture the bed always stays inside the house, because this causes bad luck to take it out. (Interview Valerie Browning, 2011)

Bread oven
For baking bread the women dig holes outside. The „bread oven" is a hole about 25- 40 cm wide. The walls are covered with flat stones on which the bread is baked. First the women make a fire in the hole to heat up the stones. Then the bread is baked on the stones.

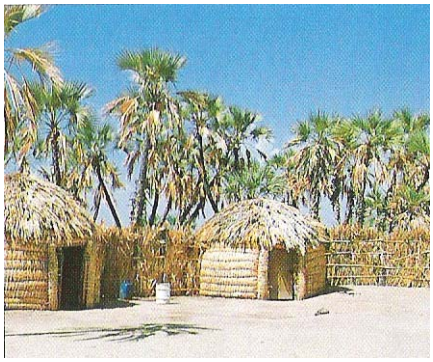
Smoke perfuming
For perfuming the clothes and the body a hole is made in the ground and a small clay-oven is built. A stick-dome, reminding of the construction techniques for the Afar tent, is used to put clothes over the oven and smoke them.

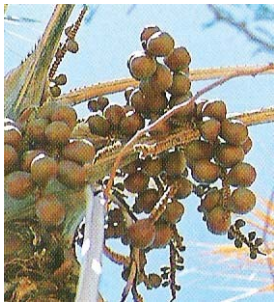
2.35

Appendix

Botany

In the following chapter a selection of plants having impacts on the design process or the local way of living are mentioned. They are used as materials for construction or can be used for food, fodder, medicine or other purposes.





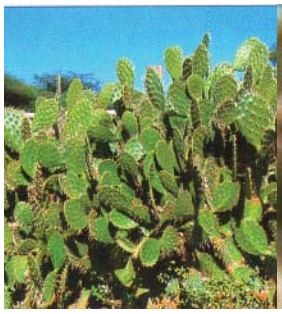
3.1- 3.3

Doum palm (Hypaene)

Doum palms form the "Hypaene" family and are native to the Arabian Peninsula, North Africa and Madagaskar. There are ten African Hypaene Palms. In Ethiopia the "Hyphaene thebaica" is most common. It can reach up to 15 m hight and its stems divide regularly up to 16 times. At the top the trunks end in a fan-shaped crown of leaves.2 The leaves reach about 1 x 2 m size. (Dharani, 2002)

In Ethiopia the palm grows in different agroclimatic arid zones from 100 m below sea level in Afar up to 1000 m hight. The Doum palms are mainly found at low plains where ground water is present, around river valleys, oasis, damp places in woodlands, but even around hot springs like at the Danakil Depression. They are used as indicators for good soil and shallow ground water. (Bekele-Tesemma, 2007)

One palm can produce up to 50 kg fruits. The orange-brown fruits consist of an edible pulp surrounding a seed.3 The sap can be used to produce a strong brew and the wood as timber. The leaves are used for weaving baskets, thatched roofs and mats. (Dharani, 2002)



3.4- 3.5

Prickly Pear (Opuntia vulgaris)

The prickly pear stem succulent is not native in Africa, originally it came from South America. It was introduced in Africa as a hedge plant in dry areas. It grows in altitudes below 1,700 m in bushy or open grassland. It can grow up to 4 m. (Dharani, 2002) The fruits are fleshy and edible. Still the cactus is used as a hedge or fence in many places in Ethiopia. But this is not the only use. The cactus can be used to make clay surfaces more waterproof.

Clay impregnation

There is an old technique in Ethiopia, which helps to make the loam more resistant to humidity. A mixture of prickly pear cactus (Opuntia vulgaris) juice, salt, lime and loam soil is prepared. After 5 days of fermenting the cactus-juice is ready and has to be filtered before mixing it with the other ingredients and the clay. The roofs build with this impregnated loam can be almost flat and are said to be 100% waterproof. (Zegeye, 2012)

3.6- 3.8

3.9- 3.10

3.11

Tasmanian blue gum (Eucalyptus globulus)

The Tasmanian blue gum is one of four most common Eucalyptus species growing in Ethiopia. The other ones are Eucalyptus camaldulensis, cladocalyx and rudis. (Bekele-Tesemma, 2007) The trees are not native in Ethiopia and come originally from Australia.
The Eucalyptus globulus can reach 55 m in height and is often found in high altitudes like at the surrounding of Addis Ababa. It even tolerates frost. The timber is very hard and used for construction, poles, posts and plywood. It is also used for fuel and traditional medicines. For this purpose the leaves are boiled to produce an essential oil for treating influenza, colds, asthma and fever. (Dharani, 2002) Beside this positive effects Eucalyptus causes adverse environmental impacts due to competition for water with other plants in dry areas with rainfall about 400 mm and less. It is not confirmed that Eucalyptus causes soil erosion, but as it is a deep root tree, it contributes little to the stabilization of the upper earth layers. If grown in plantations with short crop rotation, soil nutrients are depleted rapidly. The biodiversity in these plantations is limited and Termite attacks are common. (FAO- Bio-physical and Environmental Impacts of Eucalyptus Plantations)

Illustration credits - Research

Cover
Schönher Katharina, 2015

All pictures not mentioned on the list were taken by Schönher Katharina in 2011 and 2015.

Chapter 1
1.1, 1.2 Schönher Katharina, 2015, Reference: Google Earth 2015
1.3 http://maps-for-free.com/, 22.08.2015
1.4 Nasa worldview: https://earthdata.nasa.gov/labs/worldview/,14.10.2015
1.5 http://www.fao.org/docrep/005/ac627e/AC627E02.jpg, 16.10.2015
1.9 Chocian Emilia, 2012
1.10 Rieger-Jandl Andrea, 2011
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1.17 Yirgu G., Ebinger C.J., Maguire P.K.H.: The Afar Volcanic Province within the East African Rift System: London: The Geological Society

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2.1 Schönher Katharina, 2015, Reference: Concept Plan: TH Consulting 2007
2.2 Rieger-Jandl Andrea, 2011
2.15 Schönher Katharina, 2015, Reference: Plan of Radgen: Weissenböck Martina, 2011
2.16 Plan of Radgen: Weissenböck Martina, 2011, Revision: Schönher Katharina, 2015
2.20, 2.21, 2.24, 2.25 Weissenböck Martina, 2011
2.27 Zamolyi Ferenc, 2011
2.28 Rieger-Jandl Andrea, 2011
2.30 - 2.33 Zamolyi Ferenc, 2011
2.35 Zamolyi Ferenc, 2011

Appendix
3.1- 3.5 Dharani, Najma: Trees & Shrubs of East Africa, Cape Town: Struik Publishers, 2002
3.6- 3.8 Zegeye Cherenet, Helawi Sewnet: Building Ethiopia: Sustainability and Innovation in Architecture and Design, Addis Ababa: Digital Impressions EiABC, 2012
3.9- 3.10 Dharani, Najma: Trees & Shrubs of East Africa, Cape Town: Struik Publishers, 2002

Tables
Tab. 1 http://www.csa.gov.et/newcsaweb/images/documents/surveys/Population%20and%20Housing%20census/ETH-pop-2007/survey0/data/Doc/Reports/National_Statistical.pdf, 02.10.2015

Schönher Katharina, 2015

"Here we are in a role setting where this type of housing hasn't changed in maybe thousands of years. We don't know. But at least let's say hundreds of years. So this suits them and it's realistic for them. But when you come to a new thing like a school, where you need light, where you need a space for children or many people, where you need a space for the teacher to stand, you need a different type of building. You need to be bigger, you need to have air, you need to have light. So, and this is all-day-long sitting. These houses are not all-day-long sitting houses. So, for a school, for a mosque, for a clinic you need something different ..

...your houses are ideal. Your new idea of having brick, mud-brick houses for the towns...to stop stripping off the forest...And that is what we want as an organization. We want all the small towns of Afar convert from using many trees for one house to using mud bricks...it is not so expensive. And so the people like it." (Interview: Browning, 10.2.2011)

II Design

Content - Design

Preface - Design

Afar nomads have a distinguished history living in hostile environmental conditions since ancient times. Despite climate change, globalisation and gaining capital interests have not made it easier to live within this region these people still prefer their way of living. There should be a way to give the people the possibility to make their own decision, whether they want to keep their way of life.

At the moment there is little support on that. Boarder wars, new frontiers, irrigation and mono-culture make it difficult to move through the pastures they had been living at since generations. Political and economical decisions are made on the paper, in languages and scripts foreign to the majority of the population.

There must be a possibility to respond to all these problems. School education is the first step. If people want to understand the decisions that are made concerning their homelands, they have to be able to read what is written. They have to understand the language politicians talk. They have to be in the position to be part of the decision making process, not only the ones that have to live with these decisions. A local community should have advantages instead of a deteriorated situation when the agriculture, infrastructure and water management are developed.

The goal of this project is to help the people to get the education they need to participate in decision making. The community gets the possibility to learn new environment friendly, cheap and durable techniques to build a save home for everyone. It will be a place where discussions and information campaigns about women's rights, health, animal treatment, construction techniques, food growing and water management are held. A place for social interaction and free public space for everyone where local traditions and knowledge can be delivered to the future generations. A place where health services can be provided for people that can´t afford it otherwise.

A place where this knowledge will be given to people to transmit it to other people. Because of the cooperation with the Afar Pastoral Development Association (APDA) this will be possible.

In the following pages the design-process to make this vision real is explained. The planned "compound" will accommodate a student-hostel and a Kindergarten with accompanying functions and communal space. The project is planned and realized for the organisation APDA, which participates actively in the process and will run the education-complex.

1. Urban development analysis

1.1

Facts Logya

Town spellings:	Logya, Logia, Logiya
Geograpic coordinates:	11°43' N, 40°58' O
Altitude:	400 m (above sea level)
Regional State:	Afar Regional National State (ARNS)
Administrative area:	Afar Zone 1
Woreda:	Dubti
Population:	23,346 (estimated for 2015, CSA)

1.1 Development of Logya town

The town Logya is situated in the centre of the Afar Region National State (ARNS). The exact date of the founding is unknown, but is expected to be between 1942 and 1960. (TH Consulting: Concept Plan, 2009; Eigner, 2014) Although the precise date is unknown, it can be ascertained with certainty that its growth and development is remarkably rapid. In 2015 there are estimated to be 23,346 people living in Logya. (CSA: 2007 Population and Housing Census of Ethiopia)
The urban population in the Afar Region was estimated to be 81,992 in 1994. In 2007 the number raised to 188,973. This would correspond to a population growth rate of 6.55 % per year. (TH Consulting: Concept Plan, 2009) This growth is not only caused by the settlement of Afar people. There is also a high immigration from other Regions and cultures. While the total percentage of people belonging to the Afar ethnicity in the Afar region is about 90 % it is only 53 % in urban areas. This brings a new multi-cultural living and population in the cities. A brief overview of the differences from rural to urban areas is shown below. The remarkable building development from 2012 to 2014 visualized on the following pages.

Ethnicities and Religions in rural and urban Afar:
Main Religions Afar Region total: Islam (95 %), Orthodox (3.9%), Protestant, Catholic, Traditional [1]
Main Religions Afar Region urban: Islam (77%), Orthodox (20%), Protestant, Catholic, Traditional [2]
Main ethnic groups Afar Region total: Afar (90%), Amhara (5.7%), Tigray (1.3%), Argoba (1.7%), Oromo (0.7%) [1]
Main ethnic groups Afar Region urban: Afar (53%), Amhara (30%), Tigray (5.7%), Oromo (3.5%), Argoba (3%) [1]

[1] (CSA:: 2007 Population and Housing Census of Ethiopia, own calcutations)
[2] (TH Consulting: Concept Plan 2009, own calcultations)

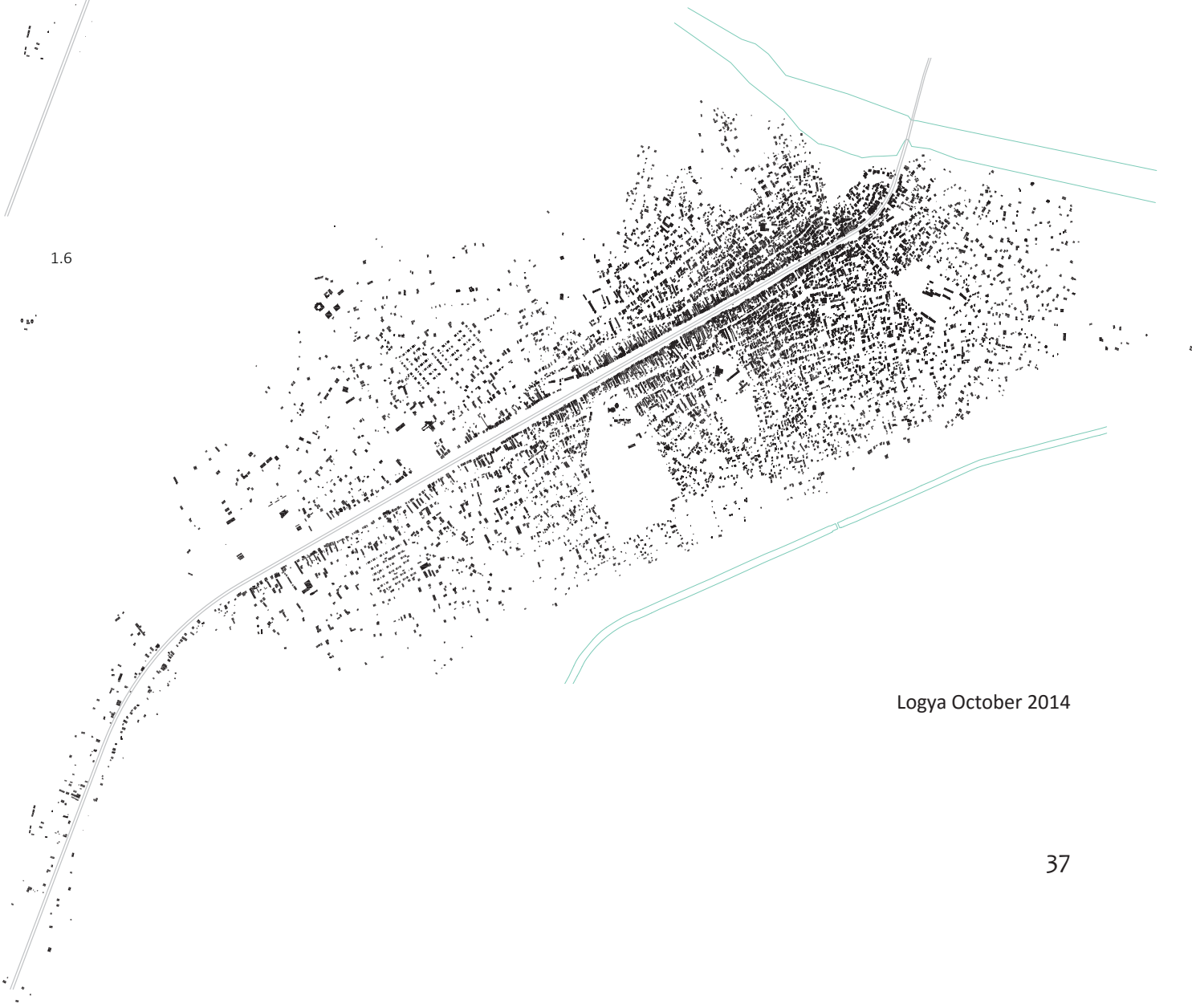
1.2 1.3 1.4



1.5

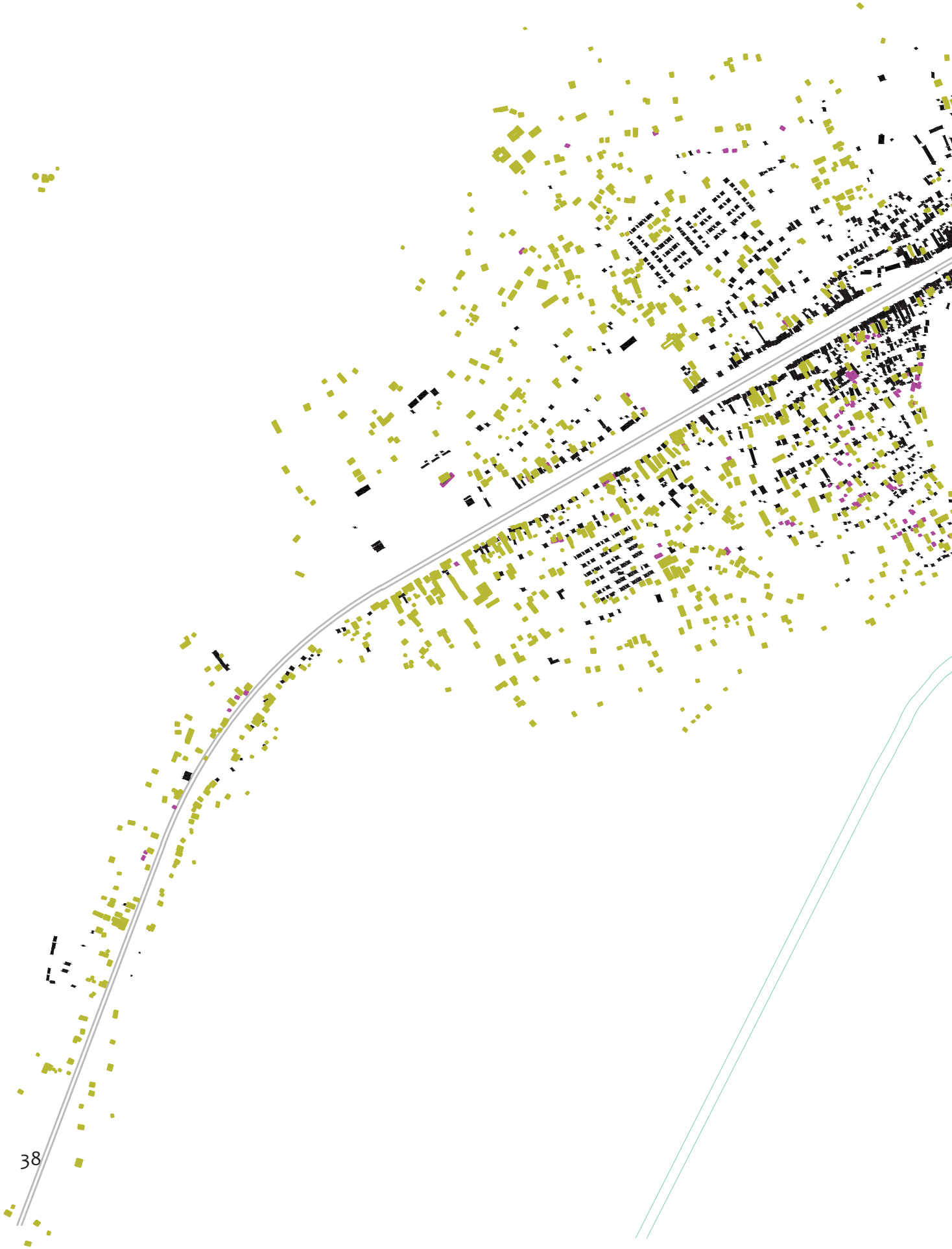
Logya July 2012

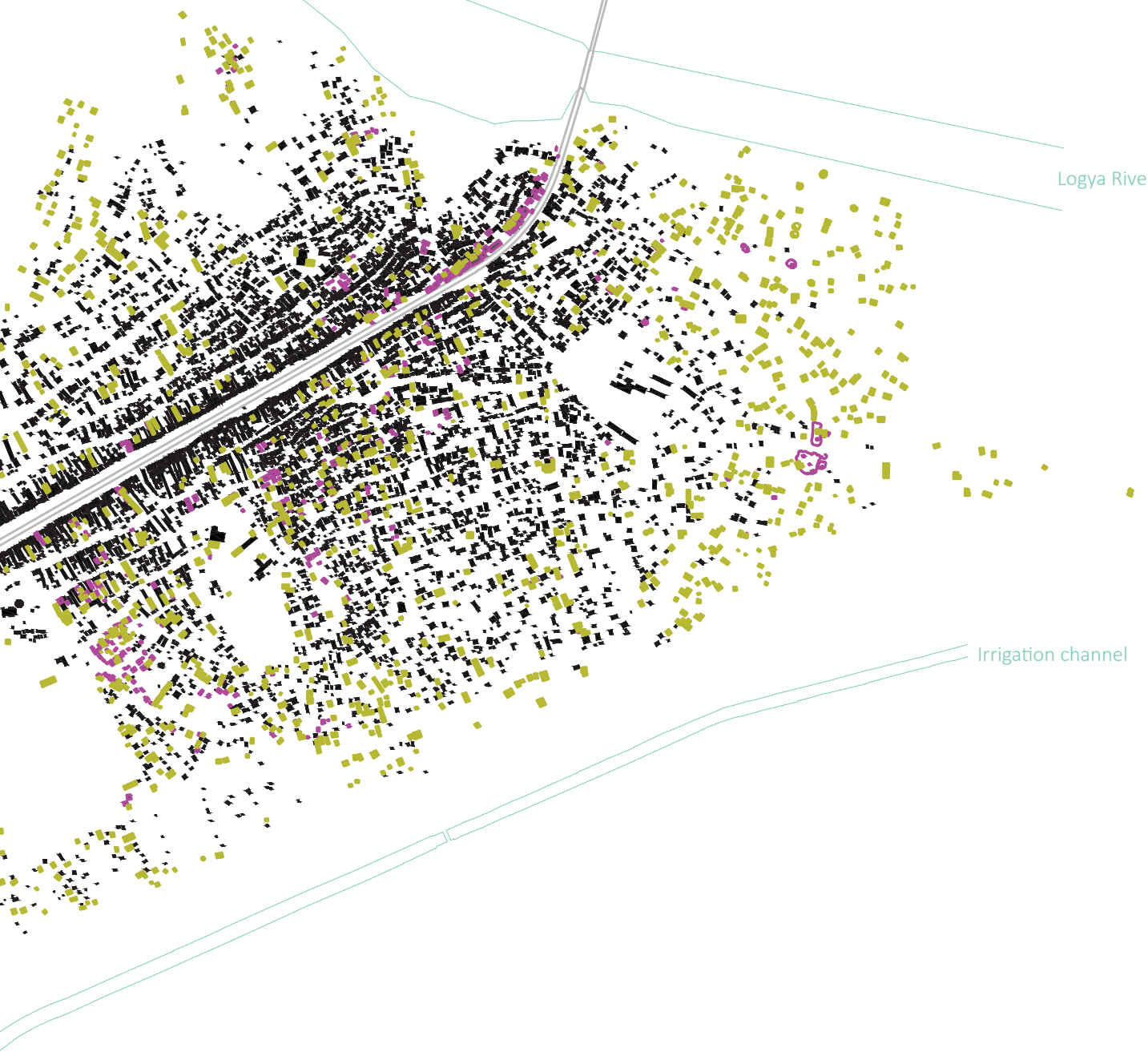
1.6



Logya October 2014

Logya development 2012 - 2014





1.7

The enormous growth of the and the expansion at the outlying districts is illustrated. Especially the expansion to the undeveloped areas in the west and east and along the highways is apparent. The demolished houses along the highway in the north-east of the town had been removed for construction works at the highway. The circular shapes are traditional *Deboitas* and the fences surrounding them. For example at the eastern end of the new developed city the change from traditional compounds to modern rectangular buildings can be seen.

Buildings existing in 2012

Buildings built between 2012 and 2014

Buildings removed between 2012 and 2014

Rivers

0 50 250 500 m

1.9

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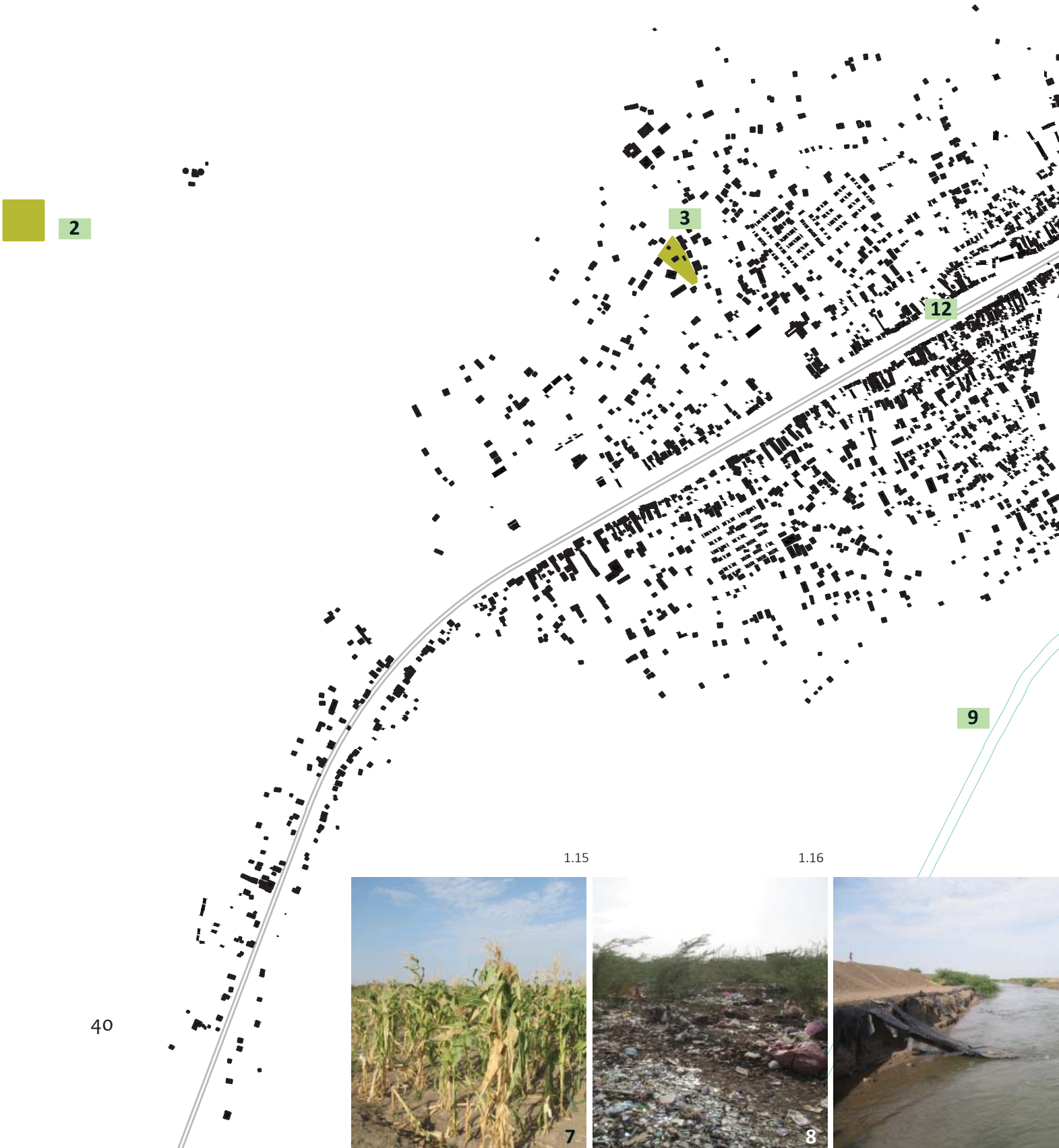
1.11

Overview of Logya



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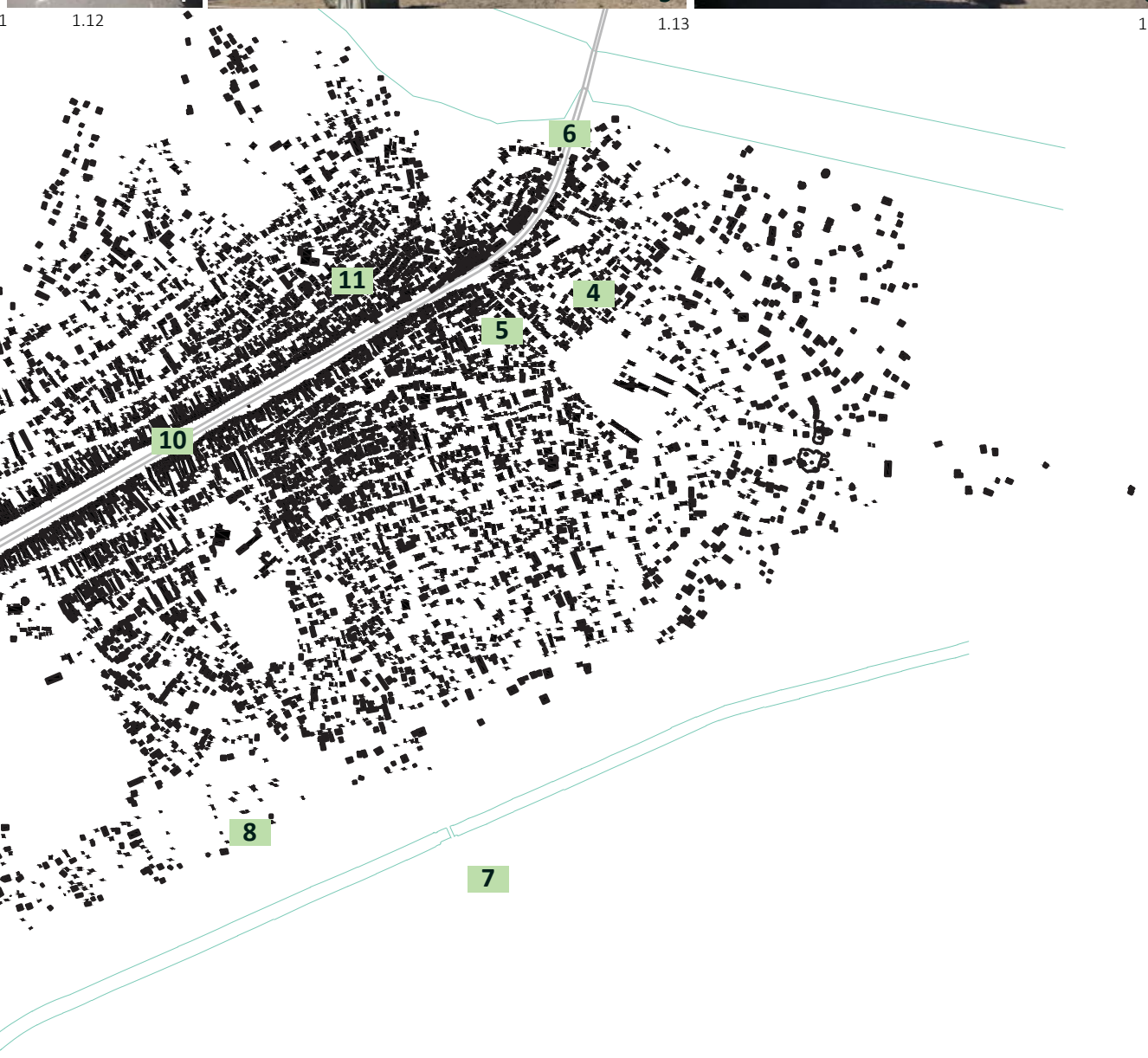

Building sites 1 and 2

1.8

1.17

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1.19

1.20

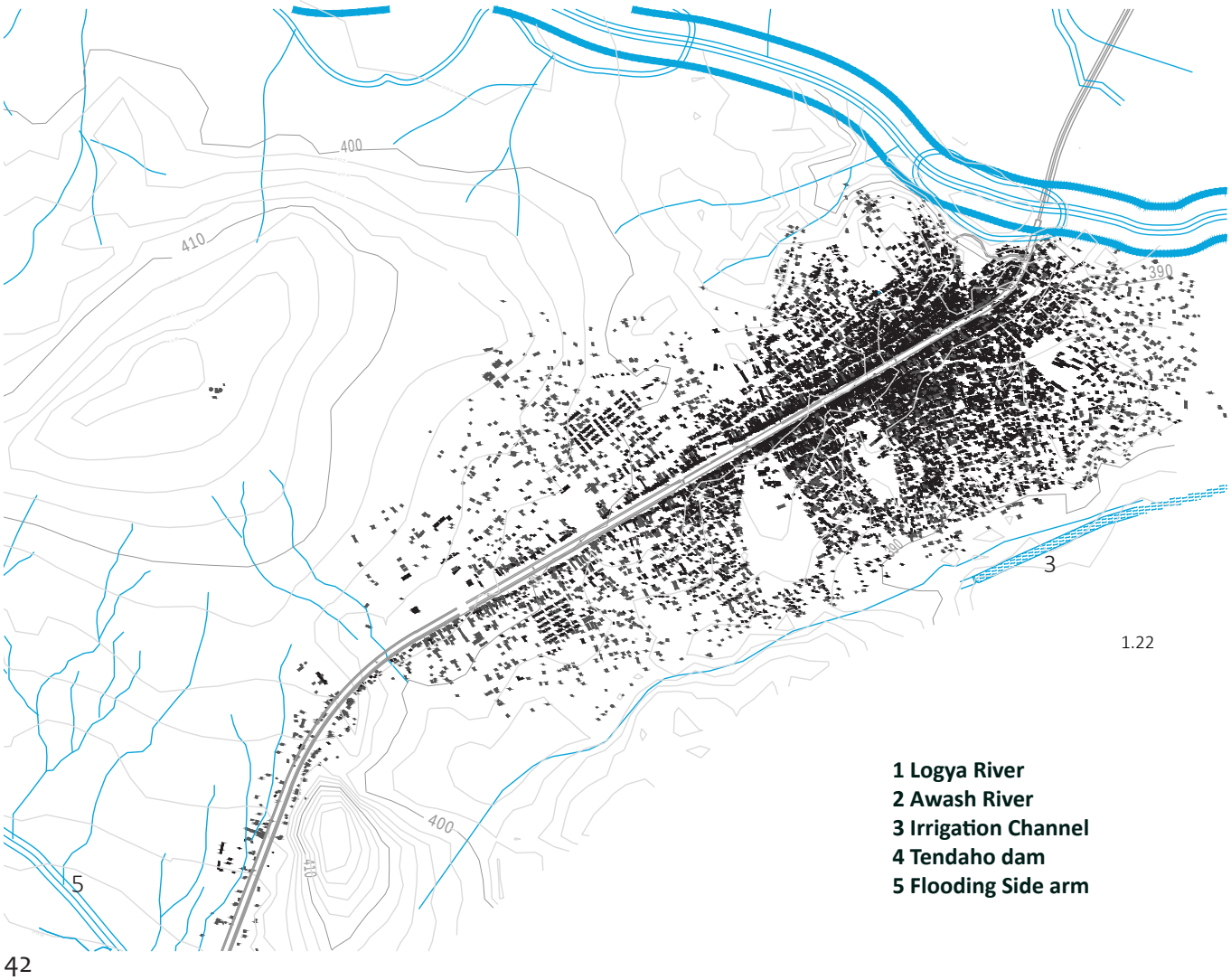
1.2 Watercourses and flooding areas

Logya is located between two rivers. The Awash River and the Logya River. The springs of the Awash River are in the highlands, so the river is constantly flowing. From the Tendaho dam an irrigation channel was built to water huge plantations. The Logya River is a Wadi river only carrying water when rain falls.

Caused by the properties of the clayey ground and the dryness, the soil is often not able to absorb the rainwater in the rare case of rain. The water runs over the surface and forms drainage channels, before it starts to seep in the ground. Along these channels occurs a transportation of sediments, similar to those in rivers. The map below shows the main flooding zones.

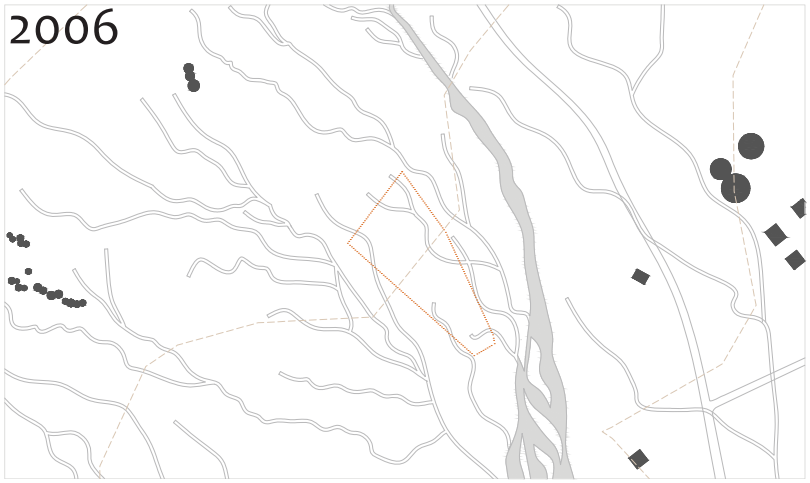
1.21

1



1.22

1 Logya River
2 Awash River
3 Irrigation Channel
4 Tendaho dam
5 Flooding Side arm



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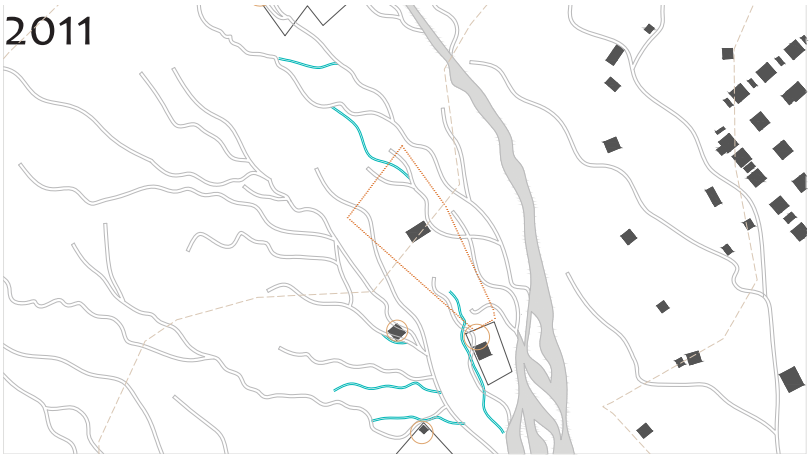

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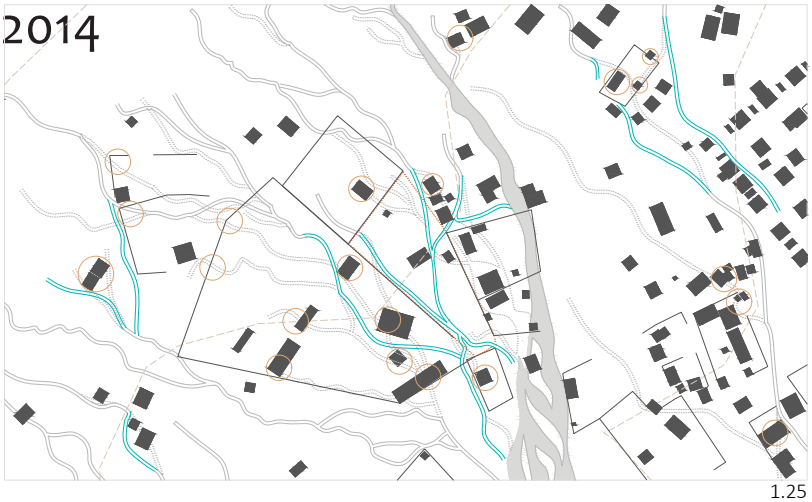


1.25

Watercourses and flooding areas around the final construction site

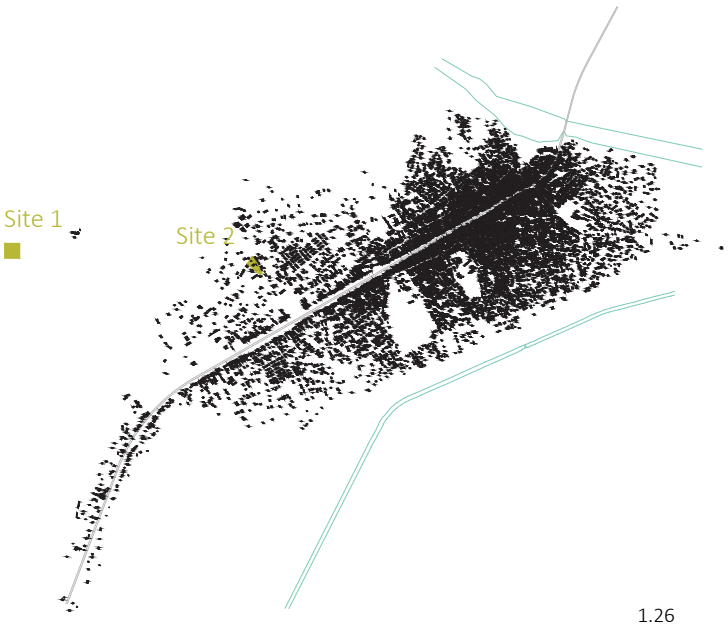
In 2006 the area of the site was undeveloped. Only a few houses were built in the south-east and a few *Deboitas* (traditional tents) in the north-west. The rainwater channels lead to the small flood river bed. The building of houses, walls and fences changes the motion of the water flow. In the meantime further houses were built and further changes of the flows had to be considered. It is possible that the flow of the water will be stopped totally in the near future if the current construction activity and expansion of the town is continuing. The figures also highlight the construction activity during the last eight years.

Symbols

- Houses/Fences
- Flood Riverbed
- Flood Inlets
- Flood Inlets new
- Object change Inlets
- Building Site
- Contour Altitude

1.3. Building sites

There were two possible building sites. The location is marked on the map below. We were taking samples from both sites and tested the properties of the clay. On the sketches and pictures the different sedimentation zones were marked with Roman numbers. The panoramic views (perspectively distorted) show the sites. A small sketch of the sedimentation zones of each side is also presented. Finally the decision was made to use the *site 2* for construction.



1.26

Site 1 (outskirts)

Site 1 is located in the outskirts about 1 km north-east from the current municipal boarder. It is 1.5 km away from the new high school, which is under construction at the moment. The site has an area of 10,000 m^2.

In zone I the ground is raised about 10 cm. Zone II is seamed with rainwater channels. In this area the transportation of sediments is more active. Zone III is slightly raised and no rainwater movement can be identified with the bare eye. Three clay samples were taken on this site, one from each zone, marked with P1- P3.

Site 2 (downtown)

Site 2 is the site that will finally be used for the construction of the compound for education and culture. It is located in the eastern part of Logya. It is very close to the new high school, about 200 m linear distance. There are three main zones on this side. Zone II marks the areas, where the rainwater flows and more sedimentation transport can be expected. The ground in zone I raises up to 30 cm at some points compared to zone II and its slightly raises in zone III. Clay samples were taken from each zone. The extraction sites are marked with P1 - P3.

1.27

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1.4. Surrounding and existing buildings

1.35

The decision was made to use the site 2 for the construction of the compound for education and culture:

Site area (grey) with street from east
1 Old Bakery on the site
2 Surrounding in the south
3 Building site from north: *Old Bakery* (middle) and stable (left) on the site, Mosque in the background
4 Street to highway in the south
5 Street to the site coming from east

1.36

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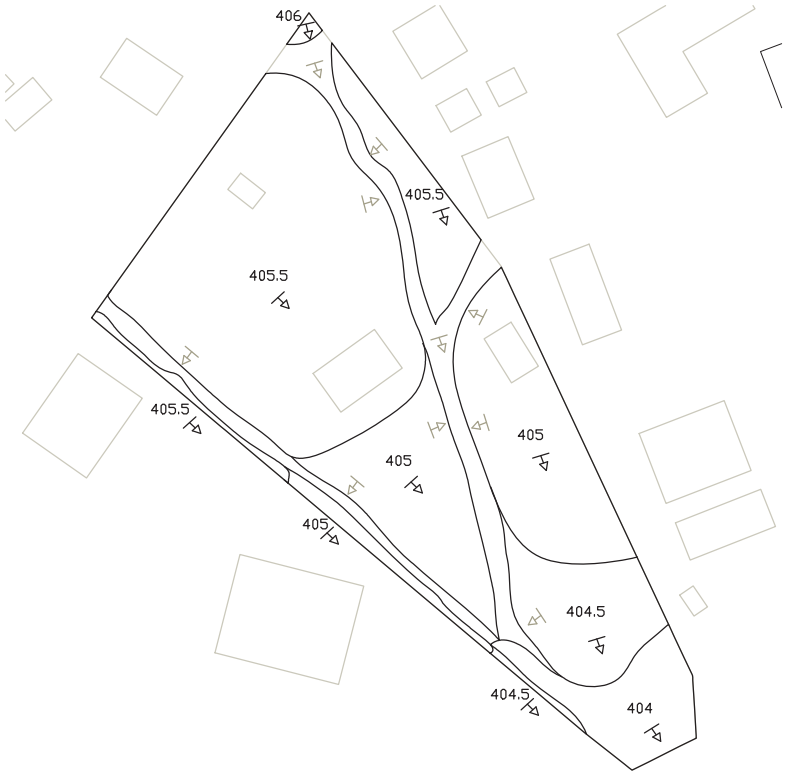
1.40

2. Experimental studies and preliminary drafts

2.1 Landscape design study



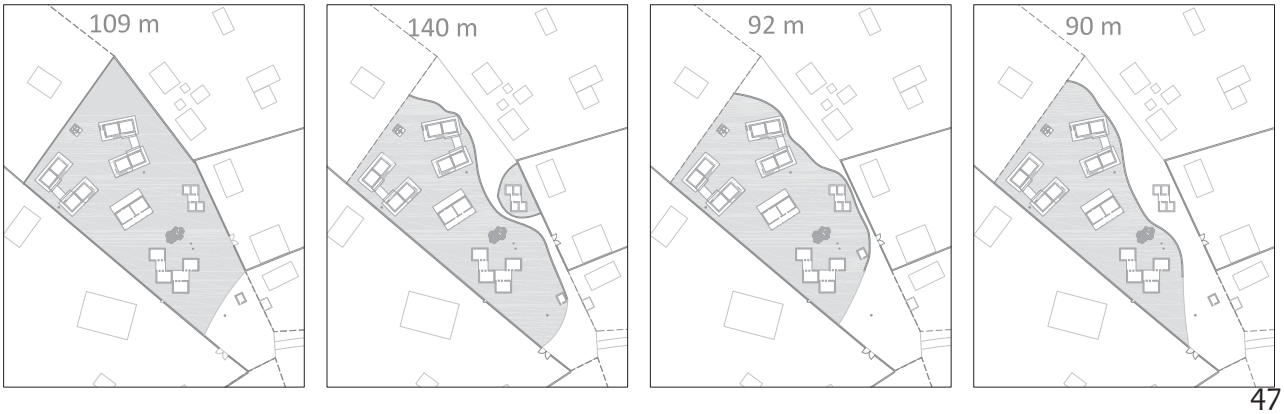
2.1

The plan above shows a rough sketch of the slopes and current rain water channels on the site. Based on this sketch different possibilities to react were produced.

The first design idea shows the regular way to keep the water out of the site. By building a water barrier wall in the north-east and north west of the site the water can be stopped for most of the area (grey), if these wall are connected with the two existing walls in the east and west. 109 metres wall have to be built. An big disadvantage of this solution is that the walls have to be deeply founded and built high, because the water will collect in front of the walls.

The other solution follow the idea to lead the water instead of stopping. While the second solution would need more built wall, the other solutions would be more economic because of the lower material consumption. The water-protected area is smaller than in the first solution.

2.2

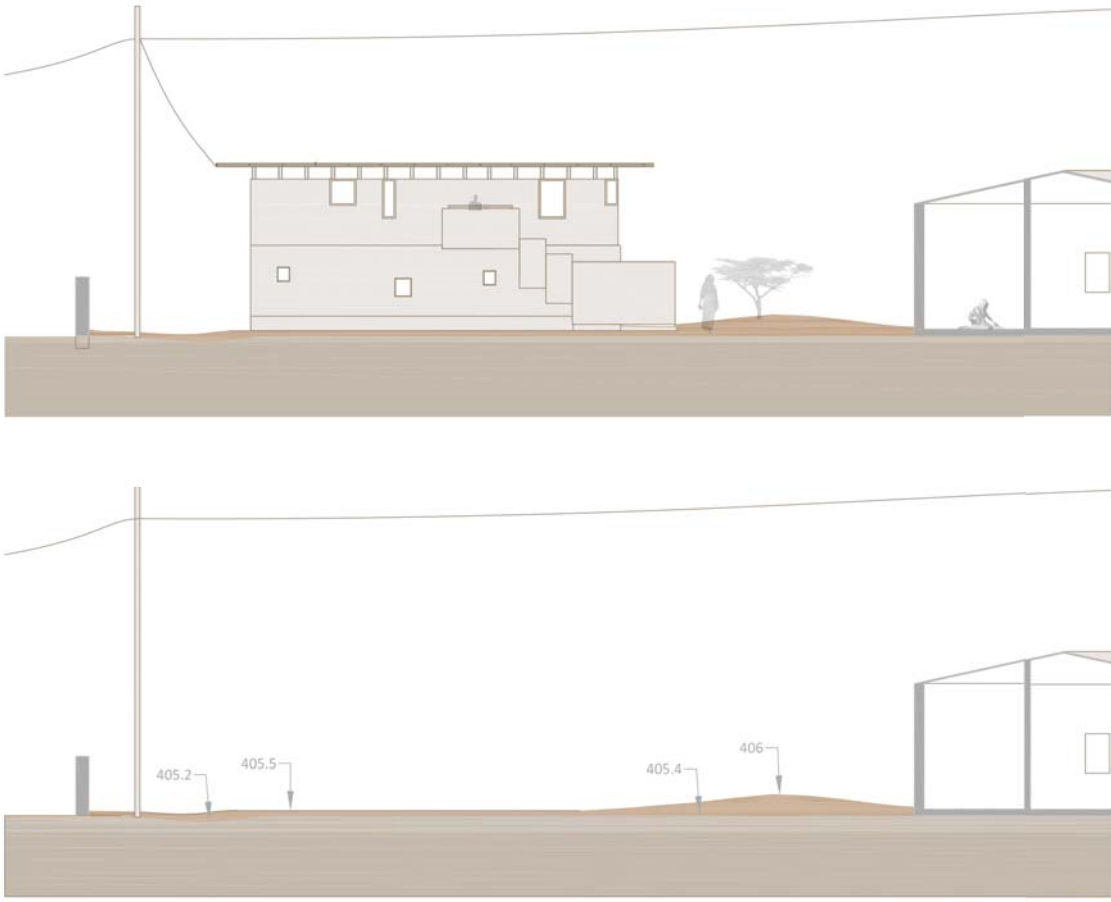


2.2. Site section

Based on the studies done for the site layouts an exemplary section through the site was done. The section cut goes through the *Old Bakery* in the middle of the site. This building will be renovated and used for the compound as a kitchen and communal space.

The first section is done through the highest edge of the flooding channels that currently exists east of to the *Old Bakery*.

At the second section a hostel building is added and the flooding edge is replaced by a stone wall. This wall is leading the flood around the hostel buildings. It can be used for sitting or playing as a landscape object. In the area flooding below the wall, a small garden will be made. The plantation of some trees and plants to grow additional food is planned.



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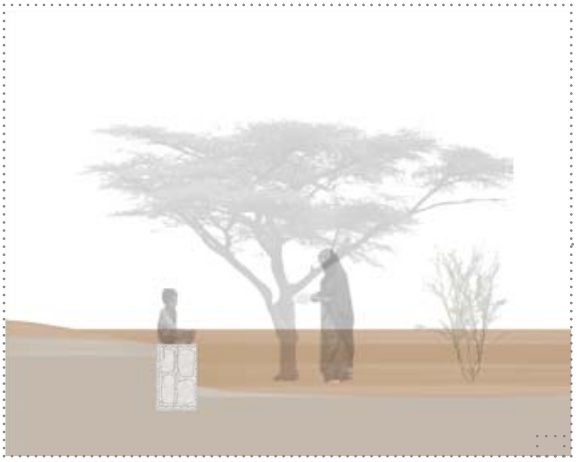

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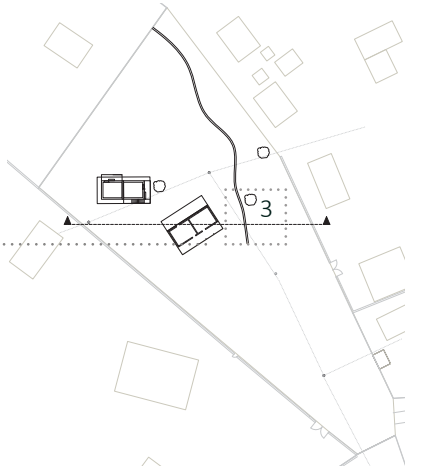
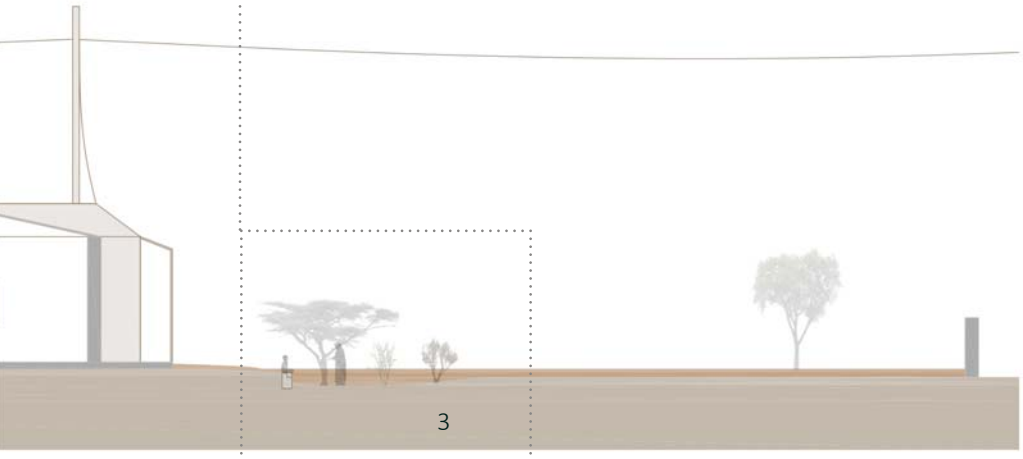
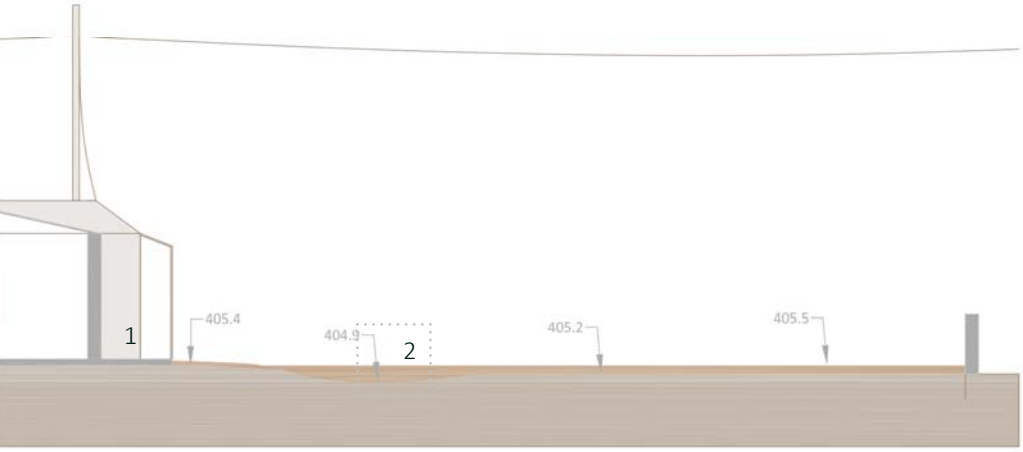


2.5

1 *Old Bakery*
2 highest flooding edge
3 stone wall and garden zone



Landscape design proposal



Initial situation

Scale 1:200

3. Design process

3.1 Overview: compound for education and culture

The *compound for education and culture* will provide space for 56 students from rural areas to live supervised in the town Logya. Pedagogical educated teachers will give lessons for 60 children coming from Logya. There will be working two supervisor, one caretaker, and to guards to look after the children 24 hours a day. Four cooks will provide meals for the children and teenagers. One caretakter will look after the compound, the buildings, the garden and the livestock, that will be provided for food production and educational purposes.

Project name: Afarkindergarten-project, a compound for education and culture

Location: Logya (site 2), Afar region, Ethiopia

Construction start: January 2015

Ownership, operation and management: Afar Pastoral Development Association (APDA)

Planned buildings:
4 Student hostels (56 beds for 28 girls and 28 boys)
4 Kindergarten (60 children)
1 Afar-structure playground
2 Staff houses (4 rooms)
1 Kitchen with communal space
1 Sanitary block (2 showers, 2 toilets)
1 Guard house

Food production:
1 Garden
4 Garden elements
1 Livestock (goats, sheep)

Employees
4 Kindergarten teachers
4 cooks
1 caretaker
2 guards
2 Hostel supervisors

3.1

Hostel

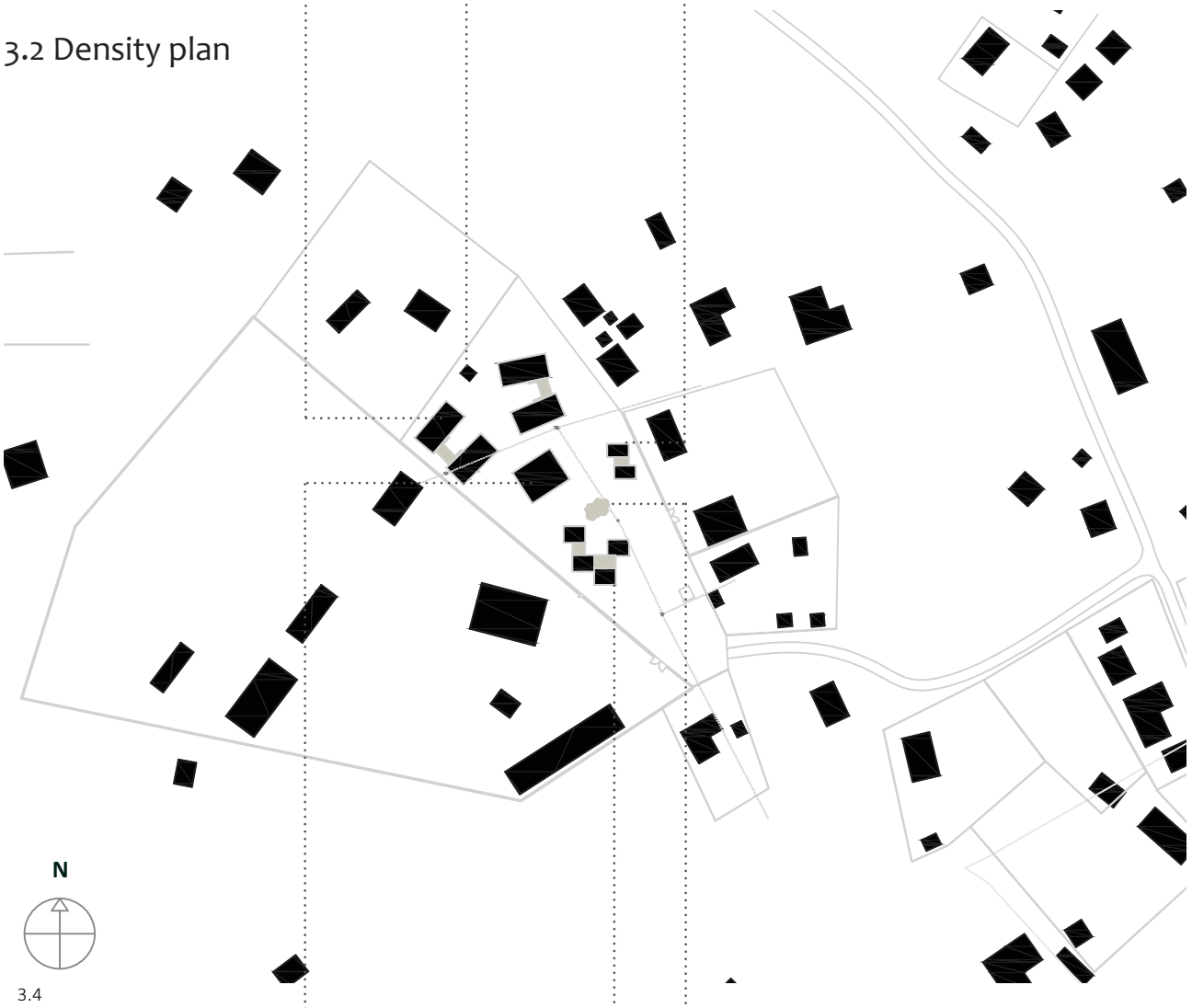
3.2

Sanitary block

3.3

Residence staff

3.2 Density plan



N

3.4

Scale 1:200

Communal space

3.5

Kindergarten

3.6

Afarstructure

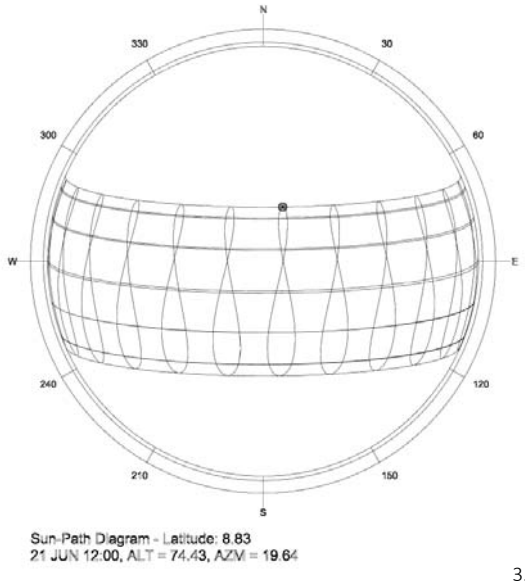
3.7

3.3 Analysis of weather impacts and climatic conditions

Sun path diagram

The sun path diagram indicates the annual movement of the sun in Ethiopia. The current position of the sun is on the 21st of June at 12 a.m., marked with the black sphere in the centre. The seasonal fluctuations are low compared to Europe because of the proximity to the Equator.

Weather station data
The data is from the weather station in Metehara. This is the closest weather station to Logya. It is located near the southern boarder from the Afar Region, about 30 kilometres away from Awash and 330 km distance to Logya. Metehara is situated 550 meters higher than Logya.



3.8

Solar study

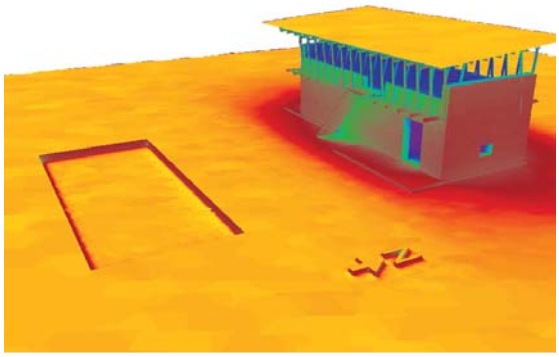
The solar radiation study was done as a comparative analysis. Different orientations, positions, shadings and roof constructions are compared to find out more about the impacts of these factors.

Shading
The shading is built with 40% cover and 60% cavity, where radiation transmission can occur. This value was taken to simulate the porosity of the bamboo and palm mats, that will be used for construction.

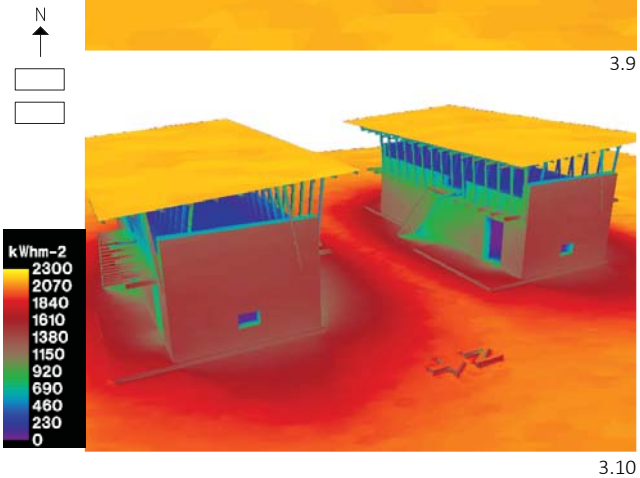
Simulation software and data
The study is done with the plug in "Diva" for the program "Rhino", which uses the engine "Radiance". The simulation shows the average amount of solar radiation, that encounters the building components during one year in $kWhm^{-2}$. The calculation uses the weather data from the city Metehara.

Simulation 1: surrounding
On the first simulation the impacts of a building on the surrounding is shown. The heating up of the ground and shading effect on the neighbouring house are shown.

Simulation 1: surrounding



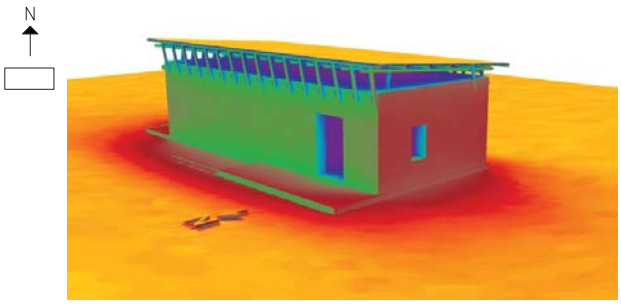
3.9



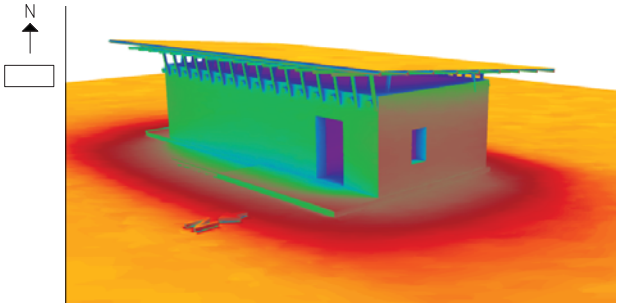
3.10

Simulation 2: roof overhang

The next simulation demonstrates the impact of the roof overhang. The simulation visualizes the shading effect of the roof on the walls, but also on the ground. The same building is shown from two sides. The first house (left pictures) has a small overhang of 0.5 meters, while for the second house (right pictures) it is 1.5 meters. The orientation of the houses is marked with a north arrow in the simulation and additional north direction symbols are beside the pictures.



3.11



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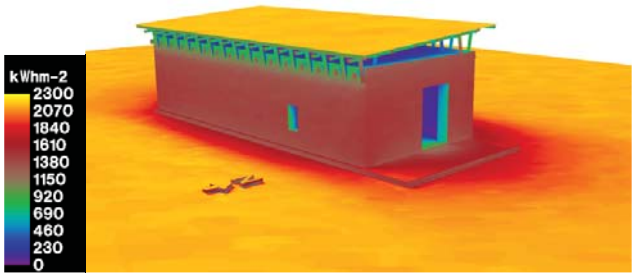

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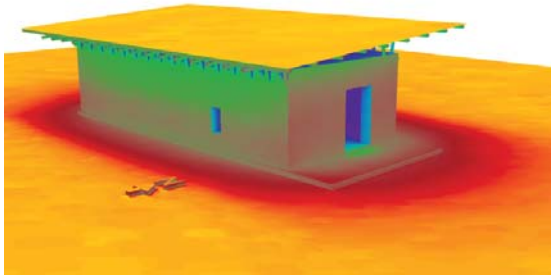
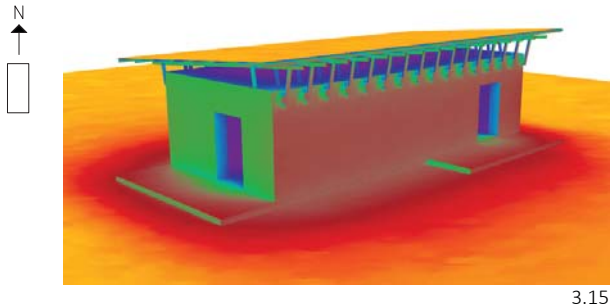


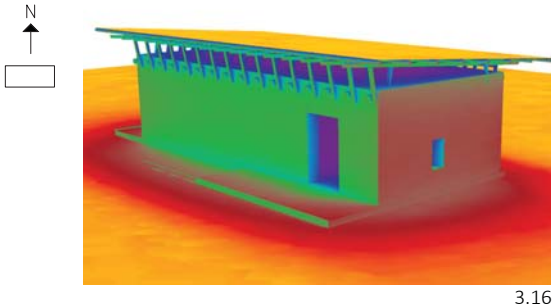
3.14

Simulation 3: orientation

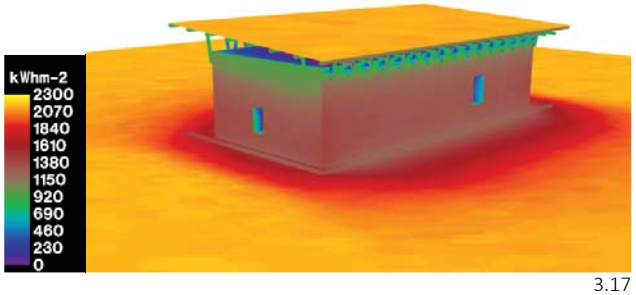
The orientation is also an important factor concerning the solar radiation that is heating up the building components. The first house (left) got a short side turned to north, while the second house (right) is rotated 90 degrees. As one long side is turned to the north, it has a far lower radiation on the walls in sum.



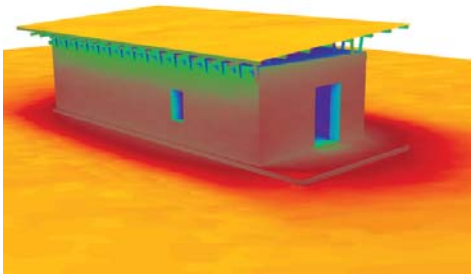
3.15



3.16

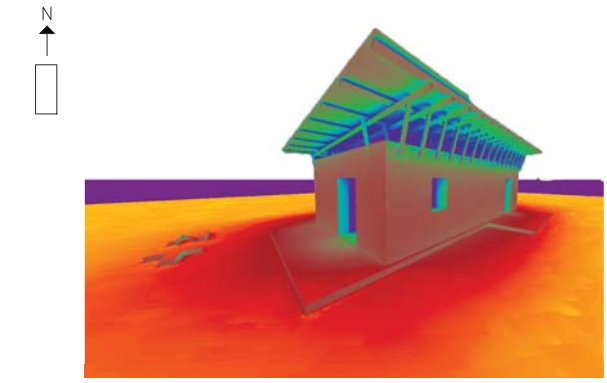


3.17

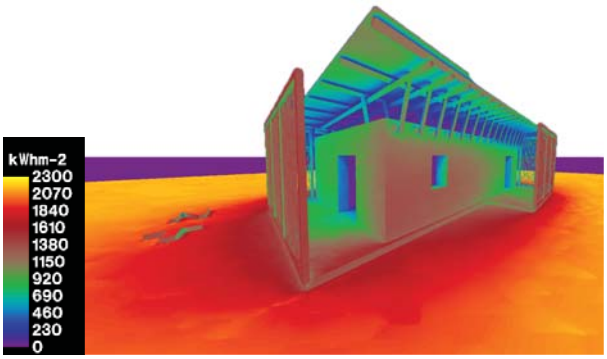


3.18

Simulation 4: sun shading



3.19



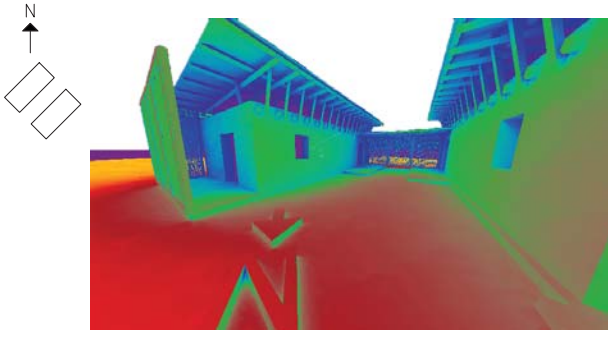
3.20

This analysis demonstrates the immense significance of sun shading. The first picture shows the building from a south-west perspective without shading. On this orientation the impact of the sun is especially big. The facade in the west and south is heated with approximately 1,610 $kWhm^{-2}$.

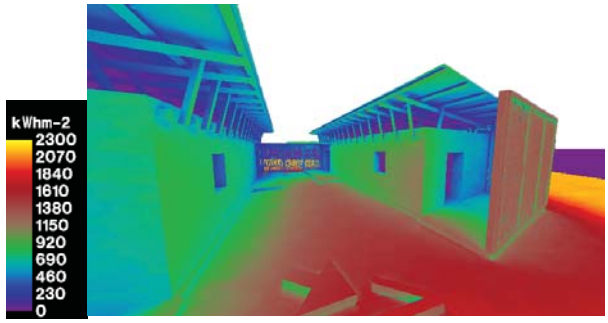
After partly protecting the facade from the strong heat radiation by building a sun shading in front of the walls, a value between 920-1,380 $kWhm^{-2}$ can be reached. The transmission - cover ratio of the shading was selected as described in the introduction.

The shading situation in the south leads to a similar advantage in the covered area. The cooling effect on the floor should also be observed. This has also an impact on the comfort and the climate in and around the house.

Simulation 5: building arrangement



3.21



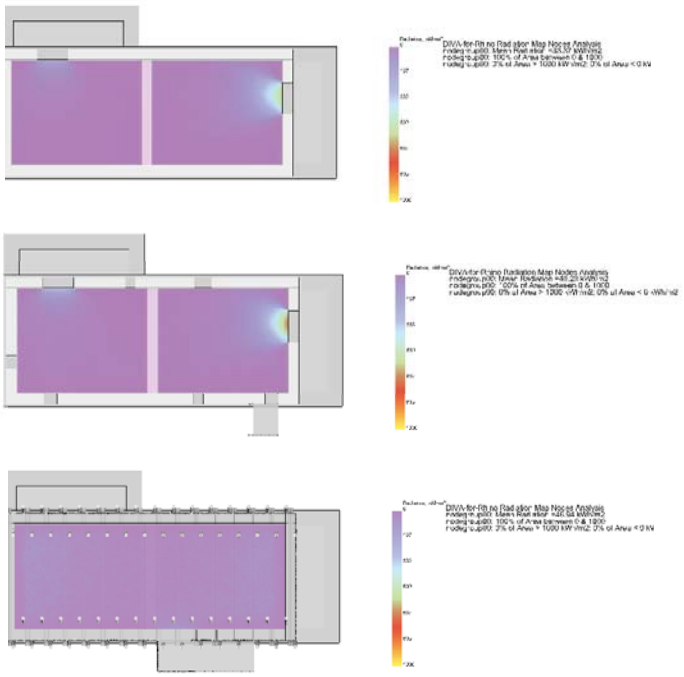
3.22

The arrangement of the houses is important. Shading houses with the proximity of the buildings is a widespread technique to reach cooling in hot areas. For example on the Arab Peninsula the houses are often built very close together leaving only narrow spaces in between. The second advantage of this technique is the stimulation of the air circulation by acceleration of the winds.

The houses in the simulation are placed in a 45° angle to the north-south axis. This orientation matches the orientation of the first hostel building, which is already under construction. The distance between the houses is three meters.

On the first picture there can be seen the north-west facade (long) and the shadowed north-east facade (short) of the left house. With the assistance of the shading values as low as 690 -440 $kWhm^{-2}$ can be reached. The effect on the partly shaded south-east facade of the house on the right side is also clearly displayed.

Simulation 6: indoor solar radiation



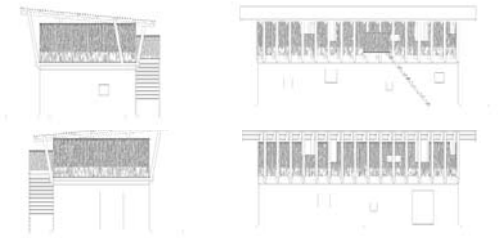
3.23

The heating up of the building is not only influenced by the rays that heat the outside of the building, also the influence of the rays passing the openings should be considered.

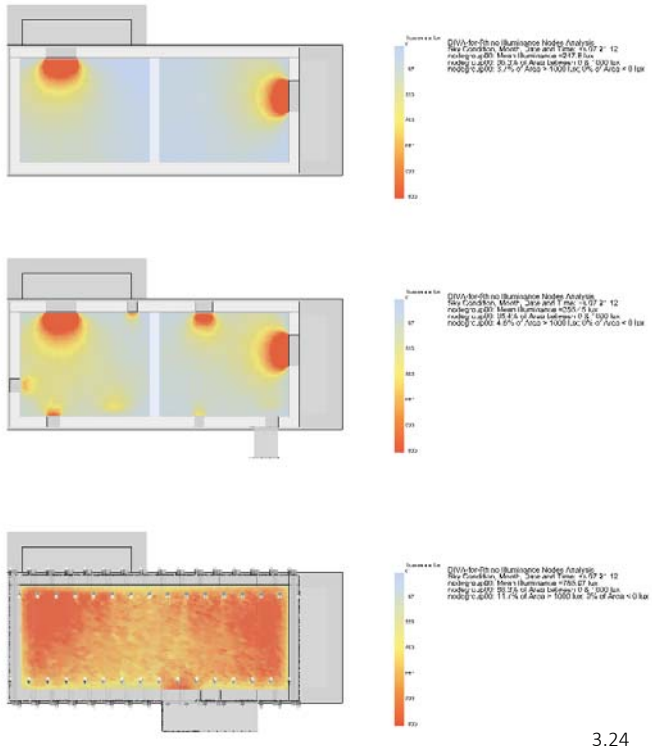
On the first illustration a house with only two doors is shown. (Mean radiation: 33.37 kWhm^2)

On the second variety the openings are expanded with windows. (Mean radiation: 40.23 kWhm^2)

The third simulation shows the upper floor of the building which is only the shadings as walls like described in the introduction. The views below of the building used for the simualtion are shown below. (Mean radiation: 46.94 kWhm^2)



Simulation 7: illuminance



3.24

This study was also made with the building shown on the views above. The intensity of the illuminance in one area and the average illuminance in the room is calculated at 12 o'clock midday on the 21st of June.

The first picture shows the house having only the doors. The mean illuminance in the rooms is 247.8 lux.

On the second the windows are added for the simulation. (Mean illuminance: 355.45 lux)

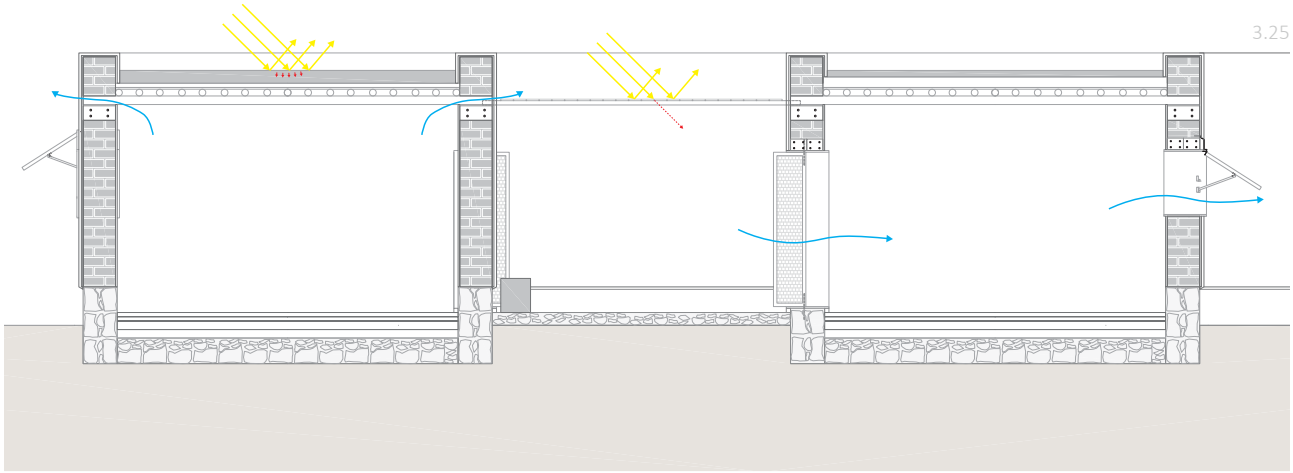
The third picture shows the second floor, which should be used as a room for studying during the day. The mean illuminance in this room is 785.07 lux. As a comparison the Austrian standard requires that the illuminace in working rooms has to be 100 lux at every area (on 85 cm height). The values reached are far above this requirement. (AK: Belichtung und Beleuchtung)

3.4 Room climate and ventilation

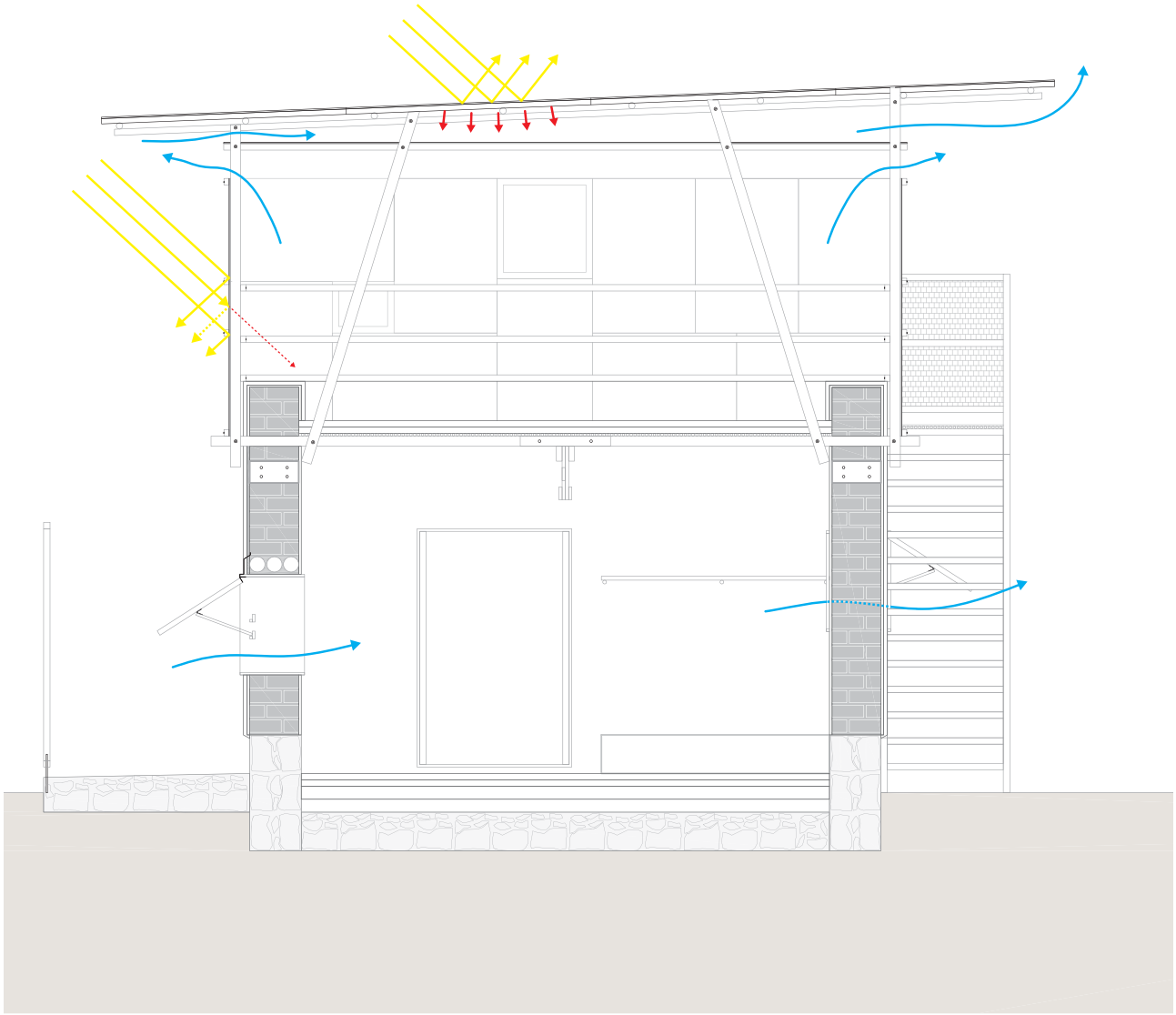
The results of the of the solar studies were used to create an optimized building shape and arrangement.

To optimize the indoor climate an additional concept was worked out. The 45 cm thick walls function as a thermal buffer. At the Kindergarten construction (loam roof, below) the roof also works a buffer. At the hostel building (above) the loam ceiling will keep the heat out of the ground floor. The second floor is cooled by ventilation. The low thermal inertia of the wood-mat construction will have the effect, that this floor cools down quickly in the evening and can be used in case of heat. The ventilated intermediate ceiling will keep the heat of the corrugated sheets away. The temperature at the floor downstairs will go down slower, because of the thermal inertia and can be used in the winter where the temperatures during the day are still high, but the nights are relatively cold.

In both buildings cross ventilation will have a cooling effect during the hot days. Shadings are used as walls, surrounding walls and roofs to protect the walls from solar radiation. The roof overhang of the hostel buildings (above) will also have this protection effect.



3.25



3.26

3.5 Landscape design and zones

3.27

Zones

1 Garden and farming
2 Student hostel
3 Communal space and kitchen
4 Residence staff
5 Kindergarten
6 Public zone (entrance shop and mosque)

The site is divided into different zones and public (6) semi-private (3,5) and private areas (1,2,4). The private area consist of the garden and farming zone, the student hostel area and the staff residences. The communal space with the kitchen and the Kindergarten are part of the semi-private area. The public area will provide access to the mosque, neighbouring residents and the small shop bordering the site. Exemplary local ideas for the design and elements are shown in the pictures below.

Exemplary small garden element
Urban farming in the garden
Tree as landscape gardening element

3.28

3.29

3.30

3.31

3.6 Garden

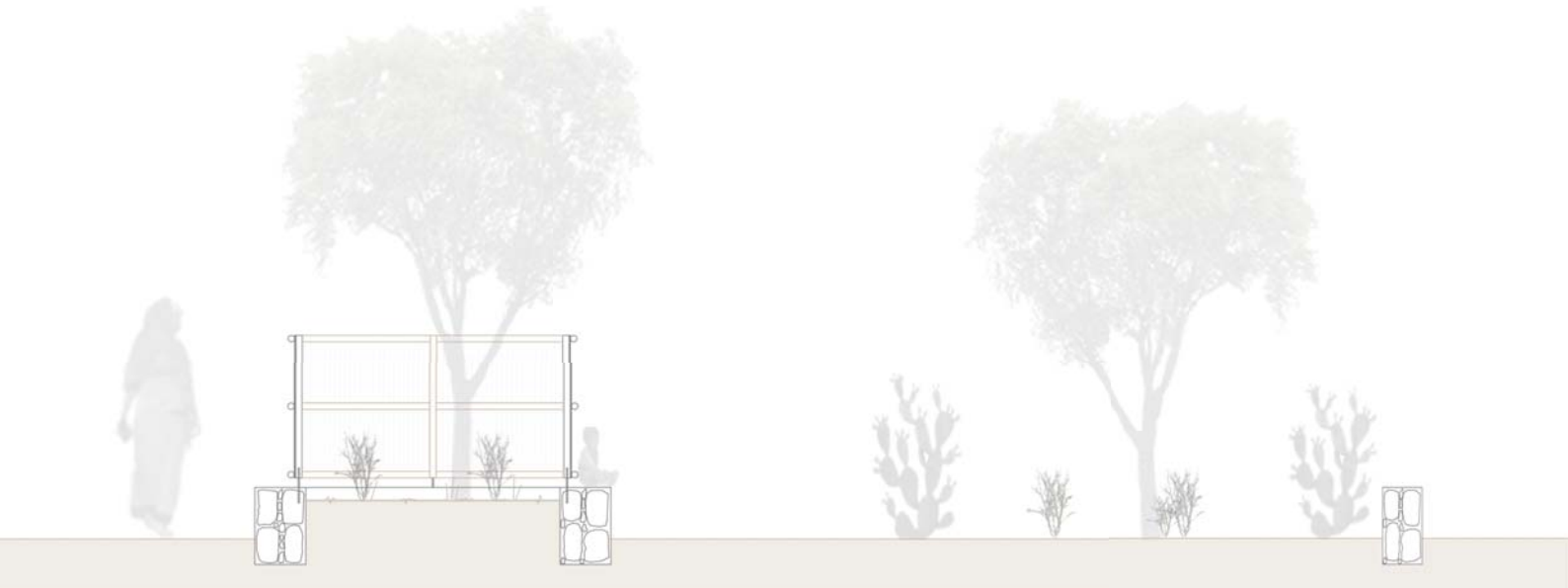
In the garden small scale farming for a better supply with food and fresh product will be done. For producing fruits, which are rare in Afar and very expensive, trees like guava, mango, orange and lemon can be planted. Date palms or the prickly pear cactus, which can additionally be used as a hedge plant and for clay impregnation, also have fruits rich in nutrients and are adapted to the climate. The Moringa tree is widely used in Ethiopia as a medical plant and a herb for the traditional coffee *púna*. Suger cane and maize are already planted in the area and are very useful and fast growing farming plants. For the supply with important fatty acid and a lot of other healthy ingredients nut trees like Cashew or Macadamia nuts can be grown. The desert rose is growing in the dry areas of southern Ethiopia and is a beautiful ornamental element in the garden, but is also useful to produce infusion to treat camels and cows. (Dhrani, 2002)

These plants could will be grown in the garden for providing useful products, but also they have a big impact on the local climate by providing shade and producing evaporative cooling. So the plants can also be seen as a part of the climate concept. Additional they are important landscape elements and will be used for educational purposes.

The children will have the possibility to learn how to breed plants and grow food in the garden. The sensibility for the environment will be raised by lectures on plants and their uses. Additional reforestation techniques will be teached. A small livestock will also be bought and kept in the compound to enable the children to learn how to deal with the animals and produce milk and other products.

Section garden elements

The section below illustrates the small garden islands (left) placed all over the site and the main farming garden. The small garden elements will be surrounded by stone walls that can be used for sitting and playing in the shade of the trees. A fence will be build to protect the young plants from the goats and other hungry animals, which is important in Logya. The fence will be used as a backrest. The main garden will be fenced by prickly pear cactuses, as the keep animals out, have an ornamental effect, produce fruits and save wood for the construction of the fence.

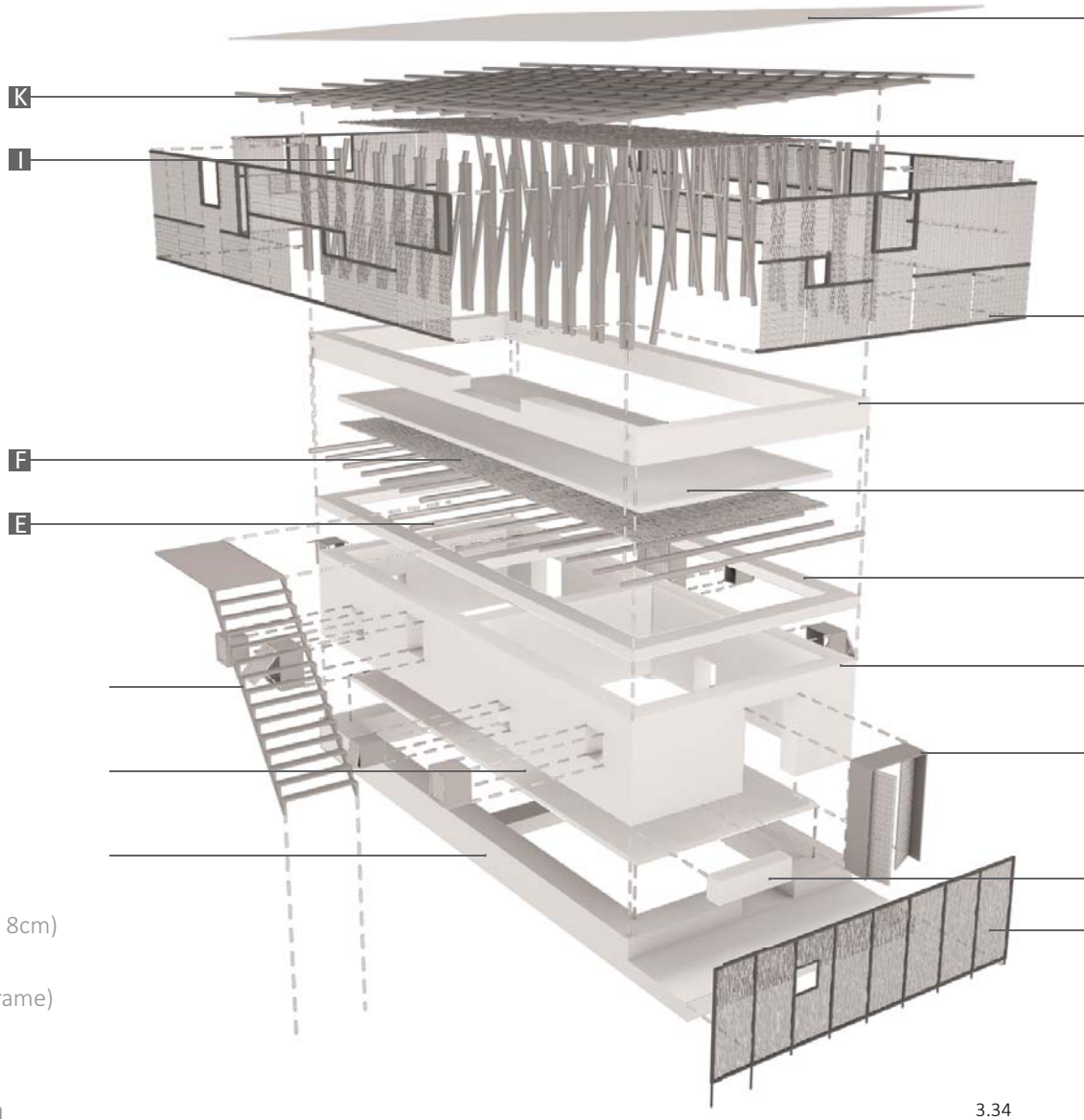


3.32

3.7 Site plan

The final arrangement of the buildings is a product of the existing conditions on the site, the results of the solar and climatic analyses and urban planning and landscape design factors. The main garden is situated in flooding area in the north. A wall leading south from the garden will help to keep the water away from the hostel area. Small garden island are spread all over the site for creating useful outdoor spaces, food and improving the micro climate on the site. The common space is situated in the centre of the site around the existing *Old Bakery*. Close to the middle and overlooking the hostel and kindergarten the staff residences are built to enable the supervisor to have an overview over the site and children. The Kindergarten in south works as a semi-private zone buffering from the public area in the south to the private area in the north. The guards mark the boarder of the public area to the beginning of the compound and guard over the entrance area.

3.8 Construction components and materials



3.34

A foundation
(stone)

B loam floor
(two layers)

C loam wall
(air dried loam bricks)

D ring beam
(reinforced concrete)

E primary structure
(Eucalyptus, round timber, 8cm)

F supporting structure
(palm sticks, Afar slatted frame)

G loam floor
(two layers)

H seating accommodation
(air dried loam bricks)

I pillars
(Eucalyptus, round timber, 8cm)

J heat radiation protection
(bamboo mat)

K primary structure
(Eucalyptus, round timber, 6cm)

L roof toping
(metal sheet)

M staircase
(round/sawn timber)

N opening frame
(sawn timber, filled with Afar mat)

O seating accommodation
(air dried loam bricks)

P shade structure
(wooden sticks, framed)

Q shade structure
(bamboo mat / Afar mat, framed)

The explosion graphic shows the different parts of the construction and the assigned materials. The first floor is built with loam adobes, while the second floor is constructed with a wooden frame covered with mats. The materials, and some compositions of the materials are displayed on the pictures.

Anorganic materials

Organic materials

L

J

Q

H

G

D

C

N

O

P

A

J
Q

E
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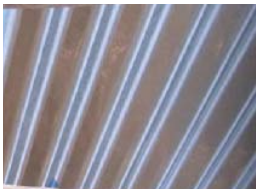
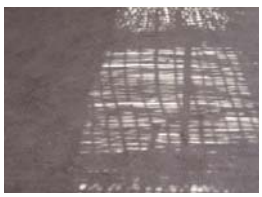


L

P
Q

C



B
G

figures 3.35- 3.48

4.1 Student hostel

The hostel will provide the possibility for rural student to visit the school in town. These students will live in the hostel and visit the high school owned by the government. APDA will provide food and shelter for free for these children and will manage the operation of the whole complex. The garden and a small livestock will be provided for the students to learn how to produce food on their own. Environmental matter will be an important matter on that education.

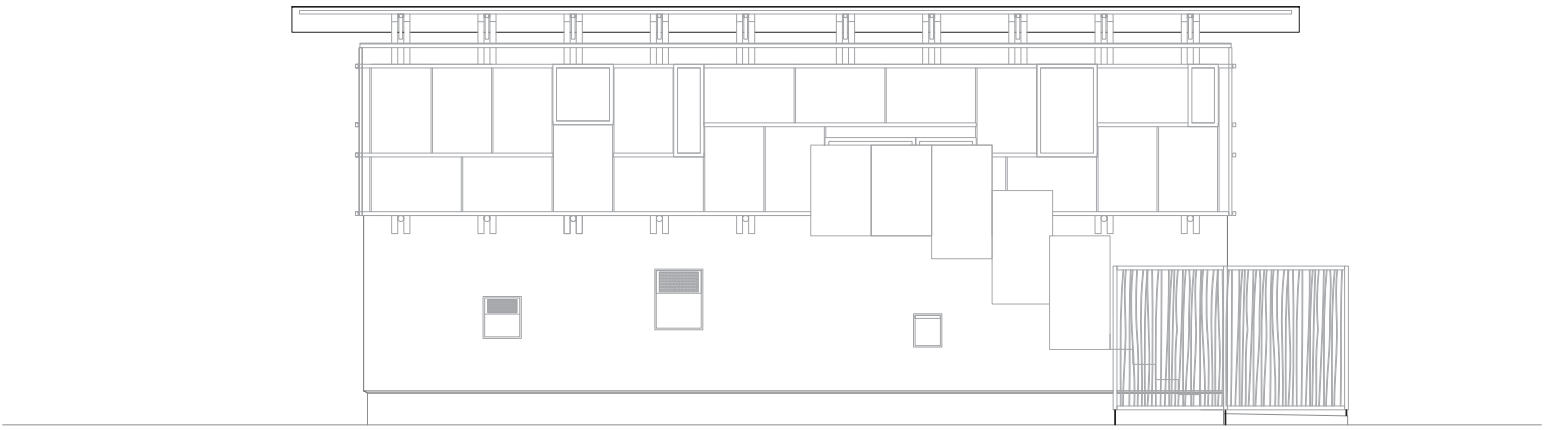
The hostel building have two floors offering different climatic zones (see chapter room climate and ventilation). In the ground floor the beds for the students are placed and the space to store their stuff is provided. The second floor is built with a light structure, with a lot of light and fresh air circulating. The design of this part of the building is influenced by the traditional Afar *Deboita* architecture.

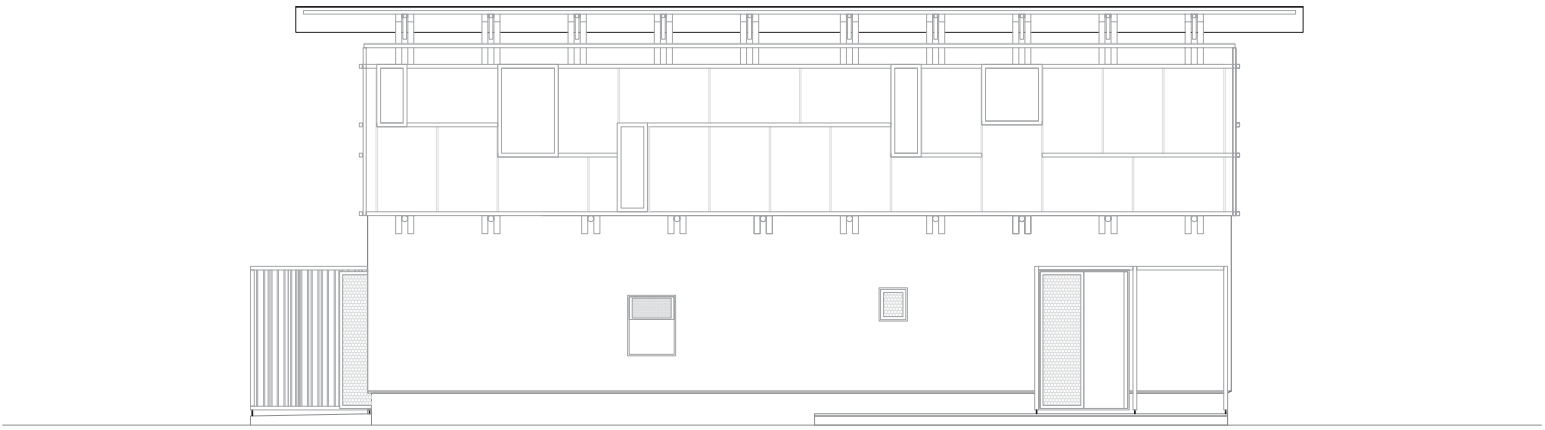
During the days and evenings this floor can be used for studying, reading, playing and communicating. In the hot summers the Afar people often sleep outside. They take the mats and sleep on the floor, as the wind and air circulation is cooling. The disadvantage of sleeping on the floor is that animals like scorpions can be dangerous. Also there is no possibility to hang up a mosquito net on the open land. As there is malaria in Afar the children will have mosquito nets for sleeping. For this purpose the upper floor can be used, as the air circulation is higher than in the other rooms and an additional protection of the children is provided.

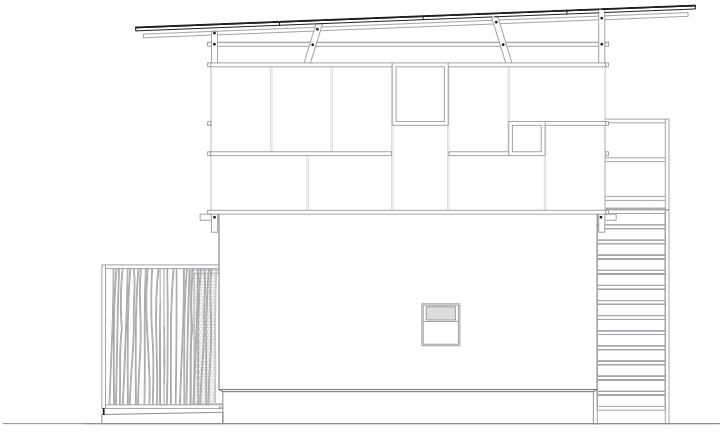
The shading structure provides additional protected, private space and cool the facade. It shields the entrances and keeps animals away from the house.

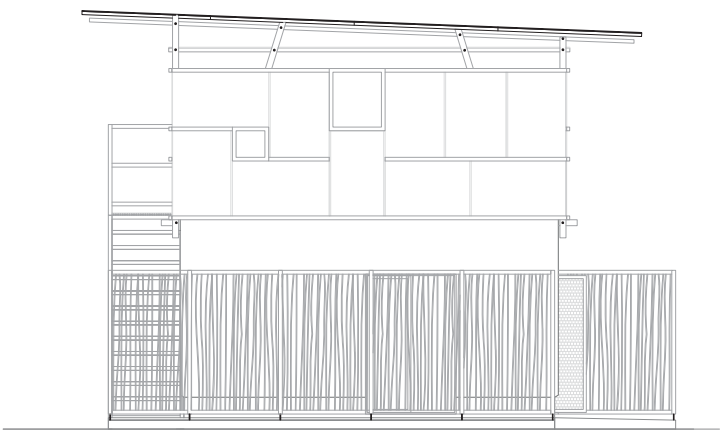
Hostel views

scale 1:100









4.2

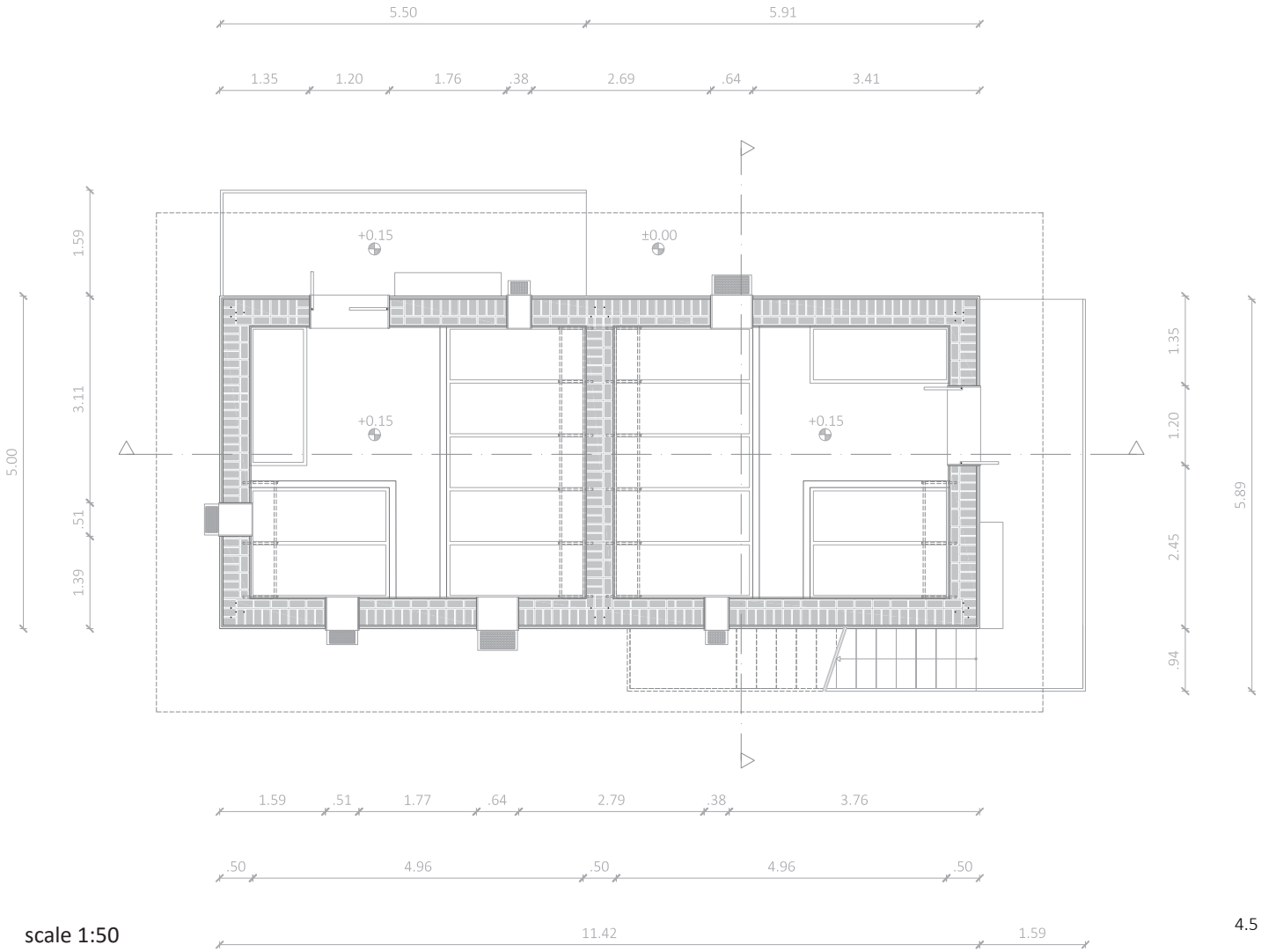
Construction process and spatial organisation

Following the processes going on at the site, but also the budgetary possibilities, there will be built one hostel after the other. So they are built as a single house (see floor-plan on the right) and will be connected to a own small compound unit by a fencing shade structure later (see figure below). In the end there will be one of these small compounds for the girls and one for the boys.

The picture on the right side shows the upper floor from inside, used for studying and communicating during the day and for sleeping at night during the hot season.

4.4

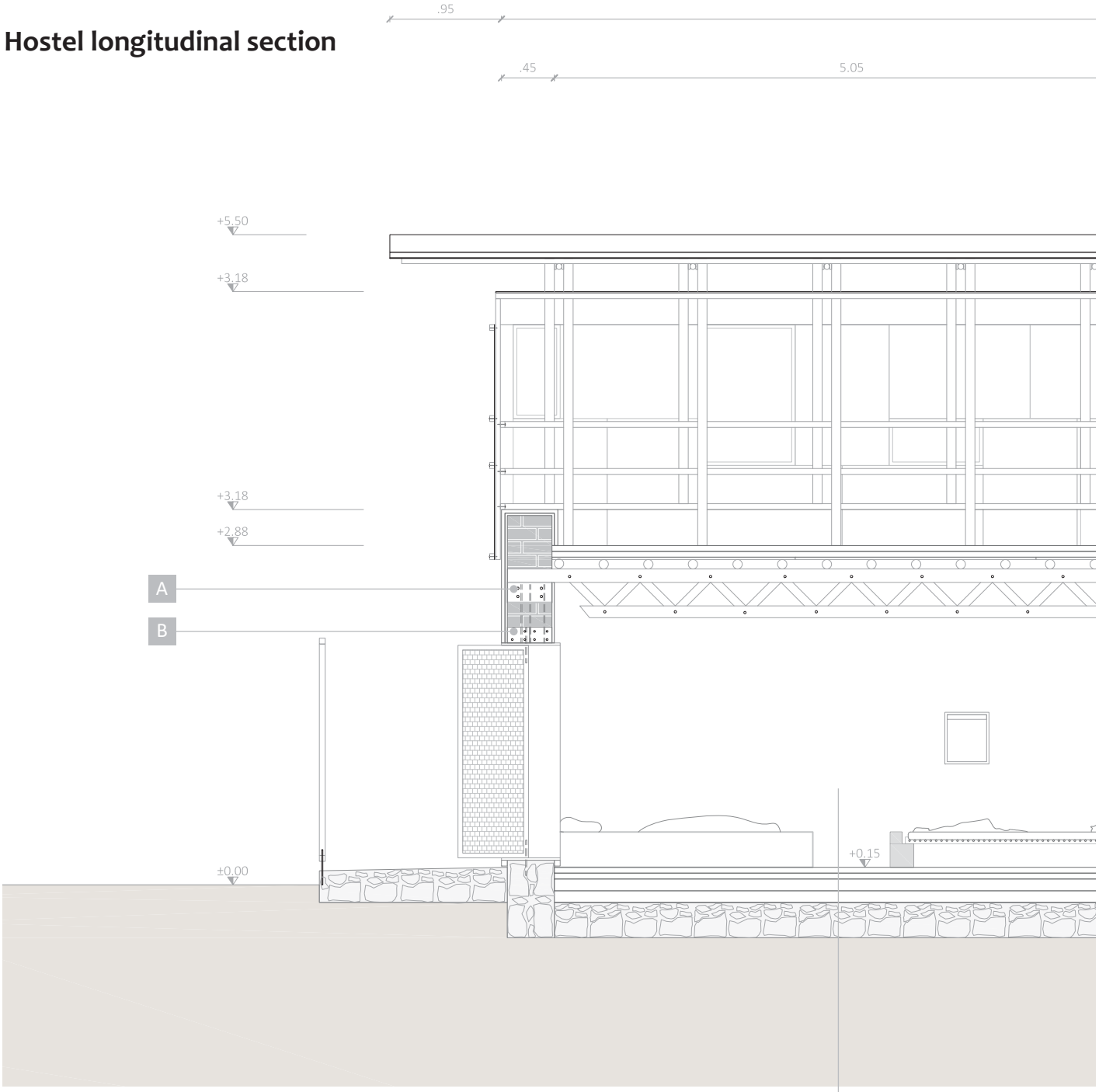
Hostel ground plan



scale 1:50

4.5

Hostel longitudinal section



A ring beam
(reinforced concrete)

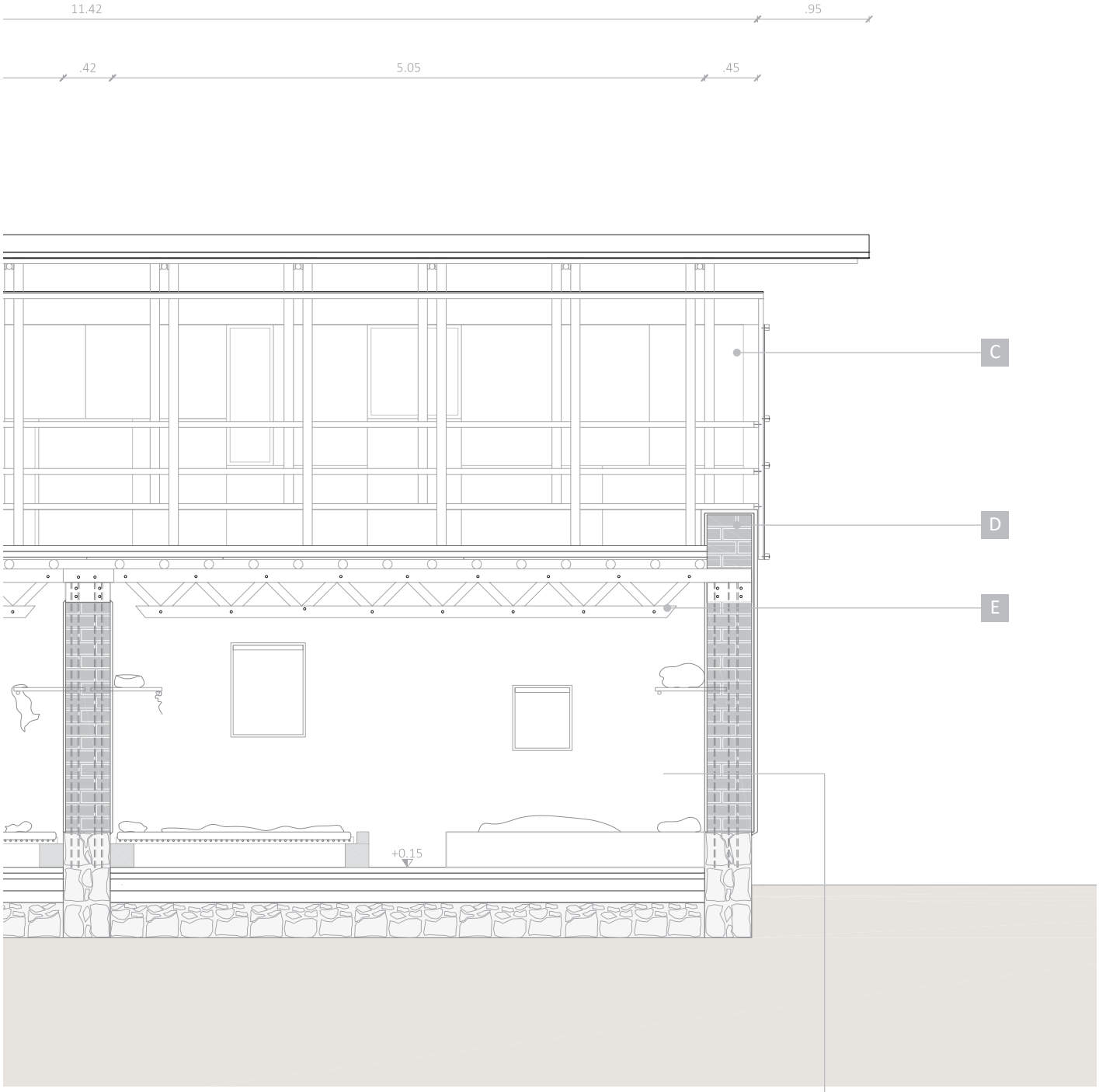
B lintel
(reinforced concrete)

C shade construction
(framed bamboo mat)

D seating accommodation
(loam, wooden railing)

E supporting structure
(trussed beam, sawn timber)

[cm]	
5	loam mortar (stabilisied by lin-seed-oil or p
5	rammed earth (higher content of aggregate)
10	rammed earth (water barrier, higher content
10	coares gravel (capilar break layer)
30	stone



[cm]

3 loam plaster
(higher content of aggregate)

2 loam plaster
(higher content of clay)

38 loam bricks
(reinforced steel 12mm,
corners and joints)

3 loam plaster
(two layers)

scale 1:50

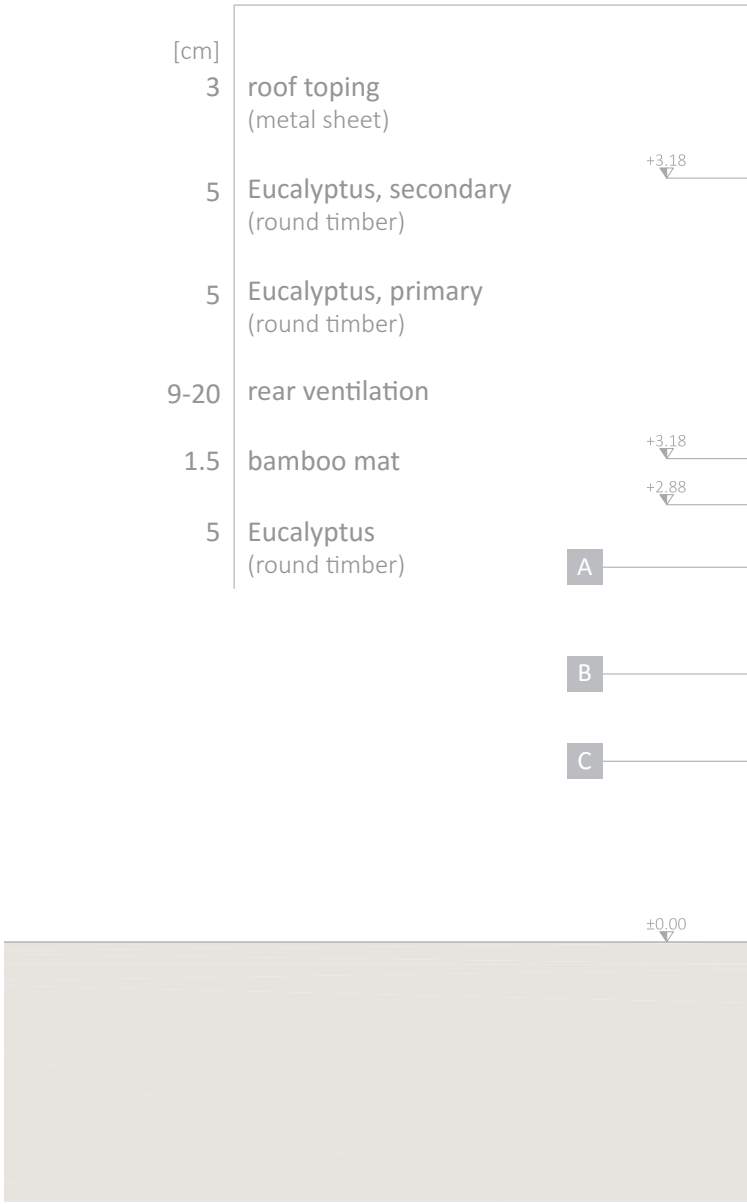
brickly pear cactus)

)

t of clay)

Hostel cross section

scale 1:50



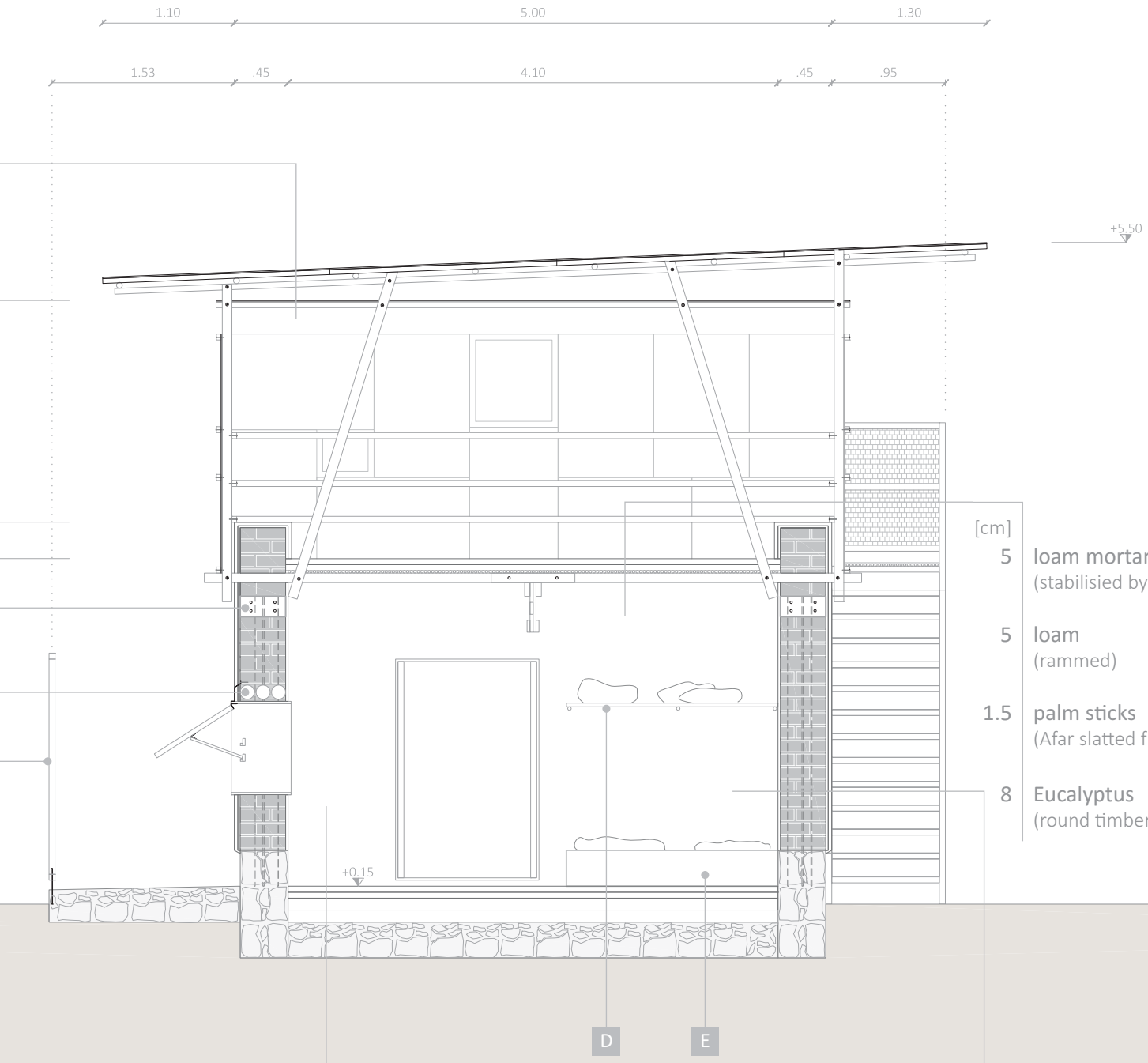
A ring beam
(reinforced concrete)

B lintel
(3x round timber, 10cm, connected)

C shade construction
(wooden sticks)

D shelf
(round timber, 4cm)

E bed
(palm sticks, Afar slatted frame)



[cm]
5 loam mortar
(stabilisied by lin-seed-oil

5 loam
(rammed)

1.5 palm sticks
(Afar slatted frame)

8 Eucalyptus
(round timber)

[cm]
5 loam mortar
(stabilisied by lin-seed-oil or prickly pear cactus)

5 rammed earth
(higher content of aggregate)

10 rammed earth
(water barrier, higher content of clay)

10 coares gravel
(capilar break layer)

30 stone

[cm]
3 loam plaster
(higher content of aggregate)

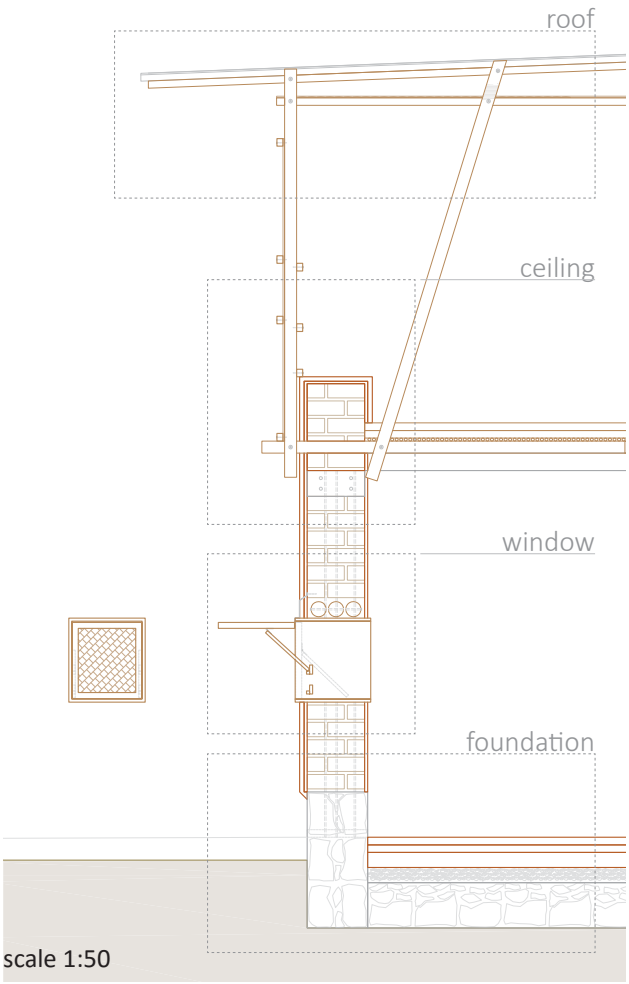
2 loam plaster
(higher content of clay)

38 loam bricks
(reinforced steel 12mm,
corners and joints)

3 loam plaster
(two layers)

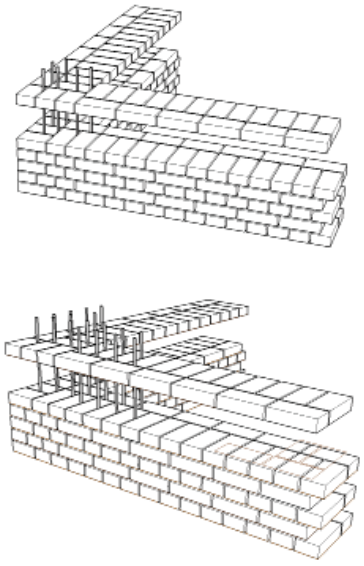
Hostel construction details

The figure displays an overview of the details shown on the following pages.



4.8

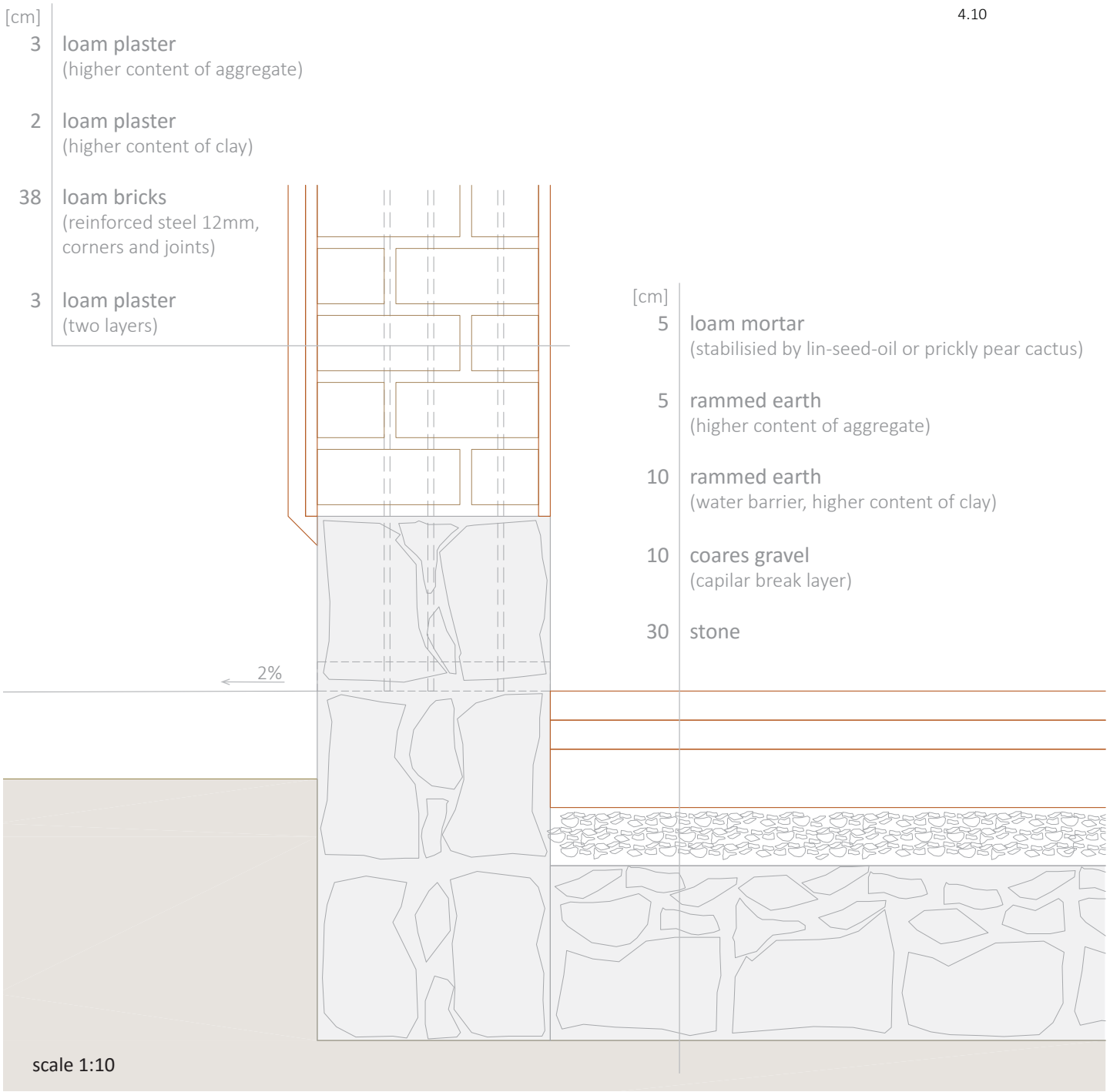
The system of the bricks was chosen the have the possibility to reinforce the whole wall or corners and joint. On first illustration the corner reinforcement, like it was used for the construction of the first hostel is displayed. In cases of earth quakes the bricks will be stabilized by the reinforcement. Especially corners, joints and lintels are weak points. So special attention is done to these constructive elements. (Minke, 2013; UNESCO, 2014)



4.9

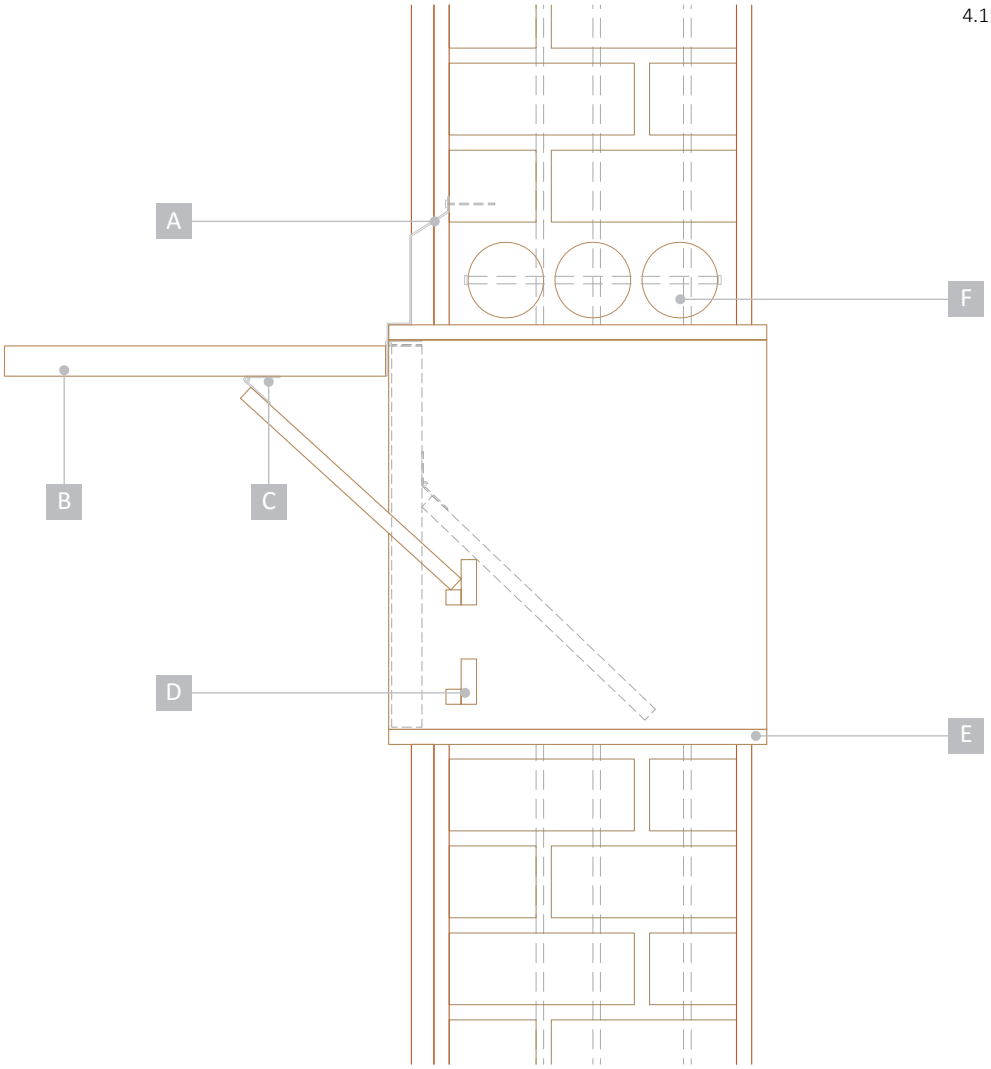
Foundation detail

4.10



Window detail

4.11



A splash water protection
(metal sheet, 0.5mm)

B casement
(sawn timber, 4x5cm, bamboo mat)

C hinge
(steel)

D opening system
(sawn timber, varies)

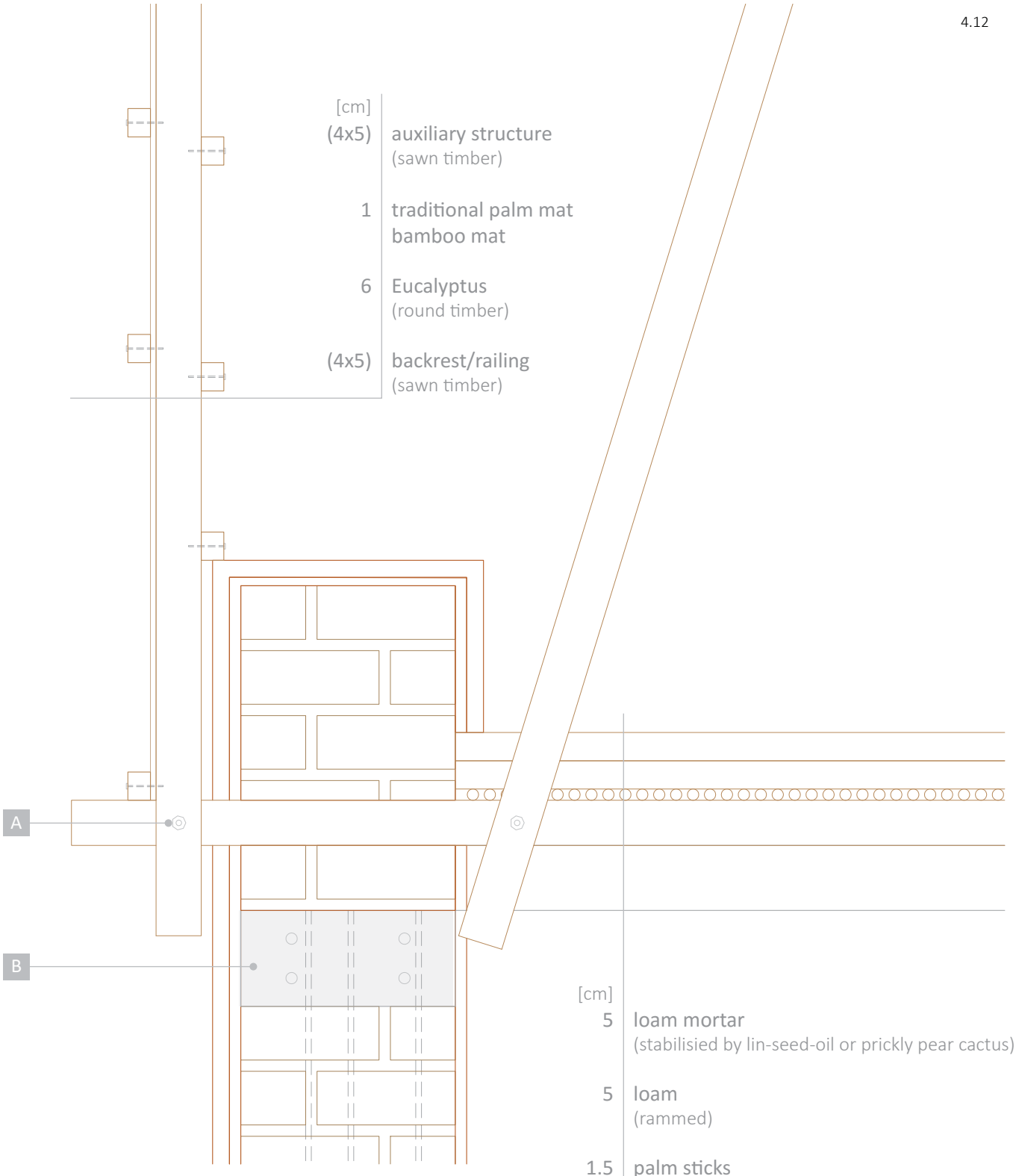
E window frame
(sawn timber, 2cm)

F lintel
(3x round timber, 10cm, connected)

scale 1:10

Ceiling detail

4.12



[cm]

(4x5) auxiliary structure
(sawn timber)

1 traditional palm mat
bamboo mat

6 Eucalyptus
(round timber)

(4x5) backrest/railing
(sawn timber)

[cm]

5 loam mortar
(stabilisied by lin-seed-oil or prickly pear cactus)

5 loam
(rammed)

1.5 palm sticks
(Afar slatted frame)

8 Eucalyptus
(round timber)

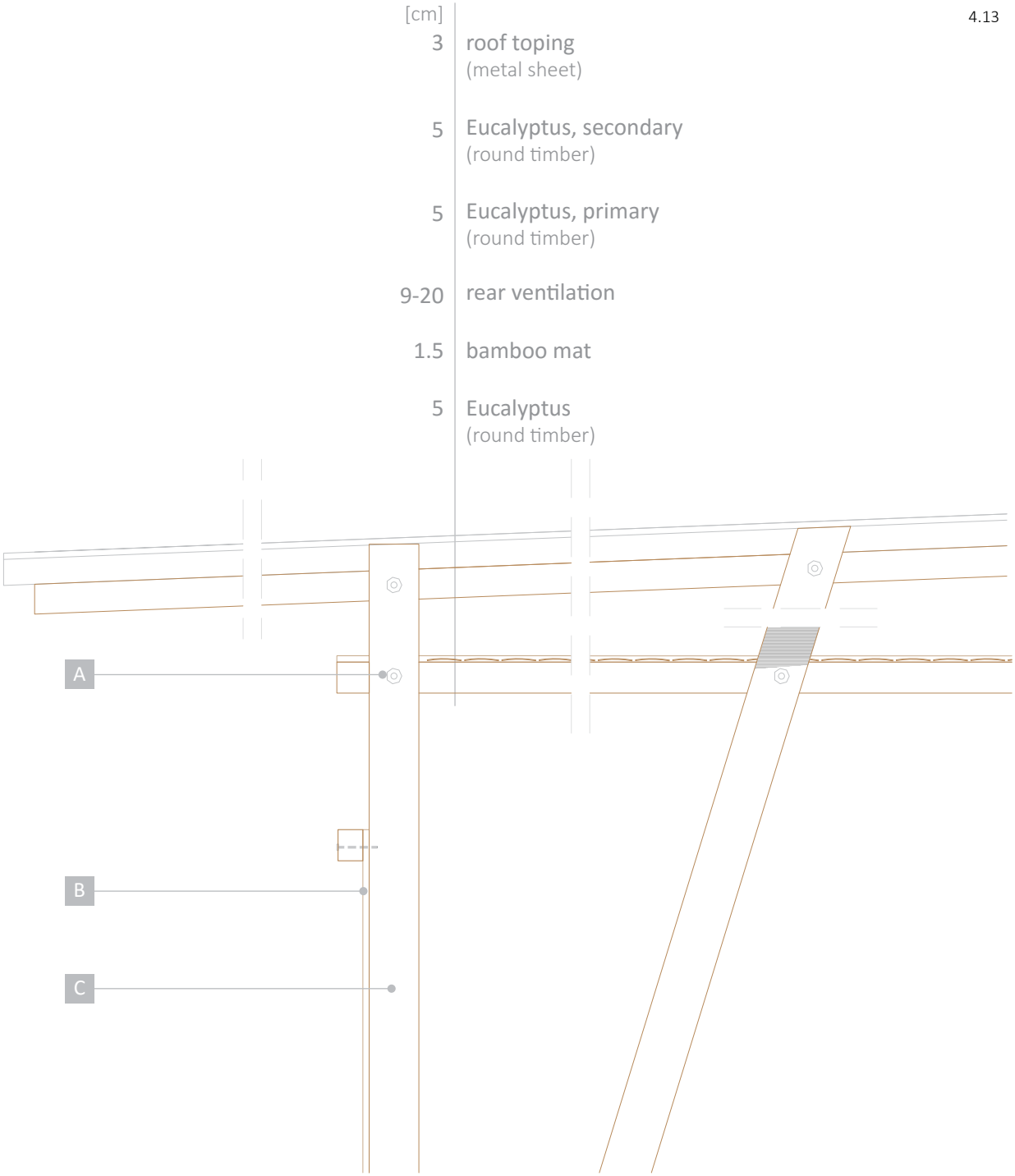
A threaded rod
(steel M10)

B ring beam
(reinforced concrete)

scale 1:10

Roof detail

4.13



A threaded rod
(steel M10)

B traditional palm mat
bamboo mat

C Eucalyptus
(round timber, 6cm)

scale 1:10

4.2. Kindergarten

Kindergarten
In the Kindergarten up to 60 children will be educated in subjects necessary for school education, but also they will learn here to read and write in their language “Afar” and will learn about their tradition, culture and environment. Classes on traditional way of life, but also on crop breeding and the use of plants will be done, similar to the hostel lectures.

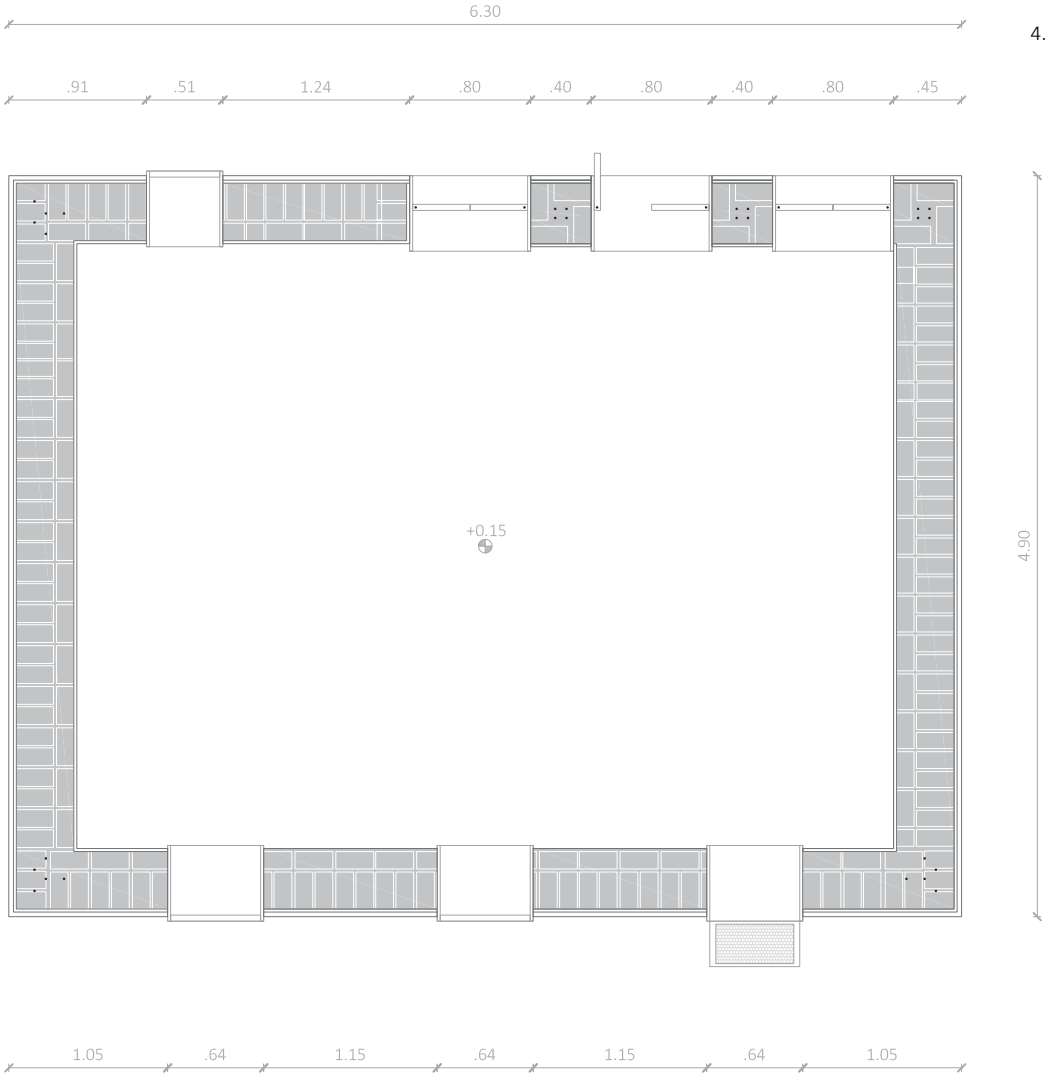
The four buildings are arranged to produce shaded courtyards in between. The shade roofs and the mutual shading reduce the solar radiation on the walls. The design was influenced by the second architectural style found in Afar beside the traditional frame-tent construction, the Arabic architecture style. This kind of architecture is found in the few old cities in Afar like at the former capital and sultanate Asaita. In Asaita the houses are constructed with stone walls. The kindergarten will be built with loam adobes.

Afar-structure
The second element of the Kindergarten is the Afar-structure, built in the traditional way with a supporting wooden frame and mat cover, but with innovations in the design.

SWThe tratitional *Deboitas* are always built as single domes, in some areas with stretched ground plan. If the tents are built together they are two single domes with a small door connecting them or another dome is built to connect them. This leads to a limited size of the room. By building the structures together, changing the diameter of the arcs and interweaving the structures of the domes new shapes can be designed and bigger rooms can be constructed. The Afar-structure built in the school yard will be part of the traditional education. Playfully the children can learn the traditional construction techniques by extending the existing structure.

4.15

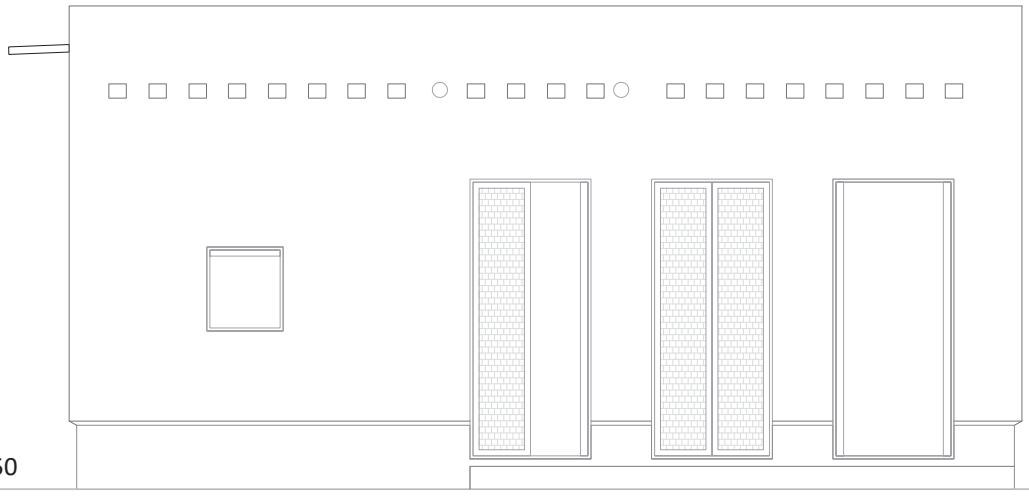
Kindergarten ground plan



4.16

scale 1:50

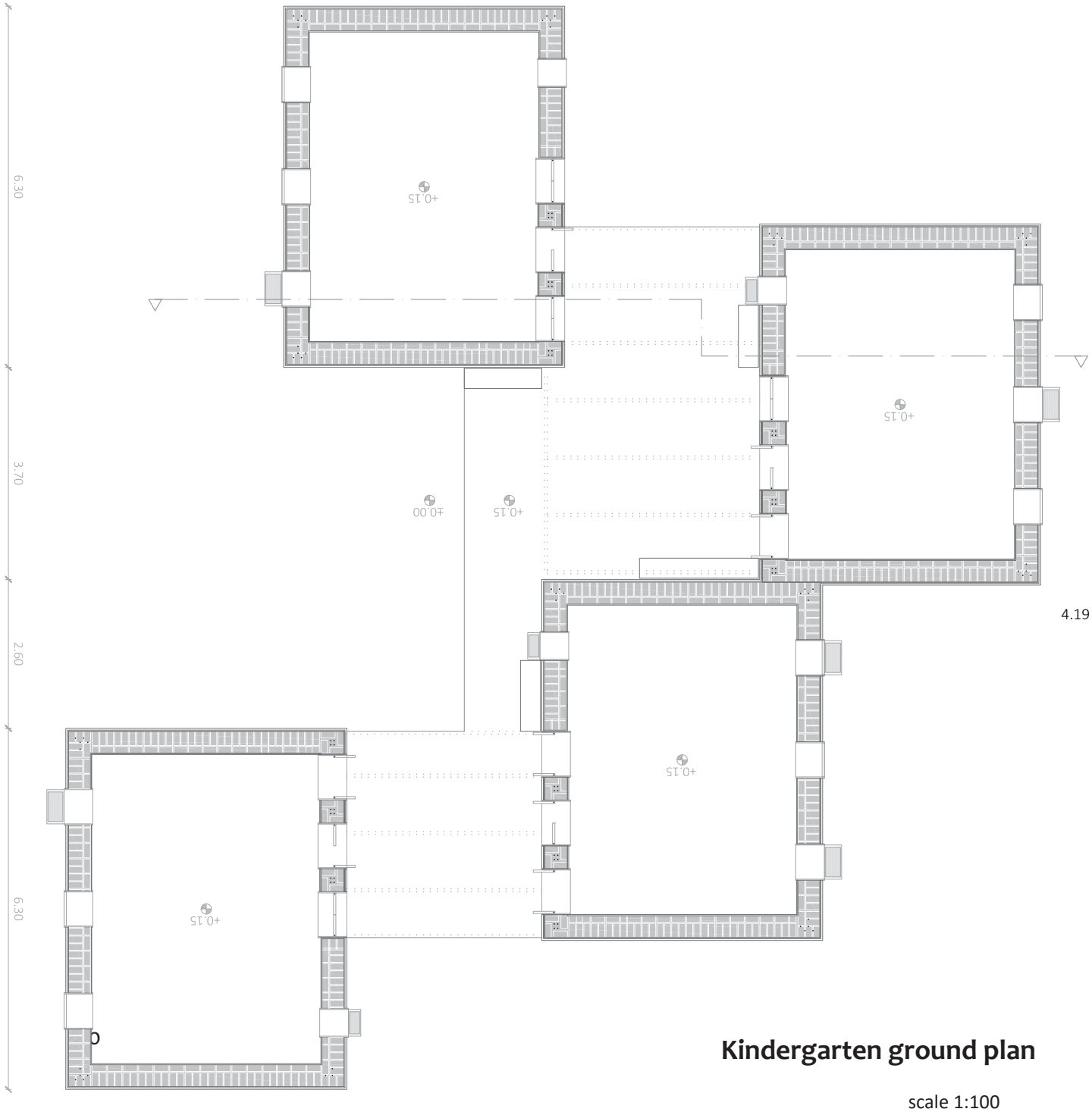
Kindergarten view



4.17

scale 1:50

4.18

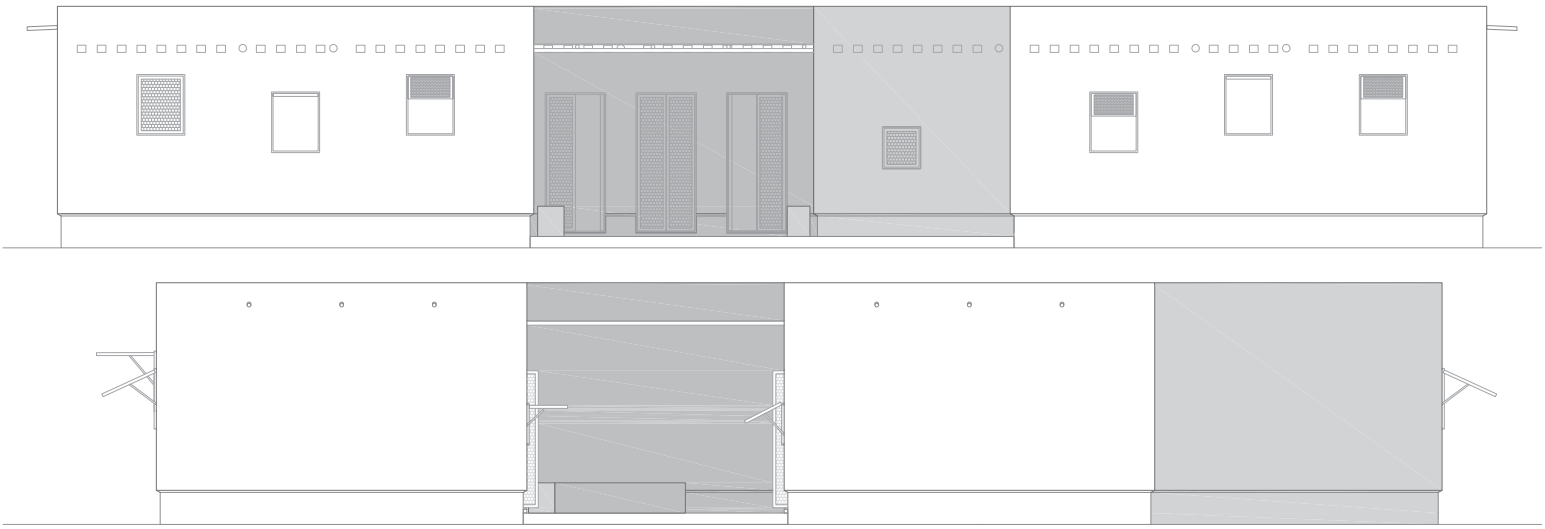


4.19

Kindergarten ground plan

scale 1:100

Kindergarten view

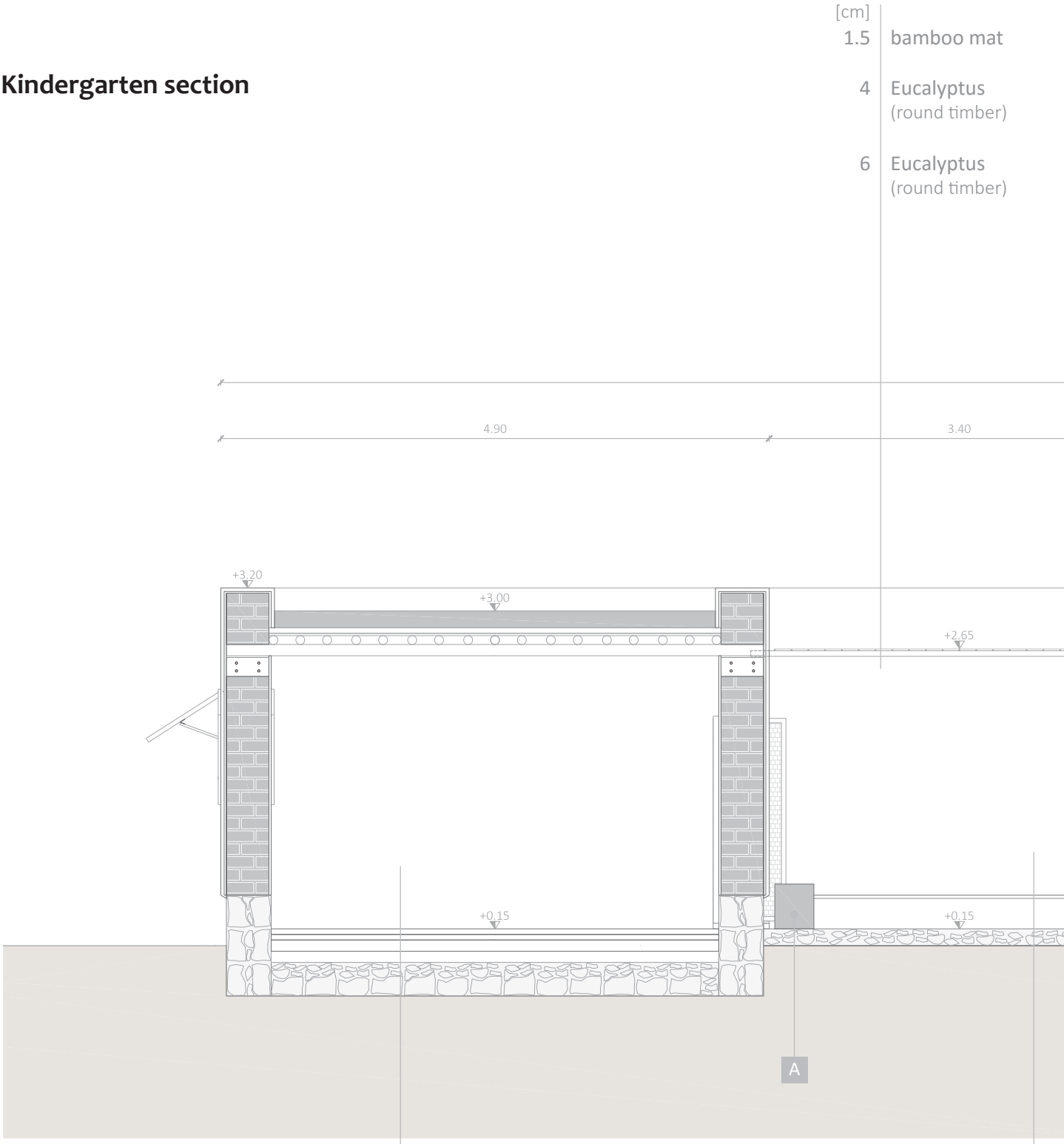


4.20

scale 1:100

4.21

Kindergarten section



4.22

[cm]

9-20 loam mortar
(stabilisied by lin-seed-oil or prickly pear cactus)

5 loam
(rammed)

1.5 palm sticks
(Afar slatted frame)

8 Eucalyptus
(round timber)

12 Eucalyptus
(round timber)

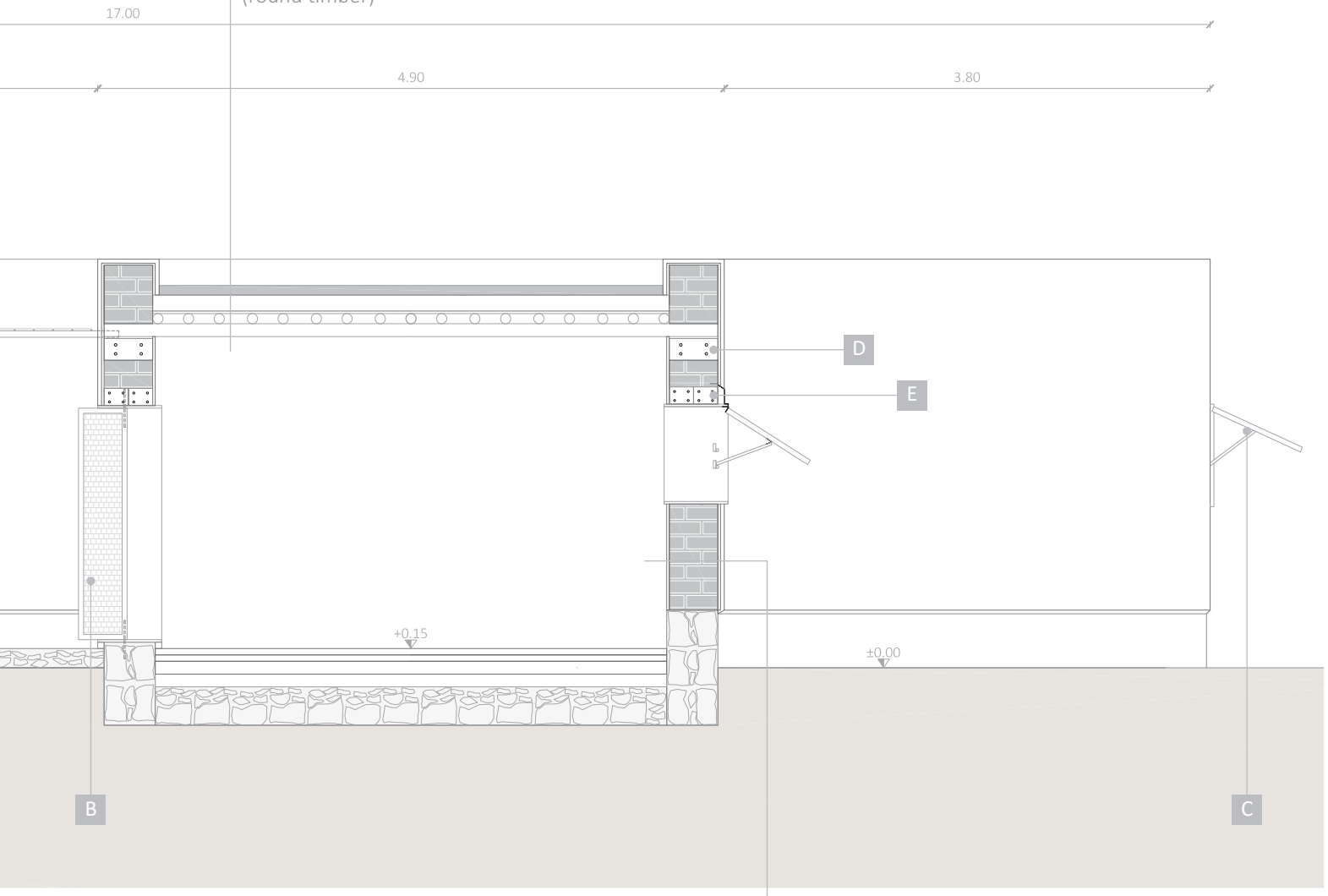
A seating accommodation
(loam)

B door
(filled with Afar mat)

C window
(filled with Afar mat)

D ring beam
(reinforced concrete)

E lintel
(reinforced concrete)



wn stones

[cm]

3 loam plaster
(higher content of aggregate)

2 loam plaster
(higher content of clay)

38 loam bricks
(reinforced steel 12mm,
corners and joints)

scale 1:50

3 loam plaster
(two layers)

Kindergarten section

[cm]

9-20 loam mortar
(stabilisied by lin-seed-oil or prickly pear cactus)

5 loam
(rammed)

1.5 palm sticks
(Afar slatted frame)

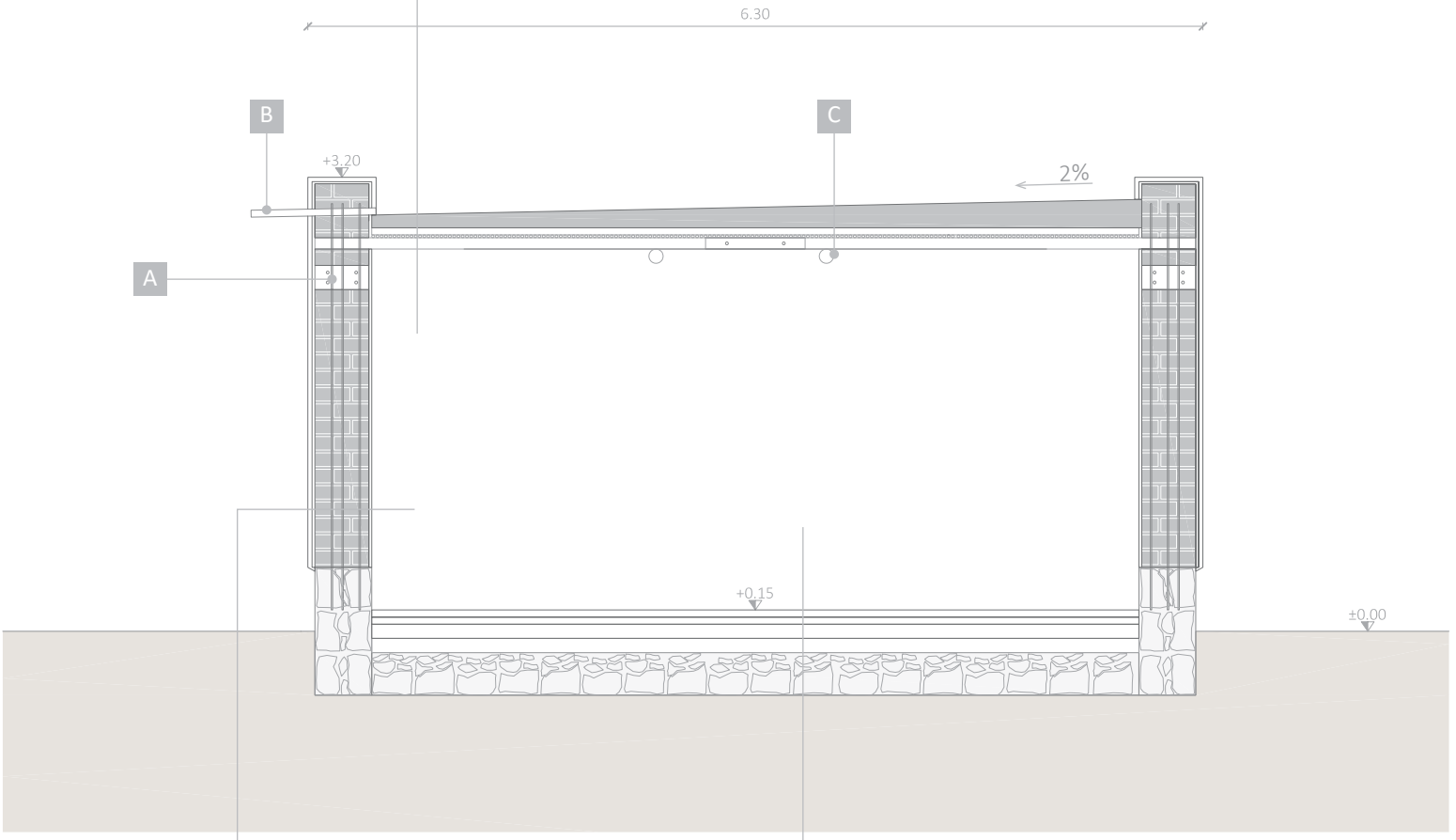
8 Eucalyptus
(round timber)

12 Eucalyptus
(round timber)

A ring beam
(reinforeced concrete)

B drainage
(metaltube)

C supporting structure
(round timber, 12cm)



scale 1:50

[cm]

3 loam plaster
(higher content of aggregate)

2 loam plaster
(higher content of clay)

38 loam bricks
(reinforced steel 12mm,
corners and joints)

3 loam plaster
(two layers)

[cm]

5 loam mortar
(stabilisied by lin-seed-oil or prickly pear cactus)

5 rammed earth
(higher content of aggregate)

10 rammed earth
(water barrier, higher content of clay)

10 coares gravel
(capilar break layer)

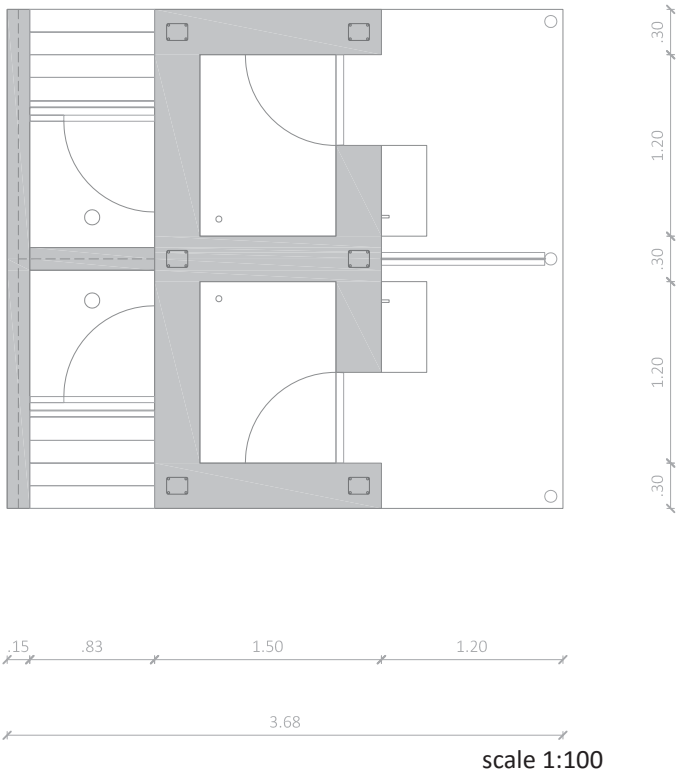
30 stone

4.3 Bathroom and toilet

The sanitary unit accommodates two toilets, two showers and two wash basins, one for girls and one for boys. Above the shower there are two water tanks with a capacity of 500 litre each. This is necessary because the pressure on the water pipes is very low and the water supply often breaks down and it is advisable to have available reserves. The toilet is planned as a dry toilet with a collection bin below, so it over the ground level.

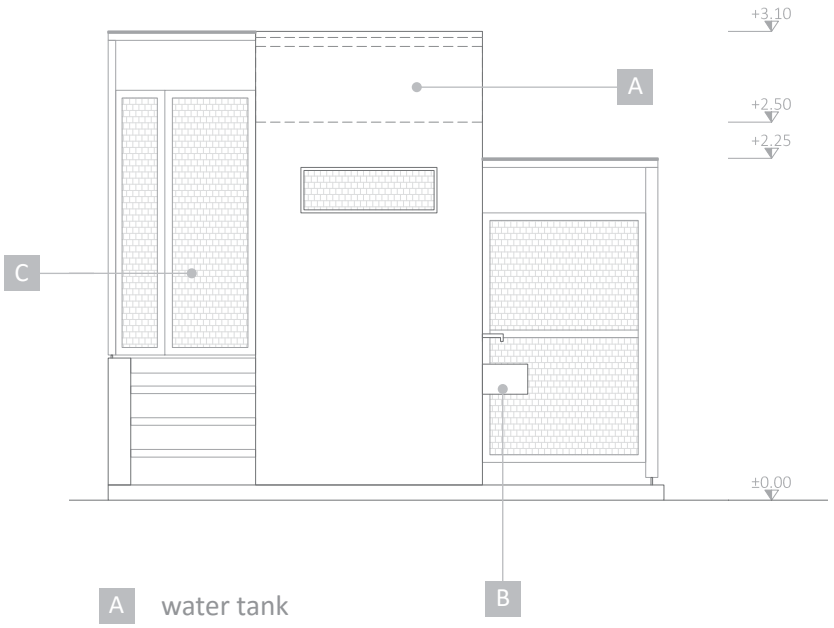
In Afar sanitary facilities are rare. It is common that there is only one shower, toilet and water tap at one site often used by many people. For the first step of the realization there will only be one sanitary block next to the hostels. When the kindergarten is built and it will be possible to finance, a second sanitary unit will be built for the children.

4.26



scale 1:100

4.25



A water tank
(1000 liters)

B washbasin

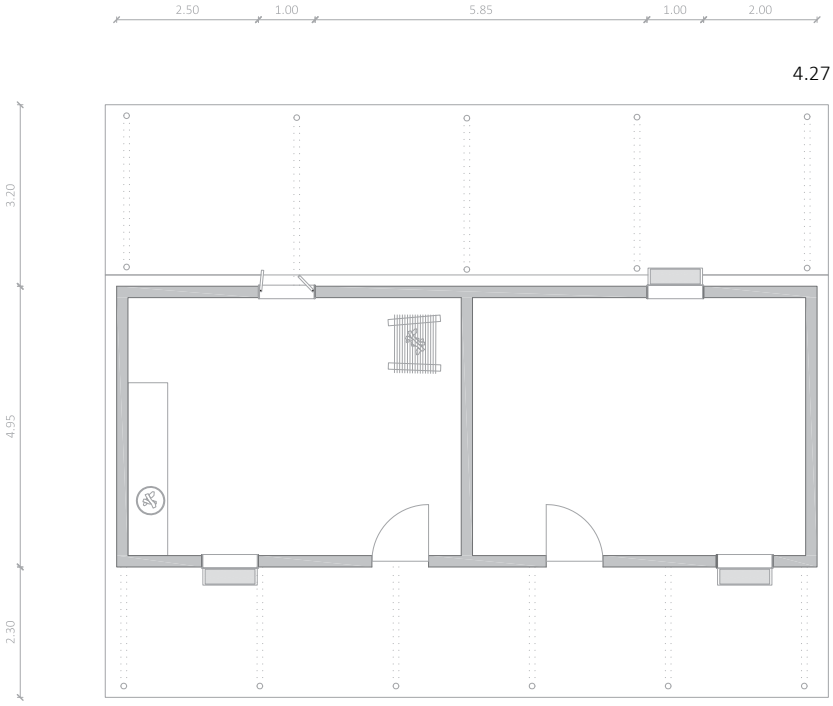
C door
(filled with Afar mat)

scale 1:100

4.4 Kitchen and common space

The existing *Old Bakery* in the centre of the site got it´s name because it was used as a bakery before. The common kitchen will be in this building. The shade construction at the backside of the building is already constructed and will used as a common space and outdoor “dining room”.

The use of the second room will be flexible. It is planned as a community room, but can be used for storage or additional accommodation for students and staff if necessary.



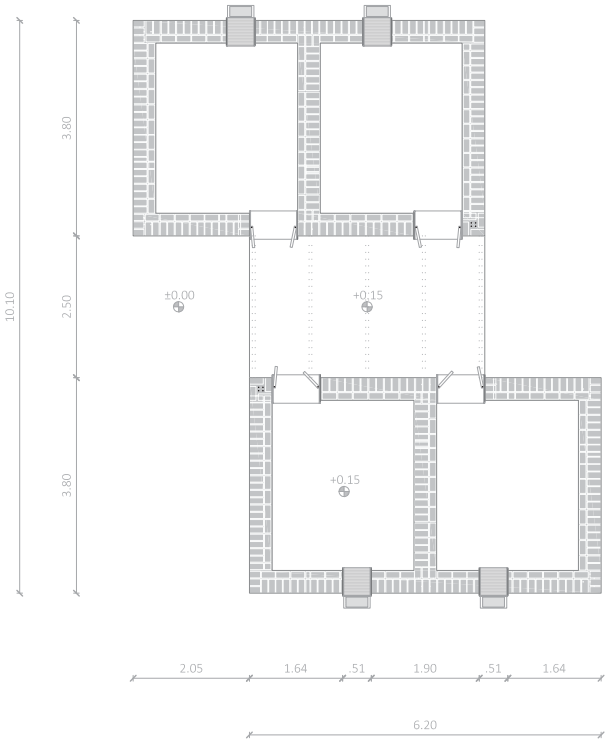
4.27

scale 1:125

4.5 Residence buildings

An accommodation for the employees working at the hostel-kindergarten compound will be built. For the first phase two houses with two rooms each will be done. If more residential houses are needed, more buildings can easily be added, as the space was around was kept free in the planning.

The children will have supervisors looking after them 24 hours a day and also guards will be here all the time. For the sustainability of the project it is advisable to have a caretaker living on the site, who will look after the buildings and plants. The maintenance of the loam houses is important and should not be neglected.

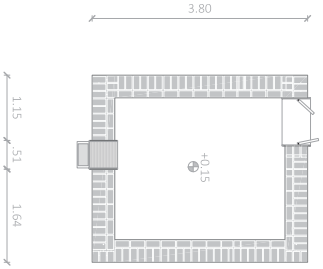


4.28

scale 1:125

4.6 Guard house

Two guards will be working on the site and watch the compound 24 hours a day.



4.29

scale 1:125

Illustration credits - Design

Cover
Schönher Katharina, 2015

All pictures, plans, illustration, sketches, renderings and other figures not mentioned on the list were made by Schönher Katharina in 2015.

Chapter 1

1.1 Katharina Schönher; Reference: Google maps
1.5- 1.8 Katharina Schönher; Reference: Eigner, 2014; TH Consulting: Concept Plan, 2009
1.15- 1.17 Alice Eigner
1.21 Google maps 2015
1.22 Katharina Schönher; TH Consulting: Concept Plan, 2009
1.23- 1.25 Katharina Schönher; TH Consulting: Concept Plan, 2009; Google maps
1.26 Katharina Schönher; Reference: Eigner, 2014; TH Consulting: Concept Plan, 2009
1.27, 1.34 Alice Eigner, Katharina Schönher
1.35 Katharina Schönher, own measurement; Reference: Google maps 2015

Chapter 2
2.1, 2.2 Katharina Schönher, own measurement; Reference: Google maps 2015

Chapter 3
3.4 Katharina Schönher, own measurement; Reference: Google maps 2015
3.5 Alice Eigner

III Implementation

Content - Implementation

Preface - Implementation

From zero to one hundred

When I started the project, I had nothing else than an idealistic idea, and someone who welcomed my support: the organization APDA. So, what do I have to do to conduct a construction project on another continent without any budget? I did not even know what the site will look like, and if it will be found by the time I arrive. I didn't even have a team. At that time I did not have an answer to these questions, but I decided to start and hope for the answers to come with time.

In the end I did learn a lot through this project: planning is good, but the reality often comes other ways! If you don´t have a solution, find it! If one thing does not work out, try another! If you go one step back, go two steps forward. Dealing with problems, stress, and handling a construction site, I learned that actually I had lovely people right by my side who helped me. The more unrealistic something seems in the beginning, the more challenging it will be, but even greater is the success in the end. Always keep your goal in mind! There is always a solution! And, of course, never give up! These are some of the many things I learned in the course of the conduction of the project.

I don´t know yet, if I found all the answers to all the problems and questions that arose during the execution phase of the project, since it is still in process. But I already solved many issues to problems that seemed very challenging at first, and I found answers, solutions, gathered experience and knowledge under challenging circumstances.

1. Research on materials

In order to start the construction, it was necessary to conduct research on availability and prices of building materials. Furthermore, I had to find out where to get the materials from, what kind of tradesmen and contractors were available in the area, and how construction companies work in Logya and Addis Ababa.

1.1 Traditional building materials - Logya

Afar mats

The traditional Afar mats are made from palm leaves. Young leaves of Doum palms (Hypaene) are usually used to weave these mats. In Afar traditionally women produce them by weaving about 8-10 cm wide strips, which are put together to mats of different size and strength. While thinner mats are used as a underlay for works suck as grinding grains, the thicker mats are used for construction to thatch the tents. To increase the resistance against vermin and to make them more waterproof mats covering tents are smoked from the inside. (Parker, 2006; Dharani, 2002; Little, 2008)

The size of the rectangular mats varies depending on producer, raw material and area. Small mats, like the ones which will be used for the construction of the project, have a dimension of about 0.8 x 1.2 m. Large mats are about double the size or larger.

1.1 1.2

1.3 1.4

1.1 Different types of mats
1.2 Edge details
1.3 Afar woman weaving a mat
1.4 Type of mat that will be used for construction

1.5 1.6

1.7 1.8

1.5 Detail: palm sticks and leather stripes
1.6 Slatted frame: palm sticks
1.7 Slatted frame: wood sticks
1.8 Bed construction with leather stripes

Afar slatted frames

In the rural area of “Uwwa” the beds are lifted off the ground about 35 - 45 cm. A wooden scaffold holds the slatted frame. Stones are also used for the supporting structure. The slatted frames are made from sticks taken of trees or palms and are connected to each other with leather stripes.

In Logya slatted frames made from palm-sticks are available on the markets. They measure 1.2 x 2.05 m and are put together with seven bands of leather stripes. Other dimensions are also available, depending on current stock reserves. The best place to buy traditional Afar material is the shopping district called “Dalaganda”, or alternatively it is possible to find sellers through asking around and word of mouth recommendation. At the Dalaganda I could also find another type of slatted frame made made from stripes of cow-skin. This type of bed construction has it´s origins in the highland areas of Ethiopia, where people do not live a nomadic lifestyle, as the construction is difficult to disassemble. This bed-construction type was was brought to the Afar region by settlers.

1.2 Markets, tradesmen and contractors

1.9

1.10

Construction markets

There are three main construction markets in Logya. All of them are situated directly at the main road. They offer a wide range of products, ranging from metal, timber and cement to tools and electrical parts. Some smaller markets offer a more limited range. Prices and stock vary depending on the dealer, supply and demand.

Stones, gravel, sand and clay can also be bought and are delivered by transport contractors. These materials are not available in shops. The sellers have to be found by asking people.

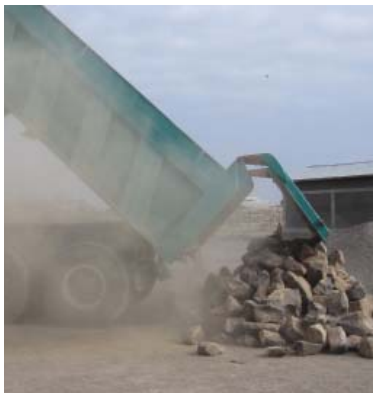
1.11

1.12

Specialized tradesmen

There are specialized dealers for example for timber, who only offer one product range. Timber can be cut in workshops. Specialized tradesman offer their products like welders, who make furniture, doors and windows out of metal pieces.

There is also an workshop where typical local chairs and benches made from wood and leather stripes are produced. It is also possible to order.
These kinds of shops and services are found mainly in the side streets close to the main construction shops.



1.13

1.14

Transport contractors

For transportation of building materials haulage contractors offer their service. The common way to transport materials is by donkey carriage. There are also pony-carriages available, but they are more common for human transportation.

Motorized transportation can be arranged with truck contractors. Different sizes of lorries are available. The prices depend on distance, order situation and negotiation. Transportation with human power is also possible, as well as hiring the local *bajaj* taxis.

1.9 - 1.10 Range of products at construction markets
1.11 Specialized shop for Eucalyptus trunks
1.12 Joiners at work
1.13 - 1.14 Transportation systems

General contractors

There are small construction companies available in Logya, often these are one person businesses. These entrepreneurs or companies are called “contractors” by the local population. They offer their construction services for specific requests or act as general contractors building the whole house from the foundation to the electric installation and painting work. The construction technique used by these contractors is a widespread technique used in the Highlands called “chikka-construction”.

1.15

1.16

1.3 Modern building materials - Logya

Timber

The primarily used wood for construction is Eucalyptus. The trunks have a length of 3- 8 meters. Eucalyptus wood is hard and brittle. The trunks are often bent and tapered. Sawn timber is also available. There are different types of Eucalyptus trees growing in Ethiopia. There is a high incidence of “Eucalyptus globulus” (see chapter botanics), so I will exemplarily mention the specifications for this tree. The gross density of the “Blue gum Eucalyptus” is 720-770 kg/m^3 and the compression strength is 37-51 N/mm^2. There is sawn timber from Ethiopia and imported timber from Australia. The Australian timber is softwood. Pine is a main-export timber in Australia, that is grown in plantations. Often foreign pines like the “Carribean pine” or “Radiata pine” are grown in Australian plantations. The Radiata pine as a gross density of 450-580 kg/m^3 and a compression strength of 36- 65 N/mm^2. The Ethiopian timber is slightly more expensive than the imported boards. There is also squared timber in 2 different sizes, partly with bark. (Wagenführ; 1996; Australian Government: agriculture.gov.au)

1.17

1.18

1.19

Bamboo, reeds and rattan

There is a salesman in Logya, who deals with bamboo. But during the period of four months which I spent in Logya, there was no bamboo available. Bamboo-mats from small stripes are widely used and always available. They are increasingly replacing the traditional Afar mats, as they are cheaper to buy. At the south-west end of the Afar Region there are local reed-products available, because this area has more water resources. Also Rattan and similar products are rarely found in construction, since they cannot be bought directly in Logya.

1.20

1.21

1.15 - 1.16 Contractor buildings under construction
1.17 - 1.19 Squared timber; Eucalyptus trunks; Australian pine
1.20 - 1.21 Bamboo mats


1.22


1.23

Metal

There are different metal pieces available: Reinforcing steel bars, corrugated iron sheets, rolled metal-sheets, rods, hollow profiles, nails and different wires and meshes. The provided metal pieces are usually not stainless and partly rusty. Scrap and recycled metals are part of the common range. Nails and screws are characterised by low hardness. In Logya there are no screws available, only nails.


1.24

1.25

Cement and concrete products

There are four main cement producers in Ethiopia, two of them in state ownership. They are called Debra, Munger, Messebo, Diredawa Cement. There are small differences in prices.

Ready-made cement or concrete products are also available, such as hollow-blocks.


1.26


1.27

Stones

Stones can be bought in different sizes. The broken stones are used to construct walls and foundations. The size of the pieces varies from about 15 - 50 cm. In the small mountain range west of Logya, the natural stones are excavated and are broken by crushers and beater mills. Also smaller stones are produced this way down to the size of gravel. This gravel is very sharp-edged and not suitable for producing concrete.

For this purpose round gravel from the river can be bought.


1.28


1.29

Other materials

Besides the mentioned materials, there is also a wide range of other products available. Industrial products such as tiles, wood-based sheet material, plastic foils, tubes and pipes for electric or sanitary installations are some of the products that are available. As these products are mostly imported, they tend to be more expensive.

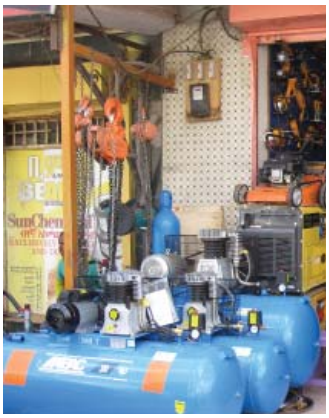
1.22 - 1.23 Hollow profiles partly rusty; metal mesh
1.24 - 1.25 Concrete hollow-blocks; Debra cement
1.26 - 1.27 Broken stones; round gravel from the river
1.28 - 1.29 Industrial, mostly imported products

1.4 Construction markets and building materials - Addis Ababa

Construction markets

In Addis exists a construction market district near the piazza, where a wide range of imported tools and products can be found. The tools are mainly from Asia, but also from Europe, the USA and Africa. Nearly everything can be bought here, but the imported products often cost the same as they do in Europe or are even more expensive. The range of products is extensively wider than in Logya, thus it was necessary to travel to Addis in order to purchase some equipment required for the construction. For example safety helmets or treated metal rods had to be bought in Addis, as it was not possible to get them in Logya.

1.30



1.31

Specialized tradesmen

As everywhere in Ethiopia there are specialized dealers offering only one product range. The wholesalers are usually based in the outskirts of the city, where large storage areas are located. Materials such as timber and metals are sold there, as shown on the pictures Compared to Logya the range of available products is much broader. Even specialized shops that offer product ranges like electronic installation and lamps are common.

1.32

1.33

Materials and products

There are specialized dealers who offer only one product range. Timber can be cut in joiner´s workshops. Other traders offer a variety of products. Specialized tradesmen offer their products like welders, who make furniture, doors and windows out of metal pieces.

There is also a workshop where typical local chairs and benches made of wood and leather stripes are produced. It is also possible to place an order.

These kinds of shops and services can mainly be found in side roads close to the main construction shops.

1.34

1.35

1.30 - 1.31 Products of construction markets in Addis Ababa
1.32 - 1.33 Specialized shop for metal; Eucalyptus trunks with Eucalyptus trees in the background
1.34- 1.35 Metal can be cut, drilled an formed before buying; Electric shop

2. Realization process

2.1 General facts and explanations

Duration of the research stay in Ethiopia
I spent three weeks in Ethiopia in 2011 for a field trip with the Department of "Kunstgeschichte, Bauforschung und Denkmalpflege" of the Vienna University of Technology. This was my first excursion to the Afar Region and the start of the cooperation with the NGO APDA and Valerie Browning. In 2014 I started with the organisation and planning of the project as my master-thesis. In 2015 I spent 105 days in Ethiopia from 20.01.2015 until the 04.05.2015. The process described in this chapter took place during this period.

Project schedule
Roughly summarized the timetable is planned as follows: June 2014 - Dezember 2014: Preparation, Design, Organisation and Communication; January 2015 - May 2015: Start of the construction process in Afar; May 2015 - November 2015: Finalization of the master-thesis and final examination. January 2016 - May 2016: Completion of the started building and start of next buildings; A detailed timetable can be found in the appendix.

The Organisation APDA
The project is planned and realized for a local Non Governmental Organisation called APDA (Afar Pastoral Development Association). APDA will run the hostel and kindergarten. Once the buildings are completed, will maintain the project site and manage further development of the project

Environmental conditions
Environmental conditions in Logya can be summarized with a few words: heat, sun, dust and occasionally rain. During the research stay in Logya the temperature increased from about 34 ºC in January to about 45 ºC in May at Midday (according to the measurement on the thermometer). Certainly the heat was almost unbearable and under these climatic conditions it was difficult to perform hard physical work. The dust was another complicating factor. It is caused by winds in the deserts, but mainly through motorized traffic on unsealed, sandy roads. Rain is rare in the area and occurs only on few occasions in the short rainy season. In the course of my stay there was a total number of two days with rainfall in Logya.

Working hours
Due to these harsh environmental conditions explained above, working times had to be set in the morning and the afternoon. Work started at 7 am and there was a lunch break from about 12 to 4 pm. Then we worked until 7, until it started to get dark. So a working day had about 8 hours, similar to Austria.

Work capacity
The realization of the project was executed with a team (see next chapter). Alice Eigner, who is an architect specializing on clay and straw constructions, was with me most of the time leading the project on-site. Mark Ortler, Jürgen Schrottenbaum and Mathias Veits came as support crew from Europe. In addition to that two workers from APDA supported the construction occasionally, according to their available time. An engineer working for APDA was cooperating with us. The whole construction phase 1-9 volunteers worked for the project. These volunteers formed the "clay construction team". Occasionally additional, temporary volunteers were present. Maryam and her family live on the site to guard it for APDA. Maryam supported us in our work and supplied us with *búna* (coffee). For the foundation one skilled mason and up to two workers were employed.

Decision on the construction technique
The main advantage of the adobe as a construction technique is that it is easy to imitate. In contrast to rammed earth the mould is very simple to build and a minimum of timber is used. Sawn timber is expensive in Afar and the formwork for rammed earth panels needs a lot more than a brick mould. Other techniques like cob-walling would also be possible but the disadvantage is the high amount of straw needed. Straw is not locally available in Logya and has to be delivered from the other regions. Therefore I took the decision to build the first house with loam bricks.

Budget
The construction was financed by private donors and sponsors and supported by APDA.

About the team and form of writing
The written report of the project realization uses mostly "we". The first person plural is chosen here for the narrative since I report the project realization, however I had a supporting team and the support of the local NGO. The realization of the project required working together as a team, thus I decide to write the report accordingly, using "we".

2.2 APDA (Afar Pastoral Development Association)

The NGO APDA was founded was founded in 1993, after a council of elders concerned with the problems of the Afar and regarding future developments and solutions had taken place. Valerie Browning (Maalika) and her husband Ismail were founders of the Organisation. APDA engages actively to improve living conditions, medical care, education and women's rights, environmental protection, water management and animal welfare in the Afar region and has already achieved progress and conducted several successful local projects. One example is the improvements in eduction- which is relevant also with regards to the goals of this project with seeks to build a school- in 1995 the UNHCR and UNESCO have approached APDA to develop the "teachers emergency package". In 1996 an educational programme led by APDA started with 21 trained "mobile Afar teachers". Today there are 231 of these teachers. More information about APDA and their projects can be found on their homepage: www.apdae-thiopia.org

2.3 Project team

2.1- 2.19 Project team

Construction team
The clay construction team consists of the people mentioned above, and an additional nine volunteers, who will complete the education in loam building techniques: Hummed Abdu, Ibrahim Ali, Ibrahim Mohammed, Ahmet Abdu, Buule, Musa Ali, Ibrahim Feysal, Ali Katar and Luubak.

Petra Gruber
Helped us a lot to get the connection with the EiABC, as visiting lecturer, and with many other things in Ethiopia.

Valerie Browning (Maalika)
Valerie and Ismail founded the NGO APDA over 20 years ago and are leading the organisation. Valerie is the initiator of the project-idea. She is leading the organisation on site and coordination the process, and will take the responsibility for the operation of the hostel and kindergarten. Valerie Browing wrote a book entitled "Maalika" (Little, 2008) that tells about her life in Afar.

Ismail Ali Gardo
Ismail was one of the founders of the organisation APDA and is head of it; together with Valerie. The hostel and kindergarten belongs to APDA after construction work is completed. The organisation will take care of maintenance and management of the buildings.

Alice Eigner
Alice studied architecture at the Technical University Vienna and wrote her master-thesis about the Afar Region and Logya. Currently she is specializing on clay and straw construction.

APDA
The engineer Yassin Habib worked with us and temporarily we had two employees from APDA on our side: Ali and Adu.

Visitors from Europe
We had three visitors supporting the project on site from Austria/Italy. Mark Ortler (prospective architect), Jürgen Schrottenbaum (master metal worker, operator) and Mathias Veits (master painter).

2.4 Building sites

Site 1

The site one is outside the town (about 1.5 km from the center of Logya) This remote spot has a beautiful view on the mountains and is regularly visited by nomads passing through with their animals. Generally, there was great interest in our work. Some people just asked, what we were doing, whereas other people mentioned that they share the opinion that it is a good idea to build with these materials, even though they were living in mobile tents. The site has two big disadvantages. The first is the long way to town, which the children will have to walk. The other problem was the total absence and long distance to any kind of infrastructure. The biggest challenge was that there was no access to water sources. This was in fact the main problem. Despite that we had already started with the work on site. Ten days later, we got the information that there was another site available which belonged to APDA that was more suitable for construction. After ten days we got the information, that there was a second site belonging to APDA suitable for construction.

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Site 2

The second site is situated in town, very close to the new high-school which is currently under construction. This is a main advantage. In addition, there was an already existing building, the “old bakery”, which is useful for storing. Furthermore, the site had a connection to the electricity supply on the site. However, no water supply was available on the site. The great interest on our work was confirmed on this side as well. It took only a few weeks, until the word spread around the town, who we are and what we are doing in Logya. Many people came to see our work and many told us, that it is a great idea what we are doing, as the forests are shrinking continuously. Many people assured that if they are going to build a house in future, they would also use loam-bricks. We heart many motivating things about our work. It was great to get the support of the local population. But also on this site we got nomads from Afar visiting from time to time (see picture) and the message about our work was spread further.

2.20- 2.22 Work and visitors on site 1
2.23 - 2.25 “Old Bakery”; Material extraction; Visit from nomads on Site 2

2.5 Clay tests

The next step necessary was to find out whether the material on the site was suitable for construction purposes. We made a series of field tests to find out more about the properties of the loam on the site. A laboratory test was made with several test-bricks at the EiABC (Ethiopian Institute of Architecture, Building Construction and City Development), where the compression strength of the adobes was tested.

Clay tests - field

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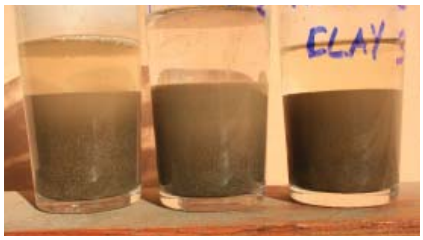

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2.26 Wash test
2.27 Cutting test
2.28 Ball dropping test
2.29 Sedimentation test

Analysis of the composition of the loam deposit on the sites

To determine the suitability of the loam for construction, we made a combination of field tests.

Smell test

Pure loam is odourless. A musty smell indicates humus or organic matter. (Minke, 2013) The tested loam was odourless.

Nibble test

Sandy soil causes a rough sensation on the skin. Clayey soil is sticky and smooth. Water is needed to clean the hands. (Minke, 2013) The soil on the site was mainly smooth and sticky.

Wash test

Humid soil is rubbed with the hands. If grains can be felt it is sandy soil. If it is sticky and hands can be rubbed clean when dry sticky soil can be identified. If it is sticky and water is needed to clean the hands it is clayey soil. (Minke, 2013) On the site we found mainly clayey soil.

Cutting test

A humid earth ball is cut. A shiny surface indicates a high clay content, a dull surface means high silt content. (Minke, 2013) The surface of the testing balls was shiny.

Sedimentation test

Earth is mixed well with water in a glass. The largest particles settle first, the finest on top. The hight of each layer does not necessarily correspond to the proportion of clay, silt, sand and gravel. (Minke, 2013) An overview of the components can be gained. The samples showed slightly varying but comparable results. A high clay content up to sand with small grain size can be expected.

Ball dropping test

With as dry as possible material a ball of 4 cm diameter is formed and dropped from 1.5 m height on a flat surface. Slight flattening of the ball and only few cracks indicate a high binding force, big cracks and crumbling into pieces indicates a poor binding force. (Minke, 2013) The tested earth showed a high binding force.

Clay tests - field

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Acid test

To define the content of lime hydrochloric acid can be used. A drop of 20 % HCl is added to the earth. If no efflorescence is notable, the content of lime is under 1 %, a strong and long lasting indicates the lime content is above 5 %. A high lime content causes a low binding force. Loams that contain lime are normally white. Dark, lime-free loam with humus contents can cause similar reactions. (Minke, 2013) As we had no access to hydrochloric acid in Afar, we used vinegar as a substitute. Vinegar contains acetic acid that also reacts with the lime. A small reaction could be observed with some of the loam samples. The result of the test can can not be interpreted with certainty to indicate the exact lime content since we had no hydrochloric acid. However, the binding forces are strong, and lime content does not impact on the suitability of the material for construction.

Linear shrinkage test

The loam is sieved to eliminate all particles larger than 2 mm. The loam is mixed with water until the right consistency is reached. (This is examined by a ball dropping test. A ball with 200g loam is dropped from 2 m. The diameter of the flattened surface has to be 50 mm.) Then the loam is put into three rectangular frames with the dimensions of 220 on 40 mm. The average shrinkage of the three samples in relation to the length of 200 mm shows the linear shrinkage ratio in percentages. (Minke, 2013) The tested samples had a relatively high shrinkage, which is caused by the high clay content.

Dry strength test

Pats of soil are prepared and dried until they are completely dry. The pats are broken and pulverized between the fingers. If the pat is very difficult to break and the soil cannot be crushed between the fingers, a high clay content is ensured. (Houben, 1989) We made the tests with balls and dropped them on the floor. Some of them only broke after two or more times dropping them.

2.30 Acid test
2.31 Dry strength test
2.32 Linear shrinkage test

Clay test laboratory - compression strength test bricks

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General facts about earth elements

The compressive strength for dry earth-elements, like the clay-bricks, differ in general from 5 to 50 kg/cm^2. This value is influenced by the type of clay, grain size distribution, sand and other aggregates and the method of preparation. For earth building elements the permissible compressive strength according to DIN 18954 is valued with 3-5 kg/cm^2. The factor for safety in earth components is about 7. (Minke, 2013)

The laboratory test

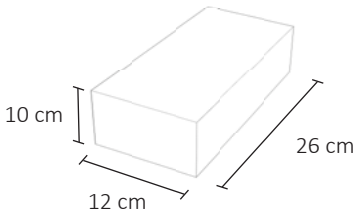
We took 25 adobes by truck to Addis and tested the compressive strength of the earth blocks at the material testing laboratory of the Ethiopian Institute of Architecture, Building Construction and City Development
(EiABC). We tested different mixtures of clay and sand. Despite the rough ride to Addis due to partly unsealed roads, all the tested bricks are according to the German norm mentioned above. The best mixture had a compressive strength of 22 kg/cm^2.
The impact of the dynamic forces during the transportation on the testing result are difficult to estimate.

Shrinkage of the bricks

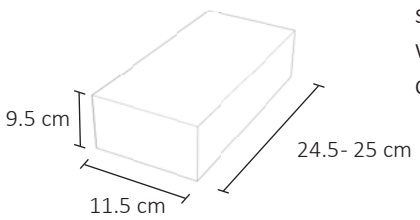
During the drying process the bricks shrink. For the sketches below 60 bricks were measured and the average size after the drying process was established.

Shrinkage of the bricks

Brick - formed

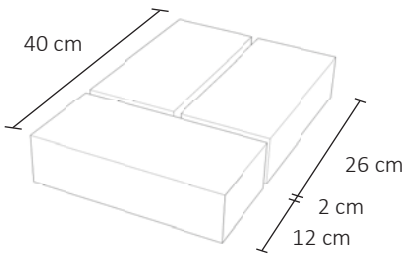


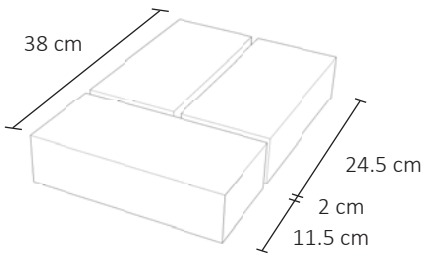
Brick - dried



Bricks facts

size (dry): 24.5 x 11.5 x 9.5 cm
weight: 1.91 kg/dm^3
compressive strength: 22





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2.33 Fracture pattern
2.34 Testing machine
2.35 Shrinkage sketch of the bricks

2.6 Shade roof

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The development of the shade-giving roof went through several different phases until it reached its final state. It began as temporary shade construction made from recycled wood pieces on site 1, it finally ended up as a permanent structure on site 2. The roof turned out to be a important place for communication and discussion.

The beginning of the shade roof on site 1
Site 1 did not have any shade at all, thus we decided to build a simple temporary shade-giving construction. With the help of Ali and Adu , using some old wood pieces found at the APDA storage we started to build up a simple structure based on local construction techniques. Then we moved to site 2, where we built the same structure again.

The extension processes on site 2
On site 2 we soon needed to extend the roof, because the team was growing. We needed space to rest and recover from the sun, have breaks and meals, have conversations, hold lectures and dry the bricks. Bricks needed to be dried in the shade in order to reduce the risk of drying cracks. So the initially 3x3 m roof grew to a 12x3 m roof in the course of time. We furnished the construction with a loam floor. This provided a flat surface for the production of bricks. But furthermore, the floor was used to make tests and study the suitable composition of the floors planned in the loam houses.

Weather protection
At the beginning of the short rainy season in mid-March we had our first experience of rain in Afar. To provide shelter from further rainfalls a second roof with corrugated iron was built. The existing construction was left as a protection from the heat of the iron sheets and for interior design purposes. Also the loam floor was covered with a thin coating of sloped concrete, to avoid that the bricks in production connect with the clay floor in case of humidity.

Permanent function
In the process of improvement of the originally temporary construction I made the decision to keep the structure as a community area and dining space for the children.

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2.36 Constructing the structure on site 1
2.37 Same structure on site 2, loam floor under construction
2.38 Extended shadow roof with finished loam floor
2.39 Weather protection roof under construction
2.40 Loam blocks drying under the improved structure
2.41 Lecture held under the shadow roof

2.7 Lectures - theoretical

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Method of operation

We made the decision not to simply arrange a realization of the project through contractor, because wanted to achieve the spreading of the knowledge of the building technique with clay amongst the local people. The construction companies are run by non-Afar Ethiopians, often Amharas and they prefer to employ people from the same ethnic group. This leads to an exclusion of Afar-people from the construction processes and causes dependence of the Afar on the contractors. And also the chances of receiving vocational training in the construction sector is very limited.

One way to react to this is to focus on education of volunteers. Since we did not discriminate people according to their cultural and educational background, we offered the possibility of getting vocational training for people, who were excluded from this before. In cooperation with the organisation APDA a concern was to find was to find people with Afar background, but this was not a necessary criteria, as everyone was welcome who wanted to learn.

Finding volunteers

The main work in this matter had to be done by APDA, as the organisation got the necessary social structures and communication possibilities to find such volunteers. APDA spread the information through word of mouth recommendation of their employees, by putting up posters and presenting the project at regional village leader meetings. Due to language barriers and missing connections to social communication networks, our influence on that process was limited at the beginning.

Education of the volunteers

Our part of the work started at the site. We were looking for two things: One team, that would be part of the entire construction process, as well as temporary volunteers who also spread the knowledge acquired.

Clay-construction team

We were trying to find a strong team, that could go through the whole construction process with us and work together effectively. After finishing the first house, the team should be able to build houses on their own and teach other volunteers the acquired building techniques.

Temporary volunteers

Strengthening solidarity and improving social and living conditions of local people was an important goal of the project. As Valerie Browning said: “Afar should work for Afar, they should help each other....” So temporary volunteers are an important part of the project for growing solidarity and spreading of knowledge.

2.42 Lecture on construction principles of loam-houses
2.43 Lecture on clay tests
2.44 Practicing plan drawing and geometry
2.45 Model 1:100 and 1:1 bricks for explaining the system
2.46 APDA poster calling for volunteer learning loam construction

2.8 Lectures - practical

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Education of the clay-construction team

The team soon developed from the volunteers by showing the highest level of interest and effort. We developed theoretical and practical lectures in close interaction. An overview of the topics is listed below.

Lectures - content

1. General construction principles
Components and construction principles of an Afar-tent, a Chikka-house and a clay-brick house

2. Supporting structure and statics
Construction principles, forces and torques

3. Architectural visualisation
Sketches, scale, plans (floor plan, section, views) , graphic visualisation, geometry, axonometry, perspective

3. Earth construction

Loam tests
Properties and testing of loam

Earth elements
Types, production, techniques

Construction principles of loam-houses
Foundation, wall construction, masonry work, loam floors and plaster, roof construction, humidity protection, earthquake resistance, maintenance and repair of loam constructions

Earthquake resistance of earth constructions
Influence of geometry, reinforced joints, reinforced walls, reinforced corners, lintel construction, ring beam, component connections, decoupled roof construction

4. Timber structures
Types of timer structures, joints

5. Concrete, reinforced concrete, stones and steel
Stone masonry work, concrete components, preparation and follow-up treatment of concrete, reinforced concrete, steel construction

6. Ecological and social aspects of construction materials and building technologies

2.47 Practical lecture on wall plastering
2.48 Loam floor construction
2.49 Wood construction principles and joints, use of machine tools
2.50 Practise on clay testing

2.9 Basement excavations and loam extraction

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Measurement
The hole site was measured and a plan was drawn. The location of the first building was surveyed and marked with stones. A scaffolding with recycled iron pieces and kite surfing ropes.

Excavation and extraction
The basement excavations were done by hand. Simple tools like pickaxes and shovels were used. A reason for digging excavations was to build a stable foundation for the construction. The second goal was to extract the loam used for construction directly from the site, to give interested people the understanding of the possibility to use the material directly in one spot. Usually the loam for construction is transported from the river bed to the sites in town. This causes additional costs for the builders.

Dimension
The excavation had a dimension of 11.5 x 5.1 m and a depth of about 0.45- 0.50 m depending on the elevation of the uneven surrounding soil. The size of the hole was determined by the dimension of the foundation plus additional 10 cm space for the masonry work.

Work experience
The clay-rich, dry soil is very hard. A lot of power had to be invested into digging the hole. It took elven days to finish the excavation with a varying number of 3-8 people working. In addition to the heat, the dust caused by the excavation work was an additional difficulty.

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2.51- 2.53 Digging work during the basement excavation
2.54- 2.55 The finished hole with a average depth of 0.45 cm

2.10 Foundation

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Raw material

The raw material for the foundation comes from the volcanic mountain range that is located about four kilometres east of Logya. The basaltic stones are transported by truck to the town. In this area crushers and beat mills are located, where broken stones are produced. These shredded stones are not suitable as an aggregate for concrete, because the edges are very sharp. They are more suitable for road- and railway construction or as filling material and drainage layers. The sand and gravel needed for the concrete is taken from the river bed.

Construction technique

The foundation is a natural stone masonry. The stones are stabilized by concrete. This common construction technique is used for foundation and walls in Logya, but also in other areas of Ethiopia and Afar. Two covering Layer with hewn, big stones are built. The stones are hewn by the mason directly on the site, until they have the right shape and size. The space in between is filled with smaller stones and the gaps are filled with concrete. About 30 cm high sections are produced this way and the wall can be vertically extended. The foundation was built by a skilled worker.

Corner reinforcement

For improving the earthquake resistance of the loam brick wall, the corners are reinforced with steel bars. These steel bars are anchored in the foundation and will reach up to the ring beam. A reinforcement with bamboo sticks would have been preferable, but as there was no bamboo or similar material available in Logya, and thus steel was used.

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2.56 Beating mill in the mountain range with deboitas of the workers
2.57 First stones placed in the excavation hole
2.58 Placing the reinforcement
2.59 Foundation under construction: fresh concrete in the back, placed stones in the middle, dried concrete in the front
2.60 Foundation for the walls is finished, foundation for the forecourt under construction

2.11 Loam preparation

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Natural earth consistency on the site

The earth on the site consists of a thin layer (5-10 cm) of sand, silt, clay and small stones. Below this layer there is loam with a high content of clay (see chapter clay tests). As the earth was very dry and compacted it was excavated in stone-like fragments.

Thinning

The loam had to be mixed with sand, as the clay content was to high for the brick production. Coarse aggregates like sand increase the compressive strength and reduce shrinkage. A high shrinkage value can cause cracks during the drying process. Also the stability of the form is not given, if the clay content is too high, because the size is changing too much. (Minke, 2013) I recommend to mix the loam and the sand in dry condition to ensure a good blending and because it needs less effort than in wet condition.

Soaking

The clay-sand mixture can now be mixed with water. We applied the same technique, that is used to mix concrete by hand. It had proven as appropriate method for clay mixing as well. In a first step a pile is formed with the loam and a hole is made in the middle, so it looks like a volcano. Water is filled in the crater and the material is shovelled in the middle. This material should be left for soaking for 2-4 days. (Minke, 2013) It had to be covered with plastic foil, otherwise the strong sun would have dried the material rapidly.

Mixing

In order to develop good binding forces the adhesive forces of the clay minerals must be activated. This is achieved with an adequate amount of water and movement. (Minke, 2013) Before using the loam-mixture for construction it has to be well mixed. For this purpose human power, animals or machines can be used. Since we had no machines available, and the negotiations for renting a camel were not successful so far, we mixed it ourselves.

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2.61 Natural loam from the excavation on the site
2.62 Preparing the loam for soaking
2.63 Mixing the loam
2.64 Loam preparation: preparing for soaking (front), mixing soaked loam (left), washing of the brick moulds (right)

2.12 Earth components production

Brick production

Brick moulds
A simple mould for three bricks with handles was designed. Two of them were built in Austria, five more were produced in Afar.

Production of earth bricks
The adobes are made by throwing a pasty loam mixture into the wooden moulds. A strong force is important for the throwing, since this force influences the compaction and dry strength of the blocks. (Minke, 2013) The surface is smoothed by a piece of wood or, in our case, with a plaster tool made out of wood and metal. Then the mould is removed slowly. The mould has to be washed regularly, otherwise the blocks stick to it. To make them slide more smoothly, it turned out that some drops of vegetable oil in the washing water can help.

Drying process
The adobes must be protected from rain and humidity. The drying process for loam bricks should occur slowly, so they should not be exposed to the sun. Direct sun radiation can cause shrinkage cracks. (Minke 2013). For this purpose we built the shade dispensing roof described in the chapter before. After two to three days the bricks are hard enough to be moved and can be stacked.

Mortar production

The raw material for the mortar is prepared the same way as the material for the bricks. Only the composition is different, because the mortar has a higher amount of sand inside and therefore it is necessary in order to prevent drying cracks and rise the compression strength.

Brick and mortar composition

The loam found on a site is can vary greatly, thus there is no general formula for the mixture. We had to find out the best mixture through tests and experimentation. For the adobes the best formula was a ratio of 1 clay : 0.6 sand. While the mortar had a composition of 0.25 clay : 1 sand. Since these numbers are difficult to measure in practice, we measured it in wheelbarrows. (see below)

Bricks	***Kalla Buloket (Afar)***
9 Clay	***9 Kallay***
5.5 Sand	***5.5 Qiideyta***

Mortar	***Fan Fana (Afar)***
1 Clay	***1 Kallay***
4 Sand	***4 Qiideyta***

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2.65 Throwing the loam in the mould
2.66 Smoothing the surface
2.67- 2.68 Removing the mould
2.69 Fresh bricks (front), dry bricks (back)

2.13 Masonry work

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Preparation of the masonry

The order of the bricks was planned at the beginning, because, as the reinforcement had to fit in the joints between the bricks. The mortar was produced in the way explained in the previous chapter.

Masonry work

The bricks in the corner were placed first, since this is a common technique used for masonry. Ropes were tightened to measure hight and direction of the blocks. Then the bricks were fixed and the joints mortared. It turned out to be helpful to place the bricks over the hole length as determined in the plans and check the position before fixing. Through this method mistakes in the system caused by irregular joints or missing reverse order of the following layer can be avoided and simply corrected. The covering of the joints is an important factor for the stability of the wall.

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2.70 Placing corner blocks with lines
2.71 Mortaring the joints
2.72 Ready mortared joints
2.73 First layer of the bricks mortared on the foundation
2.74 Construction team at work

2.14 Wooden construction

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Roof construction
For the construction of the roof Eucalyptus trunks will be used. We made some experiments concerning the load-bearing behaviour and oscillation of the wood. Testing joints were build to collect further information about suitable solutions.

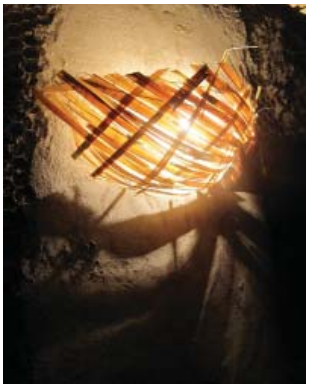
Door and window
Testing objects for possible construction of the door and window frames and doors and window shutters were made.

Concrete
Different concrete objects had been, made like floor or a shuttering for a reinforced concrete lintel.

2.75 - 2.76 Studies for the wood construction
2.77 - 2.78 Studies for doors and windows
2.80 Shuttering for reinforced concrete
2.81 Plaster testing
2.82 Lampshade in front of newly plastered wall and self made electrical installation

2.15 Plaster and interior design

2.81



2.82

Plaster
Experiments for a suitable plaster composition have been done. Also the plastering techniques were tested. We partly plastered the wall of the “old bakery” house for this purpose, which needed to be renewed anyway. Different compositions of loam-plaster were also put directly on testing bricks to assess the behaviour.

Electricity
The electric installation in the “old bakery” house was defective. So the installation was renewed and that made it possible for us to have light and charge machines.

Interior design
Some studies for possible interior design objects were done. For example we created a lampshade made from bamboo mats and wire.

3. Review on the project

3.1 Difficulties

Every beginning is hard
When we arrived, we had to face some difficulties. At first we found out that there was a light scepticism regarding the stability and durability of loam constructions. So we had to convince with our work. This challenged us in the beginning, because there is no universal formula for loam and the first tests with the material and thus it is necessary to conduct tests with the material to begin with. The tests produced satisfying material as well as results that were not good enough in the beginning. And this includes insufficient, as well as sufficient results during the experiments with the material.

Change of the site and communication with office
Since the site was changed after ten days, the whole process of clay testing, taking samples and making test-bricks had to be done twice. This and other small communication problems with the office sometimes slowed down the progress. Example were the cancellation of water carrying donkeys or the absence of the mason because of missing remunerations.

Heat, sun, dust and the lack of shadow
In Afar the dry seasons characterised by burning sun every day. Hardly ever the sky is covered with clouds. Temperatures reaching 40 ºC or more during lunchtime are normal. The heat made it hard to work and also the rate of progress and efficiency of efforts is reduced significantly compared to easier conditions. Another complicating and health influencing factor was the dust which is partly caused by wind blowing over the sandy deserts, but mainly caused by increasing traffic on unsealed streets.

Traffic
During the time we were in Logya the highway which is passing directly through the centre of the city was under construction. Daily traffic jams up to total barrier of the only paved road (not at that time) through town made it difficult to get to the site and back. The road construction caused additional fine dust over the city with hundreds of trucks driving on the unsealed highway from the ports in Djibouti to the cities in the Highlands and back.

Water, electricity, toilet and other luxury
Water is a rare in Afar. This fact became a significant challenge for our project. As it turned out when we started on site 1 the connection to the supply would have been too far away. We had no water or electricity. On site 2 it was the same in the beginning. For the clay tests we transported the water in containers to the site. When we started with the final construction process we had to find another solution. The construction of a water pipe was difficult, because the main line is far away and it is expensive to build such a long pipe. Negotiation with the neighbour and the nearby mosque failed to connect a water pipe with their existing pipes. We had to order water by donkey carriage to be able to continue working on the site. Without water the mason could not mix concrete for the foundation, no loam bricks could be produced. The donkeys were cost intensive and no long-term solution. There was no toilet on the site.

The ablation of humus
One thing we did not expect, was to find humus on the site, since the covering layer layers consisted solely of sand, silt, stones and loam. European construction theory tells you to remove the first 40-60 cm of earth to eliminate humus-contents. We found humus contents at this level on one side of the excavation. This material had been removed from the construction material.

Mason work and loam pile are no friends
Unexpected difficulties are on the daily orders of such projects. Hewing stones splinters flew meters away. These sharp stones had to be kept away from the loam material, because the material had been mixed barefoot.

Goats, pilferer and other pranks
The material and tools had to be guarded or locked to protect them from disappearance or damage. Especially fresh bricks had to be protected from goats. One night water leaked from the tank and damaged 200 bricks. The cause of the leakage could not be found.

Personal challenges
It was not that we came to Afar and everything just worked. We had to find out how things work in Afar, how people communicate and negotiate. Where to get material from, how to find a team. We had to learn to deal with the material, since the products, qualities and availability of required things varies a lot from Europe. Almost daily we had to deal with things that were not working out. We had to find develop alternative plans day by day. This is how life is working in Afar. You will not always get what you need, but you will find another way to reach your objective. There were these moments, when you feel like nothing works out. When you doubt that you can achieve this. We learned to deal with it. And after some time we knew that a new challenge is just a little step forward on our way to reach the objective.

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3.1 Lacking shade on site 1
3.2, 3.4 First trials with blocks and plaster mixtures
3.3 Dried out soaking hole after one night without cover
3.5 Heat during lunchtime in May. Measured in the shade, on the sun exposed wall in front of our room (no absolute value, because the wall was heated, but for sure hot)
3.6 Buying old cooking oil containers for water transport
3.7 Water delivery by donkey
3.8 On our way home at the mainroad/highway under construtions. Dust and daily truck-traffic jams on the agenda.
3.9 Flooded bricks after the “water pipe accident”
3.10 Stone spliters on the loam hill
3.11 Goat was running over the fresh bricks
3.12. Finding plan b

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3.2 Success

Interest of the local people
The enormous interest of the local population delighted us a lot. Not only that every step we made was observed by interested people from the surrounding area. After a few weeks we had the impression, that our project was known in the whole town and surroundings. Strangers knew who we were and what we did. They told us about the problems of the deforestation, that it is causing environmental damages and changes the climate. People assured us that it was a great idea to use loam instead of wood to construct the wall. They told us that they had the intention to build their future houses from loam bricks. There was little left for us to say. It was a great experience to see the already existing awareness to the problems and the way most of the people appreciated the new ideas and methods of construction.

Good cooperation and exchange with the EiABC in Addis Abeba
All this would not have been possible without the support of the EiABC. It was great exchange knowledge and share experience with students, lecturers and professionals and have to the possibility to use the infrastructure of the institution in Addis.

Help yourself
There was an official connection to electricity at the "old bakery" on the site, but the installation within the house was defect. We waited for four weeks in vain for the ordered electrician to come. Finally we decided to help ourselves and renewed the installation. Two days later we had electricity!

Unexpected aid is also possible
On the first of April something surprising was going on when we entered the site. A water pipe was built. After the firstly failed negotiation, it finally was successful. The mosque allowed us to build a water pipe from their pipe. The hope was back!

Quality of the bricks
We were very satisfied with the result of our adobes corresponding to the German standards. We were also very happy with the general strength, abrasion resistance and the form stability of the bricks, that made a very precise masonry work possible. All this only became possible trough the exact and professional work of our "loam construction team". It was a big pleasure for all of us to see the successful outcome.

Strong team, good work
We were very lucky to find such a professional and motivated, strong team. The work of our volunteers was a decisive factor for the project. The lasting power and effort of the "loam construction team" was impressive. We often worked until one or two o´clock and eight in the evening.

Happiness
It is difficult to explain, but although life seemed to be hard in Afar, we had a lot to laugh and be happy about. Many successful moments were shared. Happiness on milestones reached like the production of the first bricks or the first block placed on the foundation (see pictures). It was a great time, we had a lot of fun, a lot of success was achieved.

International friendships
The exchange between cultures, experiences and ways of life was an important part of the project. Mutual understanding is important in a globalized world to develop it towards a more peaceful, equal and just world. For most Africans it is impossible to travel to Europe due to entry requirements and high fees and prices. So it has to be done the other way around and the friendships will be built in Africa. I think we built a lot of them. To me, it felt like I was leaving my second family when I left the compound and my friends in Afar.

Construction start
When we came to Afar everything was very uncertain (see preface realizaiton). Will there be a site, will we have a team, will we built anything at all? All in all we had only two month construction time, but we were digging the hole, producing the bricks, building the shade roof, the foundation and started with the wall. It was a great success, that we could start construction at all and that the project developed so fast!

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3.13 Interest of resident people was huge
3.14 Cooperation with EiABC and Petra Gruber
3.15 Alice and me with the finished foundation
3.16 Unexpected joy: water pipe construction
3.17 Big delight: the first bricks are produced
3.18 The young construction team: children from our compound accompanied us to the site
3.19 Búna break at work
3.20 On the way to the site: new friendships
3.21 Happiness: first brick is lain on the foundation

3.3 Calender

20.01.2015 **Arrival in Ethiopia**

20.01- 26.01. **7 days in Addis:** Research, communication and organisation with the EiABC.
28.01- 15.02. **19 days in Afar:** Clay testing, test brick production, survey, plan drawing, finding team
17.02- 20.02. **4 days in Addis:** Laboratory tests, waiting for renewed visa
21.02.- 27.02. **7 days Research trip:** to the south
28.02.- 03.03. **4 days in Addis:** waiting for a ride to Afar
04.03.- 14.04. **41 days in Afar:** Starting construction process of hostel 1
16.04.- 25.04. **10 days in Addis:** waiting for the renewed visa
27.04- 02.05. **6 days in Afar:** building the loam wall

04.05.2015 **Departure Ethiopia**

Calender statistics

Construction process
All in all we had 89 days on the final site2 to, from which I was 46 days present on the site. It took 11 days to dig the hole, 21 days to build the foundation, 25 days to produce about 2000 bricks. On the best days we were able to make about 200 blocks on one day. The construction of the shade roof took 11 days. Several days were spent for lectures and practices. There were also days spent for wood construction experiments and electrical supply. Sometimes we could not continue with the work, when we had no water for example. And some days were needed for solving problems.

Personal experience
If a journey to do a project like this is planned, there should be some unexpected occurrences calculated. For example, the visa regulations changed a few days before our arrival, and instead of having one visa for the whole time, I had to apply for three visas. This took me 12 days just waiting for a visa and made more travels to Addis necessary. Cars can break down in Ethiopia and quickly a 500 km distance turns into a 2 day trips with overnight stay. So I spent 15 days with waiting for a car and being on the road for five times traveling from Addis to Afar.

The construction process took:

7 days on site 1
89 days on site 2

From this time:

12 days clay testing
11 days building shadow roof
11 days excavation of the hole (11.5 x 5.1 x 0.5 m)
5 days preparing and hewing stones
16 days building the foundation
3 days installing the electrical supply
25 days producing 2000 bricks and doing lectures
7 days mansonry work for the wall

I spent 105 days in Ethiopia:

26 days in Addis
66 days in Afar
6 days (and 2 nights) on the road from Addis- Afar
7 days on research trip
105 days in Ethiopia

From this time I spent:

12 days: waiting for visa
9 days: waiting for a car
6 days and 2 nights on the road
7 days being sick

3.4 Cost analysis

Calculation of one Hostel-building

Estimated costs
The exact costs are not certain, as the project is still in progress. By the paid expenditure and created material lists costs can be estimated. Currently I estimate the costs for one hostel building as illustrated in chapter "design" to be about 7,598.02 €.

Variables in calculation and costs
In Ethiopia there are a lot of variables that can influence the prices. First of all the inflation and price fluctuations to foreign currencies are strong and difficult to prognosticate. Second the prices for the material vary depending on availability, tradesman, negotiations, season and bulk purchase of large enterprises. Also the general availability of material is influenced by this.

Comparison to local prices
A "chikka house" built by a local contractor with a slightly bigger base, but having only one floor costs 250.000 ETB (Ethiopian Birr). This corresponds to 11,984 €.

Conclusion of the cost analysis
If it will be possible to build the house with the estimated money, it would be a new chance for sustainable and affordable construction in Afar. It could improve the quality of life for a large part of the population and help to reduce poverty and homelessness.

All the prices are calculated with 1 ETB = 20.86 €. (This was one actual exchange rate from spring 2015.)

Item	Estimated costs €
Tools / Equipment	821.40
Material	3,342.81
Transport / Service	246.60
Salaries / Food / Tickets	3,103.55
Administrativ	83.65
∑	7,598.02

Tab. 1

Cost report

As mentioned before, the house is still under construction and final values can not be calculated yet. This cost report gives an rough overview. The foundation was finished, the wall construction partly finished and about half of the timber for the roof and window construction were bought at this time. All the other materials and costs are not yet included. The investments done already exist of following budget items:

51 % Materials (timber, cement, stones, sand, gravel,nails, screws, wire,...)
24 % Salaries and services for volunteers (transport, food, drinks,...)
18 % Tools (machine tools, hand tools, equipment,...)
5 % Service (transports, cutting, delivery,...)
2 % Administrative (laboratory test, stationery,...)

The material costs exist of:

48 % An-organic materials (stone, sand, cement,...)
34 % Organic materials (timber, bamboo, palm,...)
17 % Metal (corrugated iron, reinforcing bars, nails, screws, wire, meshes,...)
1 % Other material

Appendix

Price lists: tools, services and food - Logya

category	description	dimension	unit	price €
tools				
hand	machete		1 pc.	7,72
	masonry trowel		1 pc.	1,92
	shovel 1		1 pc.	4,89
	shovel 2		1 pc.	4,41
	hammer		1 pc.	4,79
	wheel (wheelbarrow)		1 pc.	30,68
	brush		1 pc.	2,92
machine	drill		1 pc.	0,24
clay	sieve metal	Ø 25 cm	1 pc.	1,20
	brick mold		1 pc.	14,38
	metal tub		1 pc.	4,79
saftey	safety helmet		1 pc.	3,31
others	broom plant fibre		1 pc.	0,24
	broom with stick		1 pc.	2,16
	water tap		1 pc.	6,06
service				
animal	donkey light load		1 pc.	0,96
	donkey heavy load		1 pc.	2,40
machine	transport taxi		1 ride	9,59
	transport public		1 ride	0,96
	transport bajaj		1 ride	0,48
food				
	coffee, sugar		1 pack	5,75
	water		2 lt.	0,48
	fruits		2 kg	2,40
	cookies, bread		1 pack	1,92
	puna inkl. service		per day	0,96

Tab. 2

Material price lists - Logya

category	description	dimension	unit	price €
metal				
wire	wire		1 kg	2,40
mesh	wire mesh rectangular	2 mm	1 m	2,00
		6 mm	1 m	4,50
	wire mesh hexagonal	20 mm	30 m	20,00
screw	wood screw	50 mm	1 pack	6,70
	nails	80 mm	1 kg	1,50
rod	threaded rod	Ø 1 cm	1 m	4,80
	nuts	Ø 1 cm	1 pc.	0,10
	metal fitting		1 pc.	1,00
sheet	corrugated iron		1x2 m	9,40
steel bar	reinforcing steel bar	Ø 1 cm	6m	8,00
electrics				
	electric cable		1m	0,44
	bulb		1 pc.	2,40
plastic				
foil	plastic foil (floor)	1x2 m		2,88
	plastic foil (blue)	1x2 m		0,96
container	plastic tub	Ø 35 cm	1m	2,64
	container	25 l	1 pc.	2,40
sealing	sealing ring		1 pc.	0,96
tube	tube	Ø 1/2“	1m	1,44
	tube	Ø 3/4“	1m	1,20
organic material				
bamboo	bamboo mats	1,7x1,9 m	1 pc.	1,25
Afar traditional	afar mats	80 x 120 cm	1 pc.	1,20
	afar sletted frame	1,2 x 2,05 m	1 pc.	8,63
	afar braided cord	2 m	1 pc.	0,96
round timber	round timber 5–6	5-6 cm, 6-8 m	1 pc.	2,40
	round timber 6-8	5-8 cm, 6-8 m	1 pc.	2,88
	round timber 8-10	8-10 cm, 6-8 m	1 pc.	3,12
	round timber 10-15	10-15cm, 6-8 m	1 pc.	3,84
sawn timber	Ethiopia sawn timber 30	2,5 x 30 cm, 4m	1 pc.	17,11
	Ethiopia sawn timber 18	4,5 x 18 cm, 4m	1 pc.	16,54
	Australia sawn timber (pine) 20	2,3 x 20 cm, 4m	1 pc.	12,42
	Australia sawn timber (pine) 25	2,5 x 25 cm, 4m	1 pc.	14,43
	Australia sawn timber (pine) 30	2,5 x 30 cm, 4m	1 pc.	15,44
squared timber	Squared timber 4x5 cm	4x5 cm, 3-4 m	1 pc.	9,92
	Squared timber 7x5 cm	7x5 cm, 3-4 m	1 pc.	13,81
anorganic material				
natural stone	sand		1 truck	86,29
	gravel		1 truck	134,23
	stone		1 truck	81,50
cement	cement	50 kg		10,55
	concrete hollow-block		1 pc.	1,20
interior				
bed	metal bed frame		1 pc.	23,97
matress	mattress (foam slim)		1 pc.	11,98
cushion	cushion cotton		1 pc.	2,88
ressources				
water	donkey water	200 liter	1 delivery	3,36

Tab. 2

Illustration credits - Implementation

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All pictures not mentioned on the list were taken by Schönher Katharina in 2015.

Chapter 1
1.3 Gruber Petra, 2011
1.7 Zamolyi Ferenc, 2011

Chapter 2
2.1 Peter Kumhera, 2011
2.3, 2.16, 2.22, 2.32, 2.37, 2.38, 2.58, 2.63, 2.64 Eigner Alice, 2015
2.41 Gruber Petra, 2015
2.42, 2.52 Ortler Mark, 2015
2.48 Hummed Abdu, 2015

Chapter 3
3.8, 3.15 Gruber Petra, 2015
3.12 Eigner Alice, 2015
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Tables
Tab. 1-3 Schönher Katharina, 2015

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