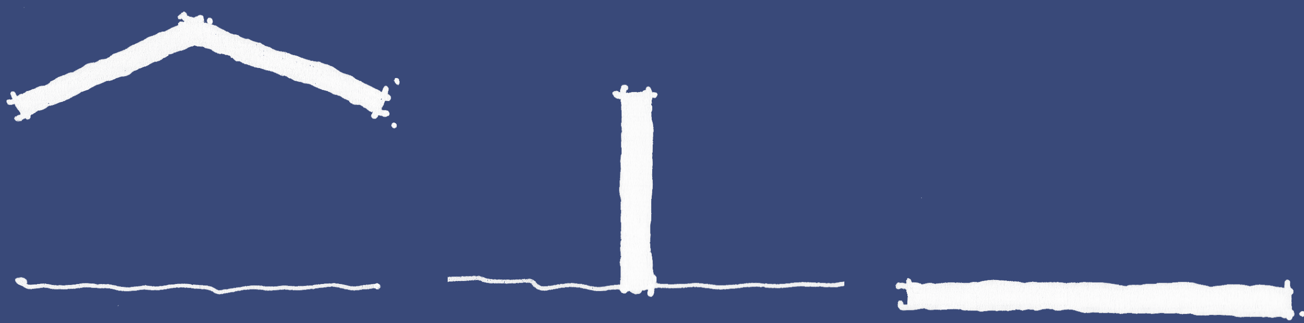

RESEARCH

From LANDSCAPE to ROOFSCAPE

A pilot pavilion design for multifunctional public use in East-Africa.

KE1.0: Community Centre Okana

authors:
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Laura Katharina Straehle

Master Graduation Project // Febr 2015 - Jan 2016
Studio Explore Lab // Faculty of Architecture
Delft University of Technology

If you want to go fast, go alone.
If you want to go far, go together.

-African Proverb-

FOREWORD

The idea to graduate with this project arose through the influence of several events. Both students have been participating in international projects outside Europe.

Laura Straehle followed a three-years bachelor programme at Technical University Munich (Germany), where she participated in various student Design-Build-Studios in Zambia and Kenya. In collaboration with local workers and architecture students from Jomo Kenyatta University a Skills Centre for children from Matharé was built in 2012 and a prototype school building in Lusaka in 2013.

Ellen Rouwendal did a three-month internship in Kenya to stimulate ecotourism in the Mount Kenya region as part of the NGO Help Self Help Centre.

The idea to work as a team has been influenced by an intensive collaboration for the three-month Master course 'International Habitat Design Studio' in Ahmedabad, India. Having seen and experienced to what extent a Design-Build-Project influences students' motivation, provided the first step to set up an own Design-Build-Project to graduate from Delft University of Technology.

ACKNOWLEDGEMENTS

During the whole graduation year we were greatly supported by our main and external mentors from Delft University of Technology. Moreover we got support from experts in the fields ranging from civil engineering, constructing with bamboo and adobe to waste, water and energy management.

Special thanks to our international mentors team from the Netherlands, Germany and Portugal for keeping us extremely motivated throughout the whole year, while always being concerned about us having enough sleep.

We would like to thank Prof. Thijs Asselbergs for being a great support in constantly reminding us to search for identity, the harmonic embedment of architecture into the surrounding and his concern about graphics in landscape. Thank you for getting so many different experts on board which benefitted the project a lot.

Dr.-Ing. Marcel Bilow, thanks to your positive and encouraging attitude towards the rare feasible projects at TU Delft, we found the best help we could in making the design ready-to-build. We really enjoyed your pragmatic true-to-life examples and tried our best to follow your recommendation on the first day to let one plus one equal three.

Last but not least, we would like to thank Ass.-Prof. Nelson A. Mota for his limitless, Mediterranean enthousiasm, his contagious cheerfulness for architecture and design and for always taking time for his students. Thank you for being the first to get on board of the team before the project actually started.

Prof. Tom Avermaete, for the inspiring 30-minute-talks we regularly had about the integration of local culture in architecture.

Frits van Loon, for his great input on thinking in sustainable cycles and landscape architecture.

Dipl.-Ing. Peter Oed, for finding statically determinate solutions to the most challenging construction principles and for understanding what an architecture student thinks.

Dipl.-Ing. Joachim Straehle, for never giving up to find the best solution, for teaching us how to keep eyes on the stars and feet on the ground. Your vast and comprehensive knowledge is the richest and most reliable source to learn from and fall back on. Thank you for all nightly brainstorming sessions, for your calmness and for your impressive talent for troubleshooting problems.

Dipl.-Ing. Holger Buchheim, for being a great 24-hr-service help in the Cinema4D Render Jungle.

James Otieno Jowi, for supporting the project as a constant mediator between two worlds, for believing in the project and managing things in Kenya with a huge smile. Asante sana!

George Omondi Ochuka, Verah, Mama Jowi and the whole Okana Community, for welcoming us that warmly, for cooperating in interviews, answering patiently all our questions and teaching us what makes life that special in Okana.

Our families and friends for the incredible mental support and our flatmates for keeping us alive and caring for us.

Thank you.

CONTENTS

INTRODUCTION

Architecture & Development in Africa

There is an imbalance in architectural identity, education and building processes between the highly industrialised countries and those with a developing background. Different levels of development have an inevitable impact on the distribution of powers, which cannot be ignored. Design-Build-Studios are a powerful means to take the first little steps towards an on a par situation. Communicating and working together on a personal and equal level with people of different cultural backgrounds in order to realise a common hands-on project will help to diminish the imbalance of powers and contribute to increased self-confidence and independence for the developing regions.

Building in Africa is about engaging with a different cultural context and the search for alternative solutions to integrate a social and humanitarian component into all design aspects; not about solely copying from western industrialised architecture.

Andres Lepik, Professor at Technical University Munich, argues for the importance of giving Africa the chance to develop its own architectural identity apart from receiving faceless projects lacking in concept. What the architectural sector in Africa benefits from – according to Lepik - is meaningful and inspiring reference projects which succeed in focussing on sustainable use of resources, the active cooperation with the local community but especially know how to empower the region through sharing knowledge. Such reference projects could help initialising a highly contextual and sustainable architecture promoting the use of local materials.

Lepik concurrently coined the term AFRITECTURE and made this the theme of his exhibition Afritecture – Building Social Change at Pinakothek der Moderne Munich in 2013-14.

It focussed on projects, which were recently designed and

New Artist Residency | Senegal by Toshiko Mori Architects | 2015

built on the continent. Amongst the ones selected were projects like those of Diébédo Francis Kéré, MASS Design Group and student building projects by TU Munich, ETH Zürich or University of Stuttgart.

According to Lepik, an African Architecture Style is hard to define as it is currently caught between modernity and tradition, own identity and increasing non-indigenous influences. In isolated regions, architecture and building are predominantly performed without any educated architects involved while local materials are often falsely replaced by modern materials from industrialised countries. Lepik notices an imbalance between the north and the south, and warns for a one-way movement of knowledge. This tension is experienced when architects from a highly industrialised and educated background encounter building processes and try to execute their plans in developing countries.

INTRODUCTION

DESIGN & BUILD

Combining European Design Education with building processes in developing areas is challenging as it requires understanding of the foreign culture. New insights should be translated into an architectural language by augmenting it with technical knowledge and aspects such as socio-economic sustainability.

Some architecture schools have set up so-called Design-Build-Studios with a clear concept: Students design and realise projects for remote regions or dense cities which need help to solve infrastructural or societal problems. The design process and the real life construction are done in close cooperation with the local people. This offers students valuable practical experiences about cultural differences and they learn how to creatively deal with it.

“Give a man a fish and you feed him for a day; teach a man to fish and you feed him for a lifetime.” This is a popular African

Women Opportunity Centre | Rwanda | Sharon Davis 2013

proverb, and this paradigm is reflected in the process of a Design-Build-Studio. Knowledge transfer plays an important role, and the overall goal should be to encourage and enable the capability of developing regions to develop skills for an independent future. It is imperative that such projects should never offer one-way solutions like the transfer of technology i.e. transporting machines to a developing country. Considering the relationship between industrialised and developing partners as donor and recipient would impose an obligation on the developing areas to act as instructed by the industrialised world. This would not encourage development of knowledge and independent skills.

On a whole, Design-Build-Projects can be a powerful means to combine architectural education and society through built interventions, as they require conscious thinking about restrictions of resources and technologies. It is a great source of new experiences and insights for students and associated professors. The projects require participants to think out of the box and demonstrate understanding and openness for the foreign culture. The goal of these studios is to act as catalysts for the region while having the people in mind who will use the building in the end. A successful Design-Build-Project is a mutual learning process and helps to let architecture develop and sustain itself.

INTRODUCTION

Challenges

Even though Design-Build-Projects represent compelling opportunities, it is important to maintain a critical stance when highly industrialised and developing countries interact. Thankfully, there are also many successful projects that provide valuable lessons to take into account.
The Berlin-based Burkinabe Francis Diébédo Kéré is the architect of the school being a brilliant example to illustrate this thought. Along with building the school for the village in which he was born himself, he makes the whole community move towards a common goal and participate in the construction process. Right from the start, Kéré makes the people part of the design, increases the level of identification and meets them as equal partners. His buildings already act as exemplary models for successful projects and depict an inspirational source for many architects to start engaging in this sector as well.

The Rural Studio at Auburn University or the First Year Project at Yale School of Architecture are convincing examples of successful studios which embed these thoughts into their studies. Initiatives to work on prototypes for Ethiopia have been started by ETH Zürich, Bauhaus University Weimar and University Stuttgart some years ago.

An increasing number of architects from highly-industrialised parts of the world have devoted themselves to smaller development projects next to their everyday business of reimagining the modern world. Some of the latest examples are Sharon Davis' Women's Opportunity Centre realised in Rwanda in 2013 or the New Artist Residency in Senegal designed by the Japanese Architect Toshiko Mori and built in 2015.

Even Norman Foster's office has just handed in a Proposal for a Droneport project launched to save lives and build economies in Rwanda.

The number of prizes and publications currently awarded and released expresses the great recognition many of those projects receive in the end. It also shows the developing dialogue and interest in this topic and may lead to follow-up orders in the future. Foremost, such reference projects should be catalysts to inspire the development of a modern architectural identity.

Library Building | Gando, Burkina Faso | Diébédo F. Kéré | 2012

A PROJECT

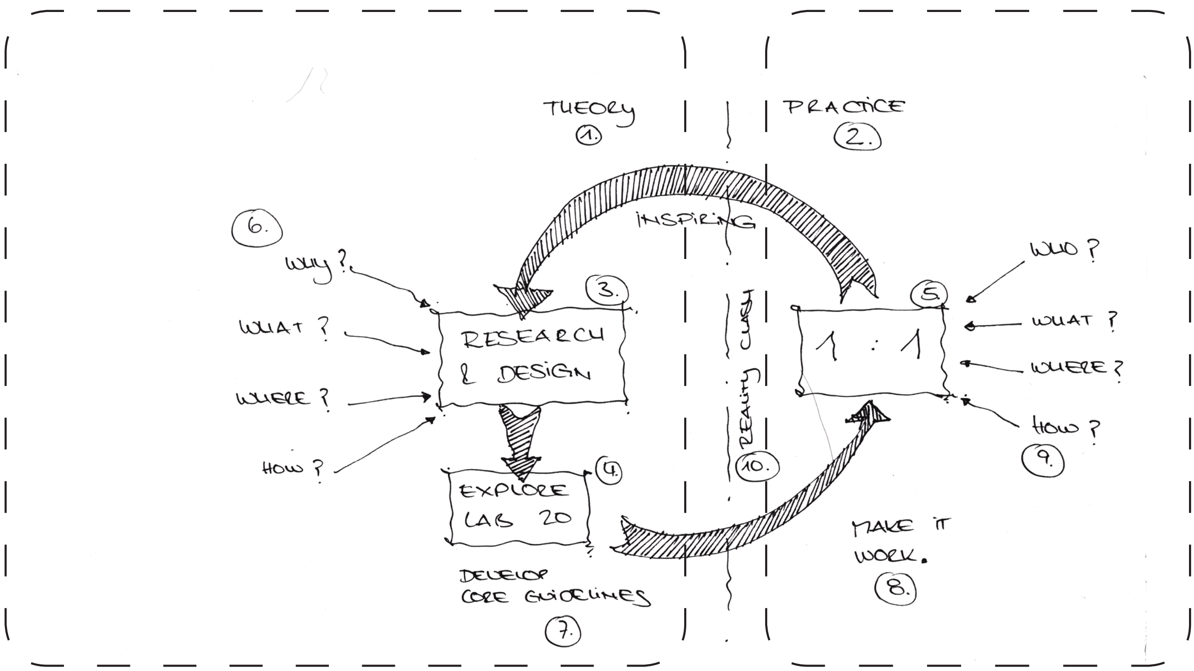
A PROJECT

Project Goal

This master graduation project is set up as a Design-Build-Project designed and realised by students themselves with technical and professional support by professors and mentors from TU Delft. The designing student team consists of two students collaborating closely during the almost one-year graduation period from February 2015 until January 2016.

The following diagram explains the relation between the Theoretical part (1. Research & Design) that involves the graduation year at Explore Lab and a Practical part (2. 1:1), the construction phase, following after graduation. From the beginning of the project research and design have been inspired by the approach to make it feasible in the context and for its construction.

Sketch:
Relation between
Theory & Practic



Research Questions

Besides the design, many hidden aspects such as planning of the construction phase, cost calculation, acquisition of funds linked with promoting the idea represent a fundamental part of the project.

The graduation project goal is defined as follows:

Design a roofscape of pavilions for multifunctional public use in the rural areas around Lake Victoria.

While the graduation goal focuses on the theoretical part of the project the goal defining the follow-up phase is to
Build the first pavilion structure as community centre in Okana (West-Kenya).

Subsequently, the project deals with designing a modular pavilion which can be clustered to form a roofscape and are flexible in the functions they house. In order to test the feasibility, the first pavilion structure will be further developed to fit the needs of Okana, a small West-Kenyan village.

The research is divided into two parts to ensure an in-depth elaboration of the topic. On one hand, a first research question deals with the aspect of the backbone of the design - the module of the pavilion. The first research deals with universality, leading to the question **'How do structural components of buildings have to perform in order to qualify for rural areas around Lake Victoria?**
Within the range of this research, it elaborates which potentials a prototype has, that is designed to be reproducible and both simply and sustainably constructed by local people using local materials in East-Africa's tropical rainforest climate.

A PROJECT

Generic vs. Specific

On the other hand, the second research question deals with the aspect uniqueness and is about ethnographic fieldwork elaborating on **'How does the cultural pattern of the Luo influence the built environment and daily life of the people in the rural village of Okana?'**

This part of the research aims at analysing the site specifics, the respective culture and traditions of the people strongly associated with the place and the built environment. It provides the basis for learning about the needs of the village and about the functions the pavilions should house.
Both separate and self-standing researches feed the project goal with important background knowledge highlighting the two sides. This approach created a more in-depth analysis of the topic and a deeper understanding of the double-sided discussion.

Illustration:
Graduation & One-to-One
Project Goals

GRADUATION
PROJECT GOAL

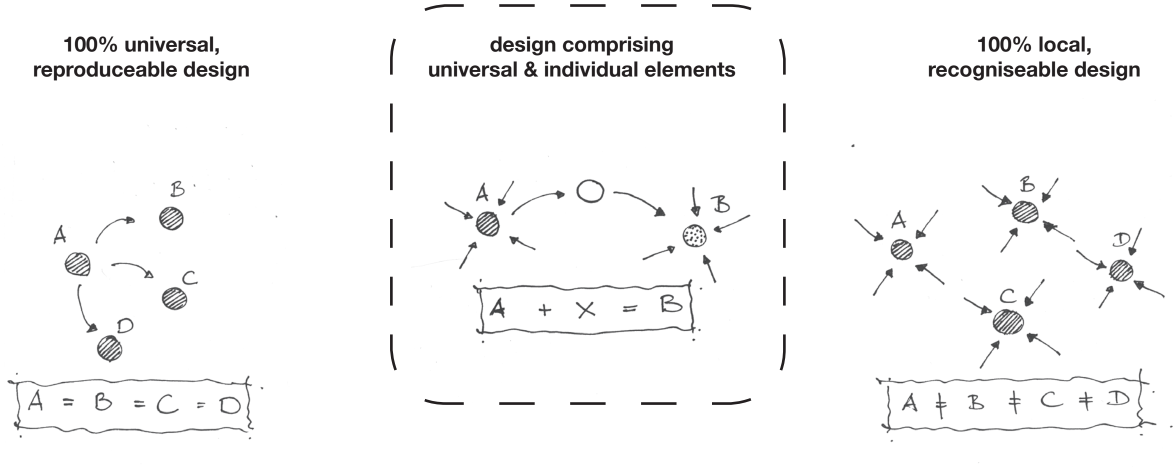
Design a **roofscape of pavilions for** multifunctional **public use** in the rural areas around Lake Victoria.

+

ONE TO ONE
PROJECT GOAL

Build the first pavilion structure as **community centre** in Okana (West-Kenya).

PROJECT STRATEGY A

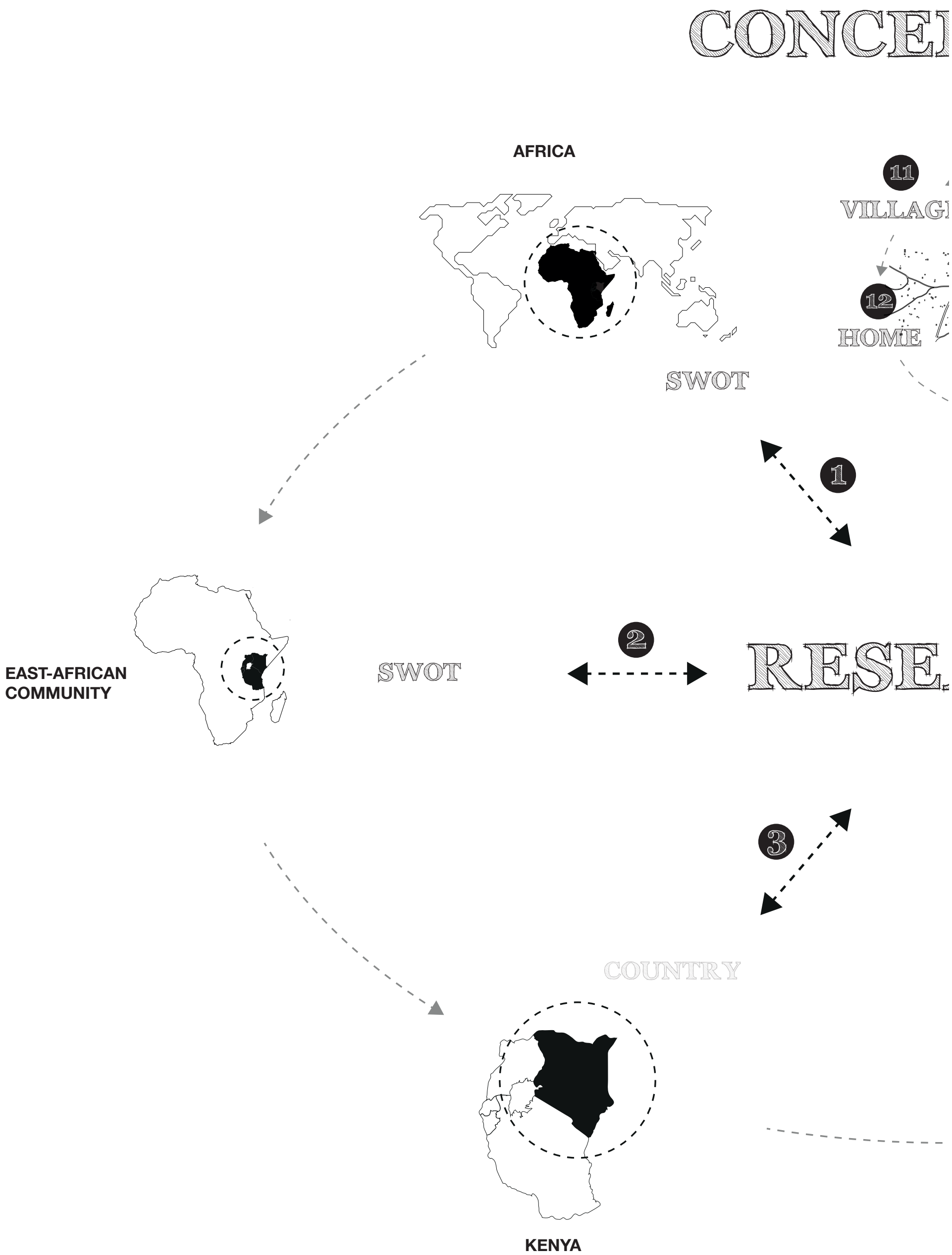


Sketch:
Generic vs. specific

The gap between both researches is bridged by first separating the topics in order to unite them afterwards by developing one common design.

The research gets an extra dimension through experiencing the **genius loci** of Okana. A four-week visit to the local partner NGO and proposed site in Kenya in the first half year provides a lot of information and insights about the local circumstances, traditions, the climate and used building techniques in the village Okana and the broader context.

Through intensive contact with the local inhabitants of the village Okana, travels in the area and established contacts with students from Moi University in Eldoret, the research is able to influence and shape the design ideas in a crucial way. According to the needs analysis in the field based on interviews and observations, the spatial program of the building was formulated and the genius loci translated into an architectural language.


CONCE
AFRICA
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VILLAG
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EAST-AFRICAN
COMMUNITY
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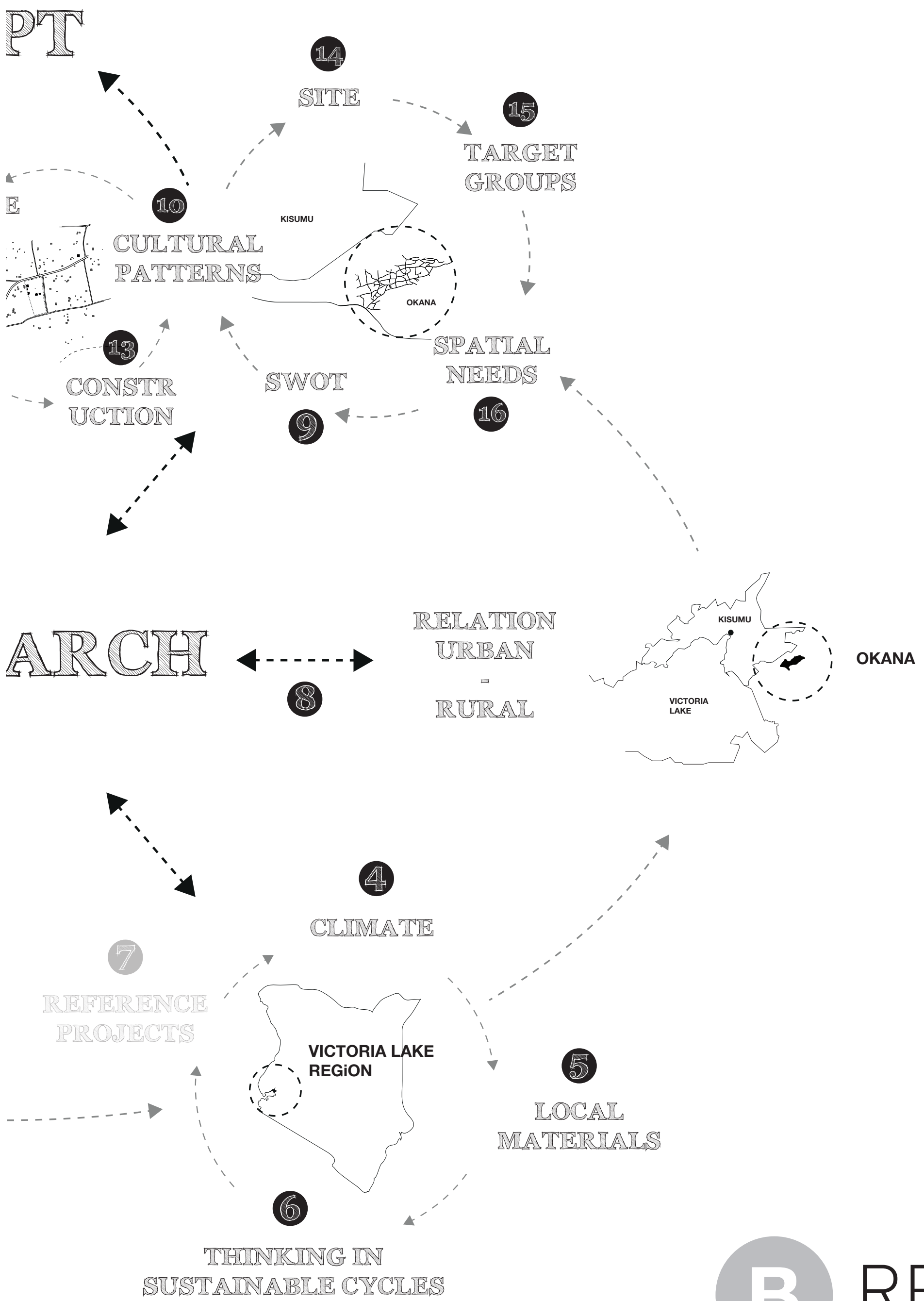
COUNTRY
KENYA


PT
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SITE
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TARGET GROUPS
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CULTURAL PATTERNS
KISUMU
OKANA
13
CONSTR UCTION
SWOT
9
SPATIAL NEEDS
16
ARCH
8
RELATION URBAN - RURAL
KISUMU
OKANA
VICTORIA LAKE
4
CLIMATE
7
REFERENCE PROJECTS
VICTORIA LAKE REGiON
5
LOCAL MATERIALS
6
THINKING IN SUSTAINABLE CYCLES

B RESEARCH

B INTRODUCTION

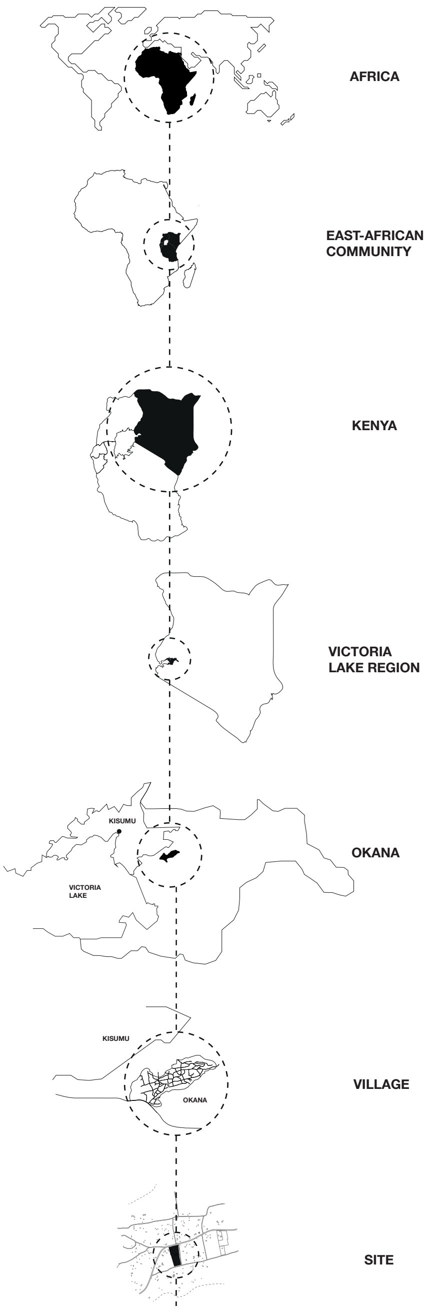
As basis for our design project, this research serves as theoretical framework and background information elaborating on the formulated project goal and research questions. The scheme on page 26-27 gives an overview of all scales and topics that have been addressed in this research and will be explained in the following chapters.

In view of the wide scope, two parts of the research answering both research questions are elaborated more in depth therby approaching the projects goal from different perspectives. The first research question includes the topics climate, construction and materials (no. 4-6) on the scale of the Lake Victoria region and the second research question will include the topics cultural patterns, village, home and people (no. 10-13) focusing on the small scale of the village Okana.

The research part consists of various sub-chapters. Firstly, the structure of the research will be explained in order to understand the relevance of the addressed topics. Secondly the methodology is clarified, addressing the strategy in which the research is being undertaken, followed by the individual topics substantiated by literature and figures. The two expanded research parts are integrated within the scope of topics, arranged by their corresponding scale. The last analysed theme is the site analysis of the proposed building site located in Okana.

Finally the research is completed with conclusions, summarizing and highlighting the most important issues.

SCALE LEVELS B



In the defined project goal several scale levels are integrated
-the developed pilot system will be suitable for the whole **Lake Victoria Region**, while the first one will be built in the small village **Okana**, West Kenya.-

While dealing with these different contexts, scale levels form the guideline of this research highlighting the most important aspects related to the context. An overview of the scale levels is shown in the overview on page.. Starting from the largest scale with the entire African continent, the research passes through the scale levels of the East-African Community, Kenya, Lake Victoria Region, Okana & surroundings and Okana zooming into the smallest scale; the site of the proposed project. Every scale will be explained by means of information, facts and SWOT analyses thereby connecting and separating the different scale levels in a logic order.

B METHODOLOGY

Literature research

The research method that is applied to answer the research question is a qualitative research method creating an understanding of the totality of the situation by using different tools. As stated in the previous chapter the project represents a pilot system that provides solutions to generic problems while on the other hand the building deals with specific characteristics of the place itself.
These two research parts ask for a different approach. Although both researches consist of a combination of literature research and field research, the 'generic part' is mainly supported by literature research and the 'specific part' is mainly supported by field research.

Literature research
Literature is used as method to collect scientific information about the research topics to substantiate and find answers on the defined research questions. In order to find valuable documents within the broad range of available materials, literature is searched on delineated themes related to the research questions and include: material and construction methods both in the Western World and in the EAC, African traditional architecture, the Luo culture in Kenya and the Kisumu/Okana region.
With the help of an extensive literature research on climatic parameters obtained by the local airport and material and construction methods applied in the Lake Victoria region, possibilities and challenges of the region are highlighted. By analysing the existing vernacular architecture of the Lake Victoria Region and Western principles through literature, recommendations can be prescribed. Next to the research specified on the Lake Victoria region, a research on bamboo is executed to explore not only the existing situation but to

focus on innovative possibilities and solutions that are suited for the area and could be introduced.

Articles and books about cultures, tribes and traditional African architecture provide insights into unfamiliar traditions and place specific aspects dating from the distant past. By analysing these case studies before going on the field trip, the determined information and focus areas serve as reference and make it possible to indicate to what extent this information still matches with the nowadays-specific area.

B METHODOLOGY

Field research

The goal of the field research is to create an in-depth analysis about the site, culture, traditions and real-life behaviour strongly associated with the place, in order to incorporate these specifics later into the design process.
Ethnographic fieldwork aims to explore different factors around a certain situation. It tries 'to describe the apparently messy and complex activities that make up social action, not to reduce their complexity but to describe and explain it' (Goffmann, 1971: 14). Ethnographic fieldwork can be subdivided into three stages; fieldwork preparation, fieldwork on site, post fieldwork.

<u>Fieldwork preparation</u>

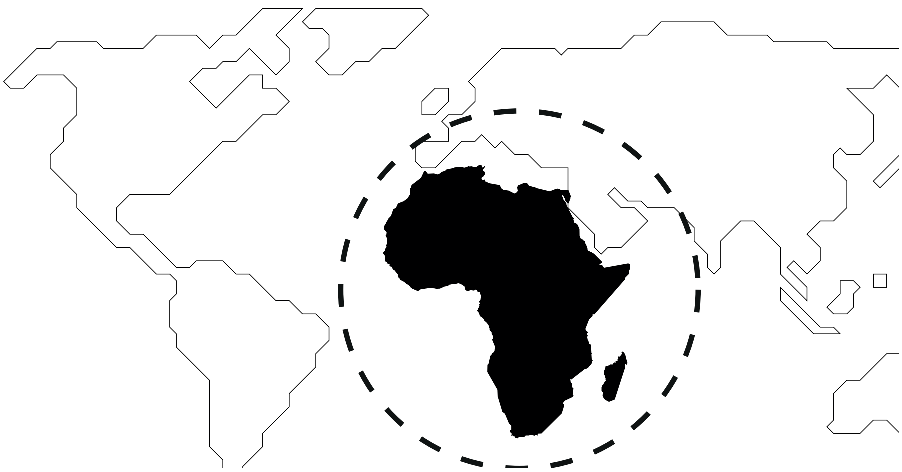
Fieldwork preparation includes all preparation and documentation before visiting the site in Okana, West Kenya. Contacts with the local NGO 'Sustainable Rural Initiatives' and earlier visitors from Delft were established in order to gain information and to inform about possible contacts and helpful connections related to the specific field of knowledge and their availability for interviews during fieldwork. The fact that the proposed site is located within a small village in the rural areas of Kenya makes it hard to find background information. Aerial photos on the website wikimapia.org served as underlay map for mapping. Meetings, interview topics, questions and goals were prepared beforehand as far as possible, in order to receive the predetermined desired information about the site, the culture of habitation, public institutions and social life. Before the site visit it was clear which aims had to be reached and how the information had to be documented, taking an alternative method into consideration in case that the planned approach would not work on site.

Fieldwork on site

The site visit took place from 6 May till 28 May 2015. The aim of the fieldwork was to get familiar with the chaotic situation of the new environment and mentioning coherent relationships. Fieldwork on site included visits to community centers, speaking to local architects, community members and Moi University. Different approaches were applied during the fieldtrip including: written observations, conducted interviews, written notes, sketches, movie shots, photographs and mappings.

Post Fieldwork.

After returning from the field all data were selected, ordered and combined to a collection of relevant information, which is combined with literature to provide a full overview. Insights and conclusions are translated into conclusions and diagrams explained further in the research.



SCALE 1:
AFRICA

B AFRICA

SWOT ANALYSIS

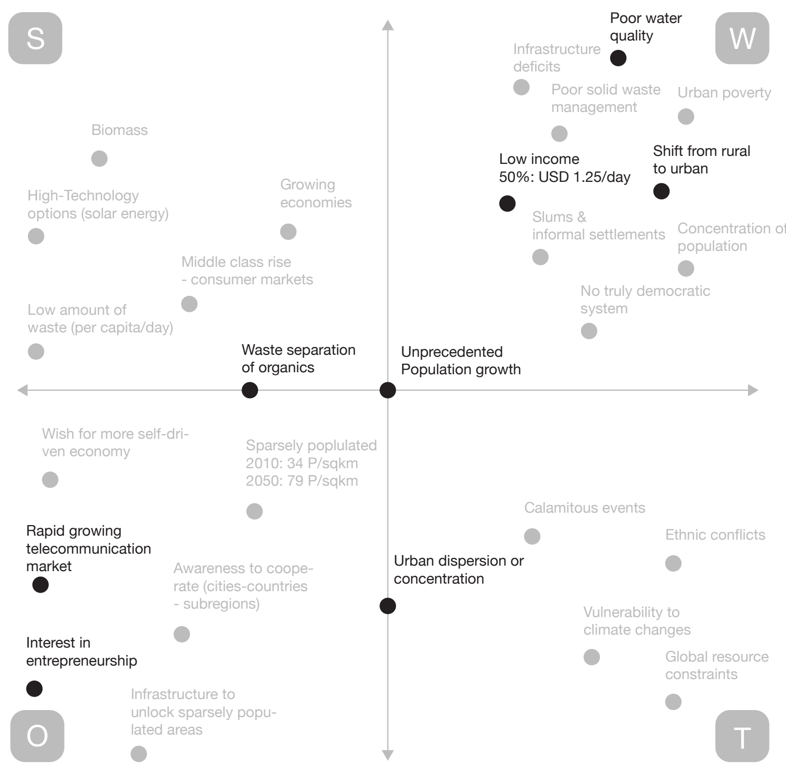
Africa is the second largest continent with a total estimated population of 1.166 billion people (http://worldpopulationreview.com) and approximately 70 percent of the population is under the age of 30 years. The entire continent is considered as the Third World, which means that the population is generally very poor and the birth rate is relatively high.

Africa is a strong developing continent, a 'continent in transition', (UN-Habitat, p16) promising major changes over the coming decades. These transitions offer on one-hand positive perceptions referring to socio-economic opportunities while on the other hand one has to react fast to these transformations. The continent has to face problems according the rapidly urbanizing populations, providing well-serviced living and working environments, even further complicated by environmental and climate changes. African economies belong to the world's emerging economies, although the differences between countries are large and depend on politics and conflicts.

SWOT ANALYSIS

The SWOT analysis of Africa shows strengths, opportunities, weaknesses and threats of the continent, of which some relevant issues are highlighted and explained into more detail.

Africa knows an unprecedented population growth that is expected to double within the coming thirty years to almost two billion inhabitants by 2040. Basic-services and infrastructure development have to expand and react on these changes, which is an enormous challenge. Unforeseen is the question whether the population mainly settles in the rural or in the urban areas. The shift of movement from rural to urban areas is unprecedentedly high. People move to the



B AFRICA

SWOT ANALYSIS

cities, as there are more job opportunities resulting in existing towns surrounded by informal settlements. 'Over a quarter of the 100 fastest-growing cities in the world are now in Africa which, by 2011, already hosted 52 cities exceeding one million inhabitants.' (UN-Habitat, p25) Urban concepts and models have to be developed to coordinate these rapidly growing cities. Towns has to be established to spread the pressures on the largest cities.

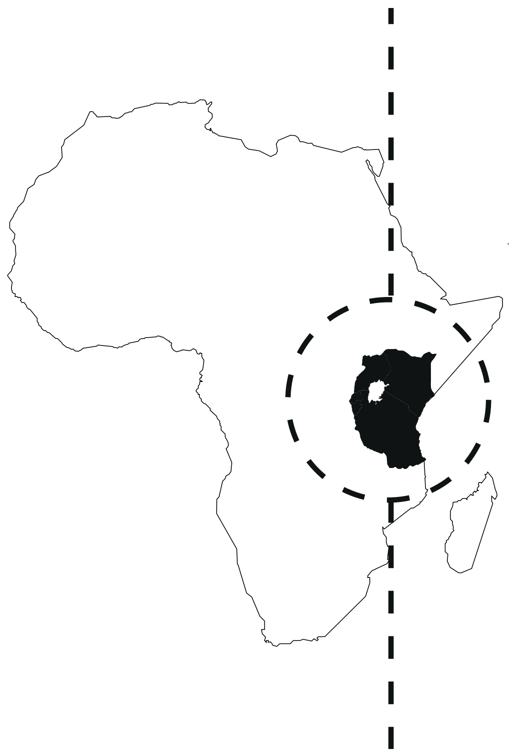
The telecommunication market is growing rapidly. Worldwide, 3 billion people are connected to Internet, for the other 4 billion people plans are being made. The continent Africa is for many market-leading companies the great promise and create an interesting market to experiment. Until now Africa is the continent with the least Internet connections and large profits can be made.
In the Tegenlicht episode 'Access to Africa (VPRO emitted on 19 April 2015) philosopher Achille Mbembe mentioned *'today it is possible to move from stone age to the digital age'* (9:54). Several steps are skipped in the development, which results in a faster development process. At this moment 75% of the people in Africa have a mobile phone and one out of five Africans has access to Internet whereby a huge difference can be seen between urban and rural areas. This connection to the rest of the continent and the world can cause big changes.

The continent showed an economic growth over the past years, due to finite natural resources, but still 50% of the people have a low income and earn less than USD 1.25 per day. The largest economic sector in most African countries is the agricultural industry, practiced on small scale often

SWOT ANALYSIS

in a largely traditional way lacking access to information. Agricultural industry offers therefore a smart opportunity for improvement to enhance economic growth and to decrease poverty. The middle class is increasing exponentially almost everywhere, it is important that jobs will be created for the lower income groups as this group forms a big percentage of the population.

Africa is a continent in transition, undergoing major changes due to the technological revolution and globalisation.



SCALE 2:
EAST-AFRICAN-COMMUNITY

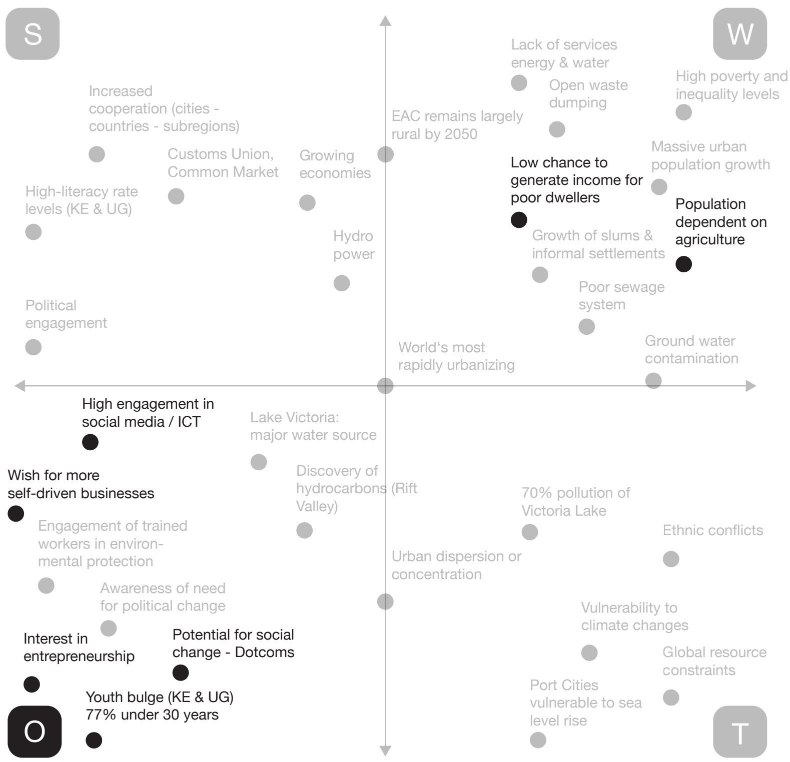
B EAST-AFRICAN COMMUNITY

SWOT ANALYSIS

The East-African Community is an intergovernmental organisation established to improve trade conditions between the five member countries Kenya, Uganda, The United Republic of Tanzania, Ruanda and The Republics of Burundi with a total population of about 150 million. (2013, EAC Vision 2050) These countries are still to be counted among the developing areas of Africa where people still have to face problems solved decades ago in highly industrialised parts of the world. According to an extensive study of the United Nations Human Settlements Programme in 2014 (UN-Habitat), the East-African countries' challenges lie within the fields of rapid urbanization and the resulting urgent need for shelter, public services and infrastructure. Moreover, fighting water scarcity, pollution and enhance drought and flood management are important issues due to the high vulnerability for climate change. Having a closer look at the countries' key figures clearly demonstrates that even the further developed Kenya has to face high unemployment rates, a low GDP and a substantial number of families living below the poverty line (CIA, 2015).

SWOT ANALYSIS

The SWOT analysis shows that East African Community is still facing many problems. In Kenya and Uganda 77% of the inhabitants are younger than 30 years a new generation that shows confidence, diversity and is self business-driven. A major challenge is to create gainful jobs for the increasing workforce, to decrease the high level of unemployment. Moreover they are the first generation that has a relatively high engagement in social media and ICT. These new technologies and means of communication have been integrated into daily lives as if there was no difference with industrialized countries. These opportunities must be exploited and can cause positive changes.



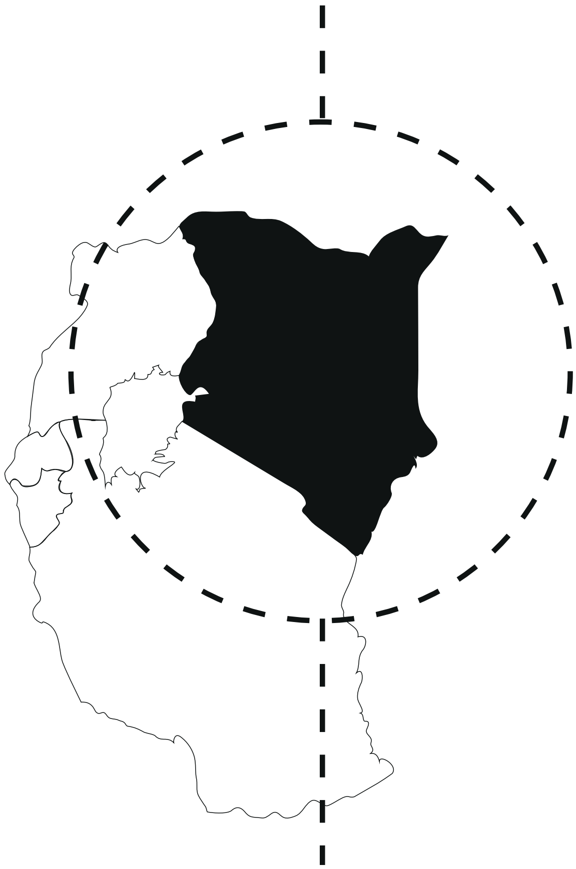
B EAST-AFRICAN COMMUNITY

SWOT ANALYSIS

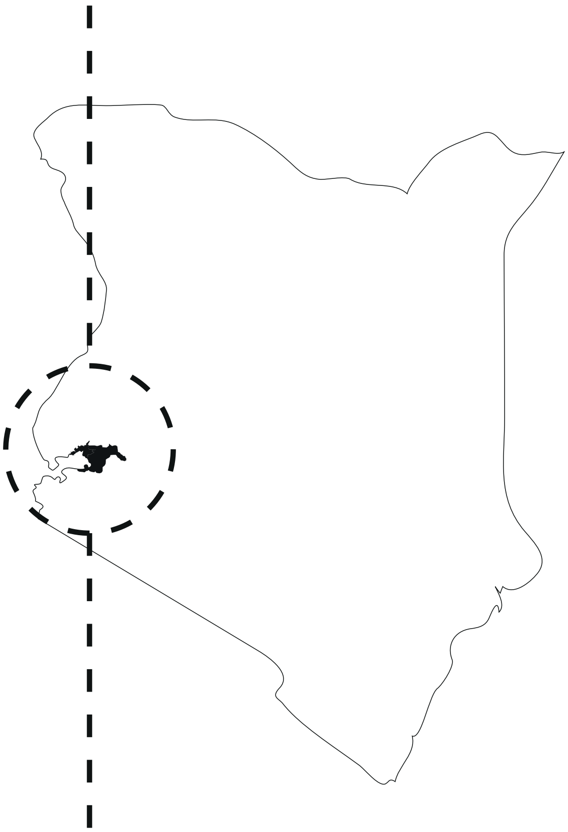
One of the development goals of the EAC is the improvement of rural development and agriculture. The population in the EAC is largely dependent on agriculture. It forms the backbone for the EAC economies, as it contributes on an average of 36 percent of the region's GDP. (EAC Vision 2050, p.69). To ensure food for the increasing population and the economic prosperity, a higher standard is needed with improved machinery, irrigation systems and higher quality of seeds.

Education plays a key role in development opportunities, as this forms the catalyst for future chances. Nelson Mandela stated: 'Education is the most powerful weapon, which you can use to change the world.' (http://www.un.org) It is of high importance that countries invest in education for boys as well as girls, that gives them opportunities to attend high school, university and practice a job.

B



SCALE 3:
KENYA



SCALE 4:
LAKE VICTORIA REGION

RESEARCH I

How do structural components of buildings have to perform in order to qualify for rural areas around Lake Victoria?

How do structural components of buildings have to perform in order to qualify for rural areas around Lake Victoria?

Subquestions

1. Which climate parameters influence the performance of the structural components and in what ways?
- Which strategies for architecture can be derived from the climate parameters?

2. What are the problems & potentials of structural components found in vernacular architecture of the Lake Victoria Region?
- Why does the roof have a special standing?
- What are the problems vernacular roofs face?

3. Does bamboo depict an alternative material to help improve problems linked to structural components?
- What are the benefits from using bamboo as construction material for the LVR?

B RESEARCH I

INTRODUCTION

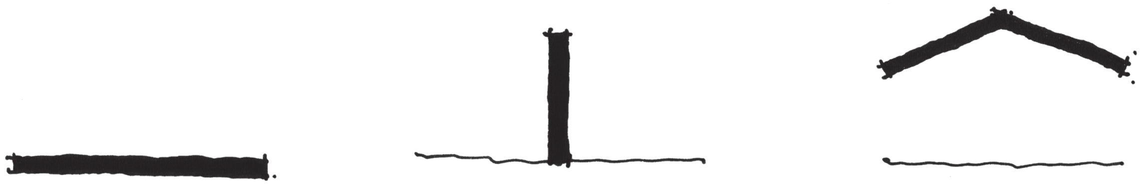


Fig. 1.1: Abstract drawing of the structural components: roofs, walls, floors.

The notion of structural components generally refers to an extensive range of elements that are linked to the construction of an architectural object - often referred to as its backbone. In this research paper, the term structural components serves as a universal concept for all building elements which are analysed as part of the research process in order to give answers to the following research question:

How do structural components of buildings have to perform in order to qualify for rural areas around Lake Victoria?

Their distinct classification into groups of building elements helps to analyse, cluster and contrast all findings from both literature and field research. To keep it simple, the number of categories is reduced to floors, walls including openings and load-bearing structure and finally roofs.
On the basis of prevailing local climate parameters and the availability of sustainable materials, each individual structural component is examined thoroughly in terms of its appropriateness and suitability for a sustainable use in the future of Lake Victoria Region. Both field trip and literature research indicate that particularly roofs have to meet plenty of requirements in order to be qualified for the tropical rainforest climate zone. Hence this assumption calls for an increased focus on the roof as specific building part.

INTRODUCTION

As the SWOT analysis of the Lake Victoria Region in the previous chapter indicates, the region and especially the rural areas do not only suffer from health problems or lack of educational programs to name but a few. The lack of regular water and energy supply, missing drainage systems and the people‘s dependence on agriculture and climatic conditions, leave the rural villages far behind the rapidly growing cities in terms of their development.

The research investigates challenges and potentials of the structural components and materials which prevail in the local architecture. The relevance is justified by the value of the research paper for the local communities benefitting from the knowledge provided and future building projects planned in the region.

The research sheds light on geographically-bound knowledge about climate, construction strategies and local materials and tries to enrich the hitherto little information and data available about rural areas around Lake Victoria. In the end reasonable assumptions and recommendations will be made as to ensure maximum benefit from understanding the use and application of local parameters.

On the one hand, all new insights can be used as source of information for future architects who want to operate in this region. On the other hand, all findings are made available to the local communities in the rural areas.

In the form of an easy-to-read handbook, the local people will be empowered to understand the potentials of the single structural elements, how to prevent or minimise problems and taught what to do in order to apply the principles suggested to their own homes in an easy way.

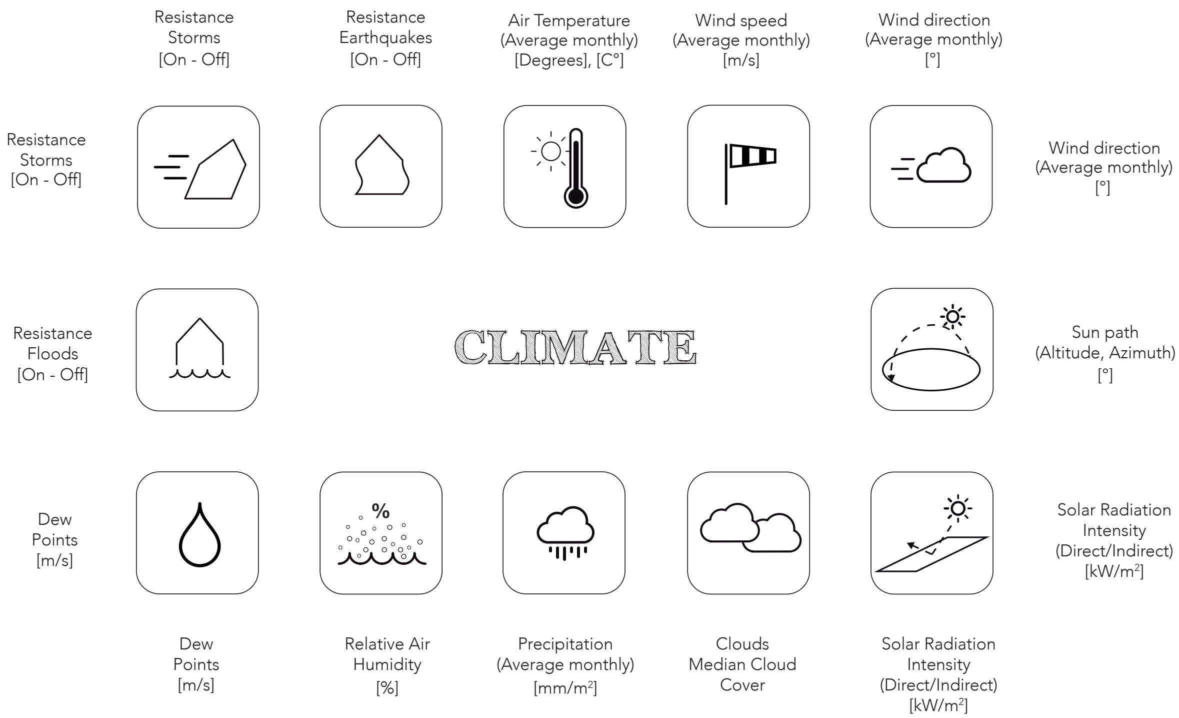
„The relevance of the research [...] is justified by its value for local communities benefitting from the knowledge provided [...].“

B RESEARCH I

CLIMATE PARAMETERS

Climate has always been a crucial influential factor on architecture as a whole and hence on the structural components attached to it.
To take but one practical example, vernacular architecture in the temperate climate zone has to meet a couple of diverse requirements regarding thermal insulation against low temperatures or snow. The walls‘ width and construction subsequently changes accordingly for the benefit of the thermal comfort inside. Whereas architecture in tropical climate zones has to fight extremely high temperatures and air humidity inter alia. The following research examines **which climate parameters influence the performance of the structural components in the Lake Victoria Region** and how to react upon these in architecture.

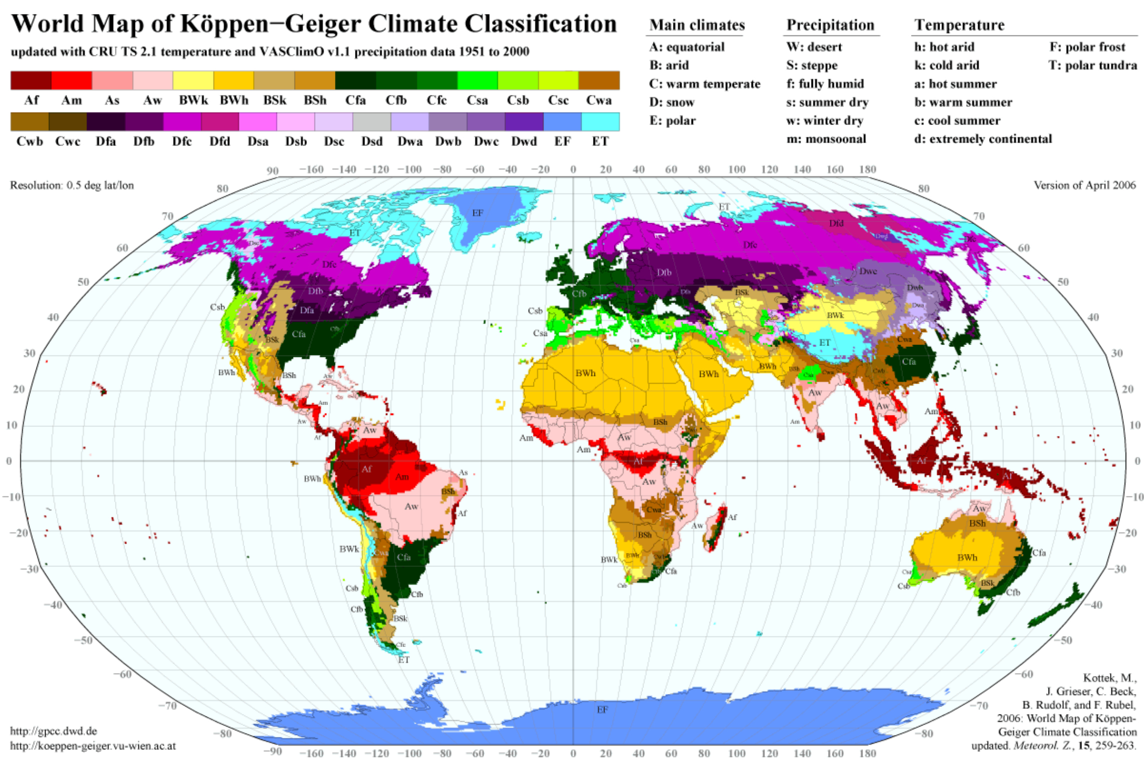
Fig. 1.2: Climate parameters studied within the scope of the research



CLIMATE PARAMETERS

Lake Victoria Region - defined as the areas located within the close proximity to the banks of the lake - is mainly characterised by a tropical rainforest climate. As indicated in the World Map of Köppen-Geiger Climate Classification, this region shows an equatorial, fully humid climate [Af] highlighted in dark red. In general this means that the tropical rainforest climate has a mean temperature of at least 18°C and precipitation rates never drop below 60mm per month (Köppen, 2006: 259-263).
All climate parameters referred to in the following chapter are taken from statistics and evaluations measured at Kisumu Airport which is located just a few kilometres from Victoria Lake (Weatherspark, 2015).

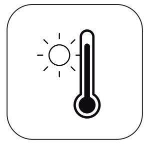
Fig. 1.3: World Map of Köppen-Geiger Climate Classification, Meterol Z., 15,



B RESEARCH I

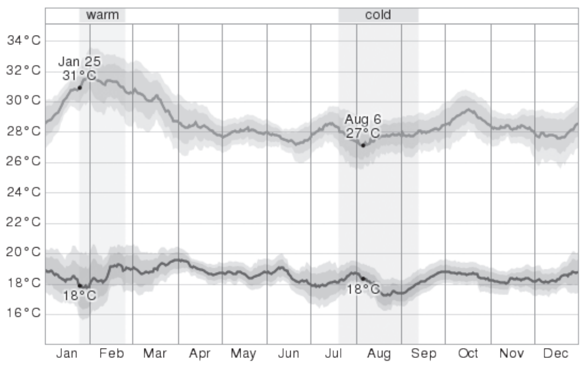
CLIMATE PARAMETERS

The first parameter to take a closer look at is air temperature. Over the course of a year, the temperature in the Lake Victoria Region typically varies from 17°C to 32°C and is rarely below 16°C or above 34°C. The warm season lasts from January 25 to February 25 with an average daily high temperature above 31°C. The hottest day of the year is February 1, with an average high of 32°C and low of 18°C.
The cold season lasts from July 20 to September 13 with an average daily high temperature below 28°C. The coldest day of the year is August 21, with an average low of 17°C and high of 28°C.



Air temperature
(Average monthly)
[Degrees], [°C]

Daily low and daily high temperature



Fraction of Time Spent in Various Temperature Bands

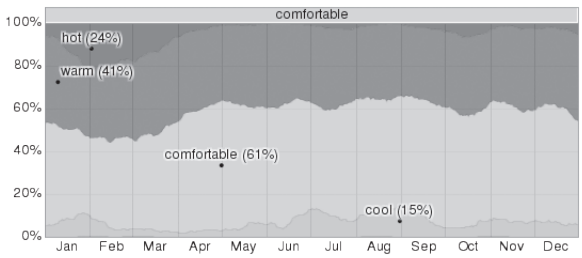


Fig. 1.4: Diagrams air temperatur (online: Weatherspark; accessed: 25 Febr 2015)

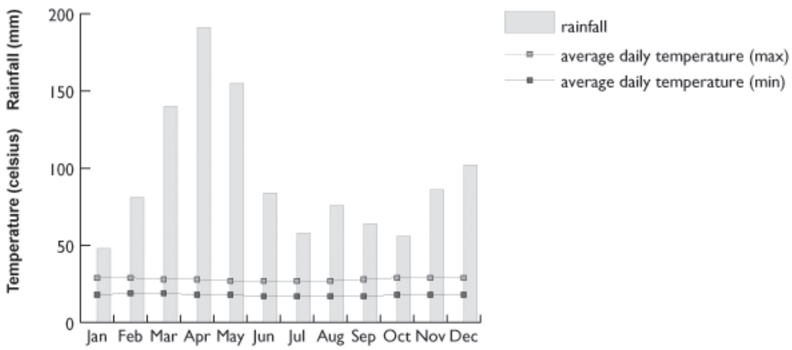
CLIMATE PARAMETERS

Precipitation
(Average monthly)
[mm/m²]

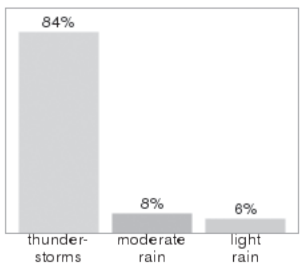
During the warm season, which lasts from January 25 to February 25, there is a 26% average chance that precipitation will be observed at some point during a given day. When precipitation does occur it is most often in the form of thunderstorms (80% of days with precipitation have at worst thunderstorms), light rain (10%), and moderate rain (10%).

During the cold season, which lasts from July 20 to September 13, there is a 53% average chance that precipitation will be observed at some point during a given day. When precipitation does occur it is most often in the form of thunderstorms (84% of days with precipitation have at worst thunderstorms), moderate rain (8%), and light rain (6%).

Precipitation rates throughout the year



Cold season



Warm season

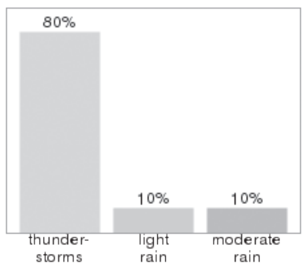
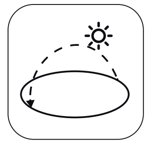


Fig. 1.5: Diagrams precipitation (online Weatherspark, accessed: 25 Febr 2015)

B RESEARCH I

CLIMATE PARAMETERS

One of the parameters making a huge difference between climate zones is the sun. Especially in the tropical rainforest climate zone, it plays an important role in architecture.
In the Lake Victoria Region the length of the day does not vary substantially over the course of the year, staying within 9 minutes of 12 hours throughout. The shortest day is December 21 with 12:07 hours of daylight; the longest day is June 21 with 12:09 hours of daylight.



Sun path
(Altitude / Azimutz)
[°]

Daily hours of daylight and twilight

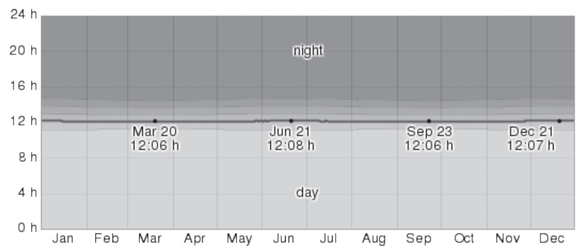


Fig. 1.6: Diagram sun (online Weatherspark; accessed: 25 Febr 2015)

Due to its location right next to the equator, the direction of the sun changes slightly from June to Dec and from north to south, yet with an angle between 63° to 65°, the sun is intensively shining on roofs and landscape.

Daily low and daily high temperature

- June 21:
9:00 // 30° Altitude // 60° East
12:00 // 63° // 20° North
15:00 // 50° // 310° North-West
18:00 // 10° // 290° West

- Dec 21:
9:00 // 30° // 120° East
12:00 // 65° // 160° South
15:00 // 48° // 235° South-West
18:00 // 10° // 258° West

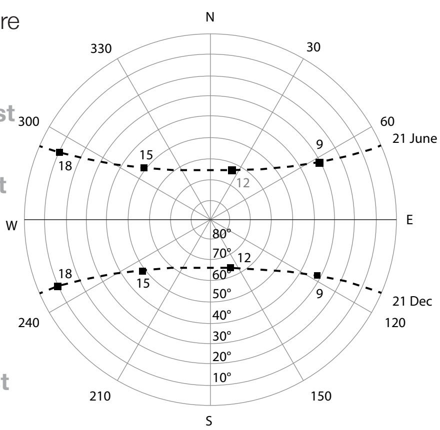
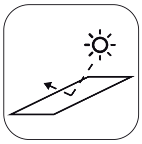


Fig. 1.7: Diagram sun path (online Weatherspark, accessed: 25 Febr 2015)

CLIMATE PARAMETERS



Solar radiation intensity
(Direct/Indirect)
[kW/m²]

The median insolation only ranges slightly between the cold and the warm season. Peaks can be found in February and March with an insolation between 6,27 kWh/m² and 6,33 kWh/m² per day. The lowest harvest of the sun is identified in July with 4,91 kWh/m² per day.

Solar radiation intensity throughout the year

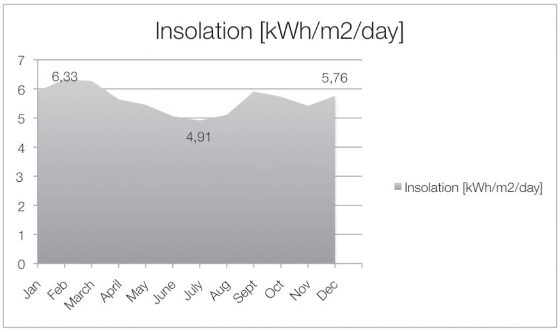


Fig. 1.8: Diagram solar radiation (online Weatherspark, accessed: 25 Febr 2015)

Clouds
Median Cloud Cover
[%]

The median cloud cover ranges from 51% (partly cloudy) to 76% (partly cloudy). The sky is cloudiest on October 17 and clearest on February 3. The clearer part of the year begins around December 25 whereas the cloudier one around March 12.

Median cloud cover

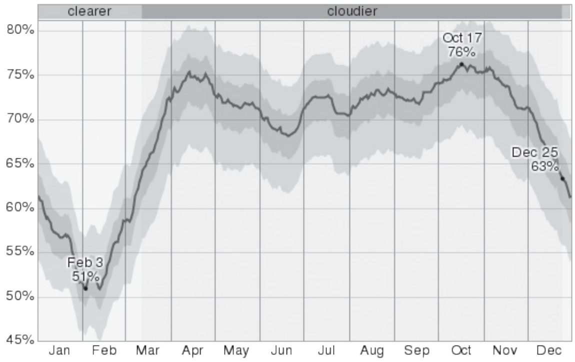
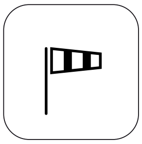


Fig. 1.9: Diagram cloud cover (online Weatherspark, accessed: 25 Febr 2015)

B RESEARCH I

CLIMATE PARAMETERS

Over the course of the year typical wind speeds vary from 0 m/s to 10 m/s (calm to fresh breeze), rarely exceeding 18 m/s (gale). The highest average wind speed of 4 m/s (gentle breeze) occurs around February 20, at which time the average daily maximum wind speed is 9 m/s (fresh breeze).
The lowest average wind speed of 2 m/s (light breeze) occurs around May 18, at which time the average daily maximum wind speed is 7 m/s (moderate breeze).



Wind speed
(Average monthly)
[m/s]

Wind speed throughout the year

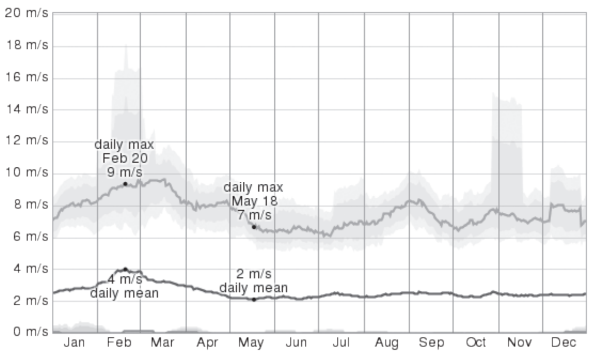


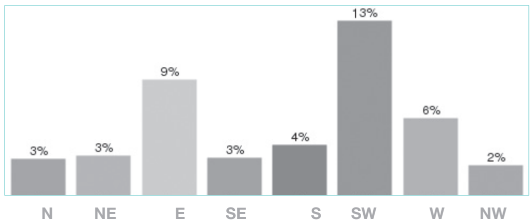
Fig. 1.10: Diagram wind speed (online Weatherspark, accessed: 25 Febr 2015)

CLIMATE PARAMETERS

Wind direction
(Average monthly)
[°]

The main wind direction is mostly south west (13% of the time). Wind from north west is scarcest (2% of the time), followed by wind from north (3% of the time), south east (3% of the time), north east (3% of the time), and south (4% of the time).

Wind drections of the entire year



The fraction of time spent with the wind blowing from the various directions over the entire year. Values do not sum to 100% because the wind direction is undefined when the wind speed is zero.

Fraction of Time Spent in Various Temperature Bands

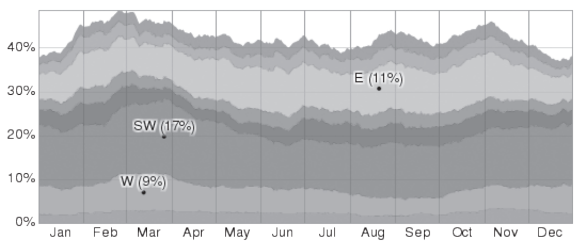
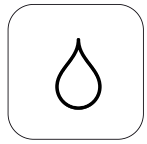


Fig. 1.11: Diagrams wind direction (online Weatherspark, accessed: 25 Febr 2015)

B RESEARCH I

CLIMATE PARAMETERS

Dew points are often a better measure of how comfortable a person perceives the weather than relative humidity as it relates more directly to whether perspiration will evaporate from the skin, thereby cooling the body. Lower dew points feel drier and higher dew points feel more humid.
Over the course of a year, the dew point typically varies from 10°C (dry) to 20°C (muggy) and is rarely below 6°C or above 21°C. Two periods in the year are most comfortable: between January 23 and February 17 and between June 27 and August 15. The air feels neither too dry nor too muggy during these periods.



Dew points
[m/s]

Dew points throughout the year

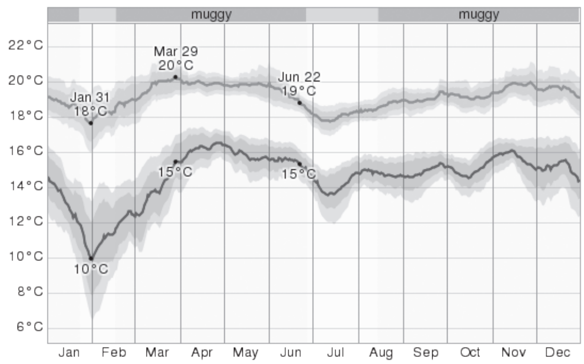
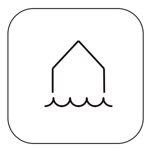
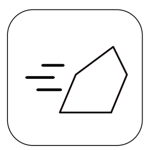


Fig. 1.12: Diagram dew points (online Weatherspark, accessed: 25 Febr 2015)

The region in question is located in the Victoria Lake Basin, also called Kano Plane. A lot of areas are wetlands and subsequently dispose of much natural water in the ground. Plants like rice, corn or other cash-crops grow rapidly under these conditions. However, without a working dike system, the area is often flooded as water flows from the higher levels to Kano Plane.
The risk of storms can generally be neglected as the average wind speed of 2-4 m/s is not high, yet there are peaks of 9 m/s and thunderstorms right before heavy rains.

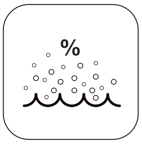


Reistance Floods [On / Off]



Reistance Storms [On / Off]

CLIMATE PARAMETERS



Air humidity
[%]

The relative air humidity typically ranges from 31% (comfortable) to 99% (very humid), rarely dropping below 21% (dry) and reaching as high as 100%. The air is driest around February 1, at which time the relative humidity drops below 37%. It is most humid around April 13, exceeding 98% three days out of four.

Relative air humidity

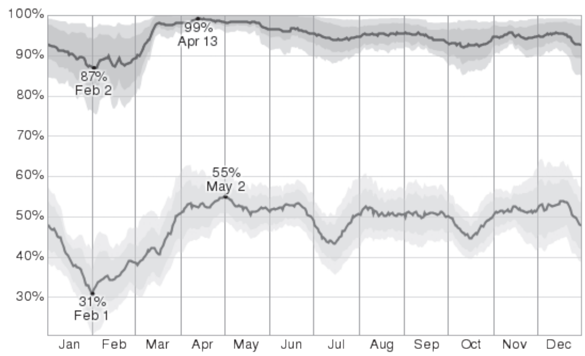
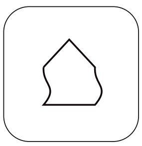


Fig. 1.13: Diagram air humidity (online Weatherspark, accessed: 25 Febr 2015)



Reistance Earthquakes
[On / Off]

The East African region is characterized by a moderate level of seismicity that is mainly controlled by the structural trend of the EARS (East-African Rift System) and its southward extension into the Indian Ocean. Most of the significant earthquakes in Kenya up to now have been the 1928 Ms 6.9 (surface wave magnitude) earthquake in the central part of the Kenya Rift and the 1913 Turkana region earthquake having a surface wave magnitude of 6.0. Apart from these three earthquakes, no M>5 earthquakes have been reported up to date.

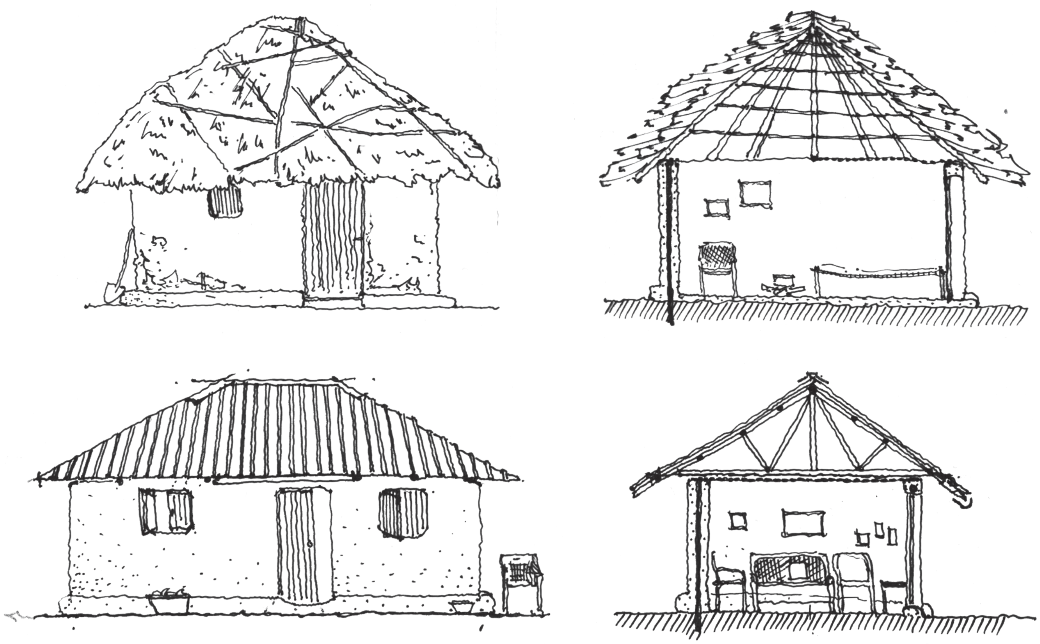
Due to the sparsity of dwellings and the inherent resistance to earthquake shaking of the local vernacular type of huts, Kenyan architecture is quite resistant to earthquakes.

B RESEARCH I

LOCAL CONSTRUCTION PRINCIPLES

Most of the buildings found during the field trip in the rural areas around Lake Victoria show remarkable similarities in building type, shape, interior layout and construction. They can be clustered into private houses, public buildings such as schools, nurseries, churches or shops and market stalls.
Figure 1.16 categorises the four most common types of a rural community into round straw huts and rectangular huts both made of mud, shops from natural stones and wooden market stalls.
The two most common forms of private houses are the rectangular mud huts with a corrugated iron roof and the vernacular round hut with a straw roof. Figure 1.14 illustrates how these two versions typically look like. Altough their sizes vary slightly from family to family and from community to community in order to adapt to their spatial program, the structure and design has hardly ever changed.

Fig. 1.14: Sketch of vernacular building types - straw hut & iron sheet house



LOCAL CONSTRUCTION PRINCIPLES

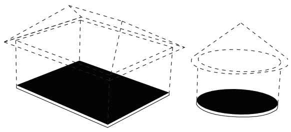


Fig. 1.15: Building types: rectangular, round (vernacular)

Research part II following this research investigates the cultural patterns of the local community, traditions and living habits. It explains the culture-based reasons behind the layout of the huts, their spatial program and how the local people use it flexibly.
This chapter deals with the pure construction and strives to give answers to the subquestion:

What are the problems and potentials of structural elements of the vernacular architecture in the Lake Victoria Region?

These problems often occur as a result of too little background knowledge about the impact of the climate or missing sustainability in the use of materials. According to the definition of the three categories floors, walls and roofs, the individual structural components will be checked for their benefits and disadvantages.

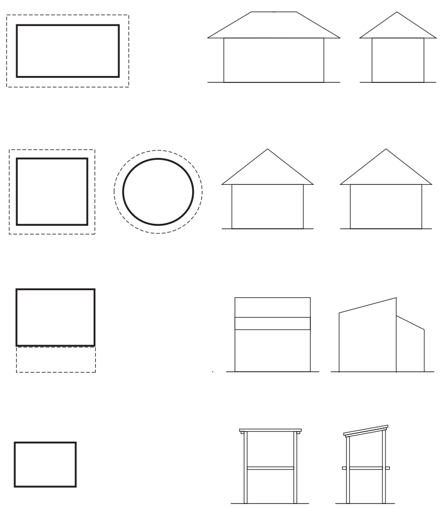


Fig. 1.16: Drawing of building types: Rectangular and round private homes, shops and market stalls

B RESEARCH I

LOCAL CONSTRUCTION: FLOOR

Structural Component: Floor

[redacted].

The first structural component one literally encounters while entering a building is the floor. As early as in front of the entrance itself, the nature of the floor covering often changes gently but firmly to mark out properties.
One would suppose to experience this throughout all different kinds of cultures. This is certainly the case, although the notion of the floor in the rural areas of Lake Victoria Region is slightly different. Here, the natural soil is seen as the optimal ground to build upon. Consequently, the change of floor covering from outside to inside is diluted due to the use of the same materials. Though by applying different processing methods, the local people reach to mark out territories.

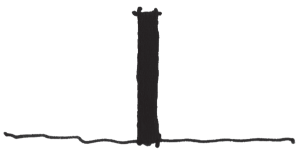
First of all, the question why people who live in the rural areas around Lake Victoria prefer to use the natural soil can be answered by its simple advantages of being omnipresent in the foremost non-paved rural communities and being available for free in their backyards.

Secondly, the tropical rainforest climate represents an enabling factor for taking the natural soil as flooring inside if it is well-compacted. The temperature hardly drops below 18°C all year round, leaving a relatively dry soil behind except from the rainy seasons. The heavy rains often soften the soil, especially in the wetland areas around Lake Victoria, with the consequence that moisture enters the houses from below.

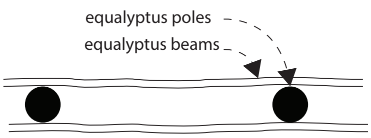
Thirdly, the natural clay soil represents a huge thermal mass and cools down the inside of the huts heating up easily during the warm seasons with temperatures rising up to 34°C.

LOCAL CONSTRUCTION: WALL

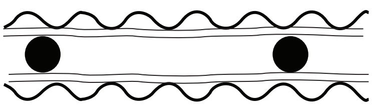
Structural Component:
Wall



Wall: eucalyptus



Wall: corrugated iron sheet



Wall: mud

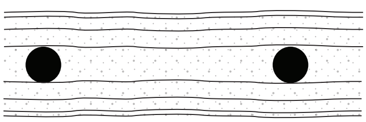


Fig. 1.17: Horizontal sections through vernacular walls

Walls in tropical climate zones vary in functions from those in temperate areas of the world. Instead of protecting the inside from low temperatures or unauthorized entering, their purpose rather lies on being an obstacle for rainwater or heat to enter and a visual protection.
Observations during the field trip and findings from the literature research confirm prior assumptions which mainly refer to the construction of private homes to narrow down the scope of this research part.

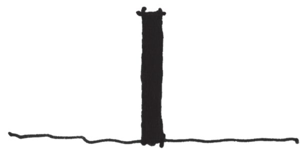
The standard and most common wall structure for private homes uses eucalyptus poles 5cm in diameter and rammed into the untreated soil around 60 cm apart. Thinner eucalyptus branches as some sort of horizontal beams are connected to the main eucalyptus construction with wood screws.
With this basic construction principle, the users can decide whether to put corrugated iron sheets on both sides of the eucalyptus beams or decide on using adobe as filling and plaster of the hut. Whereas the first option implies that an air gap between the iron sheets emerges and noise protection is simply non-existent, the second solution provides a considerable thermal mass, consisting of four layers of adobe initially meant to prevent the walls from cracking as the layers shrink differently while the adobe dries.

Adobe is a mixture of sand, clay and additives like straw fibres, for example, whose exact percentage composition is unfamiliar to the local people up to the present day. Due to the lack of appropriate means to find out those percentages and missing funds to instruct the Material Lab based in Kisumu or the Foundation Lab in Nairobi, the people keep on using the mixture of the soil as found in their backyards.

B RESEARCH I

LOCAL CONSTRUCTION: WALL

Structural Component:
Wall



The local soil in the Lake Victoria Region shows a lot of great advantages especially for the poor rural villagers as explained previously. Though the soil - also referred to as black cotton soil - has some crucial disadvantages which do not help promoting its use as standard construction material in the region and cost a lot of time due to monthly maintenance and care.

According to Steven Onderi who is working as research assistant at Kisumu Material Lab, the black cotton soil contains a vast amount of silt which has considerable negative impacts on the suitability of the soil for constructing walls. More than 3% silt included in the sand increases the Plasticity Index (PI) of adobe and consequently leads to cracks in the walls while drying. The black cotton soil unfortunately shows a high PI which makes it difficult to work with. Constructing walls as the community nowadays means that cracks will have to be repaired every one to two months.

Despite this setback with regard to the local soil, there are many solutions suggested in literature and by the Material Lab itself in order to use the local soil even though. Some sources suggest different techniques in applying the material on the surfaces, others refer to adding specific mixtures and ingredients like cow dung, bamboo or sugarcane fibres to hold the construction together.
Material tests are currently carried out by Kisumu Material Lab with varying samples taken from different spots in the whole Victoria Lake Region. The Lab expects the first results to proof that the soil varies a lot in a radius of 150m.

Tests executed at
Material Lab Kisumu:

Strength / Grading / Liquid
Limit, Plastic Limit,
Plasticity
Index, Shrinkage /
California Bearing Ratio

LOCAL CONSTRUCTION: WALL

It is already proven that the strength, plasticity and shrinkage of the wall improve considerably by adding agents like lime or cement of 3%. These agents and paint improve the water resistance to a great extent.

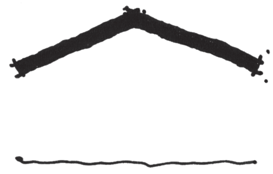
The following photo documentation of walls found during the field trip, illustrates the problems occuring after having used the black cotton soil without additives or changed percentage of ingredients.

Fig. 1.18: Photo documentation of walls in rural areas around Lake Victoria

B RESEARCH I

STRUCTURAL COMPONENT: ROOF

Structural Component: Roof

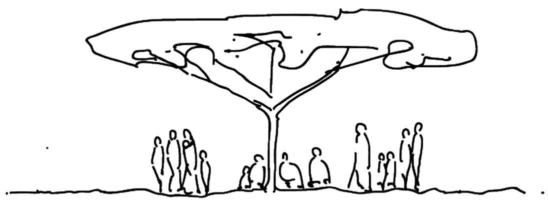


In tropical climate zones roofs seem to have a special standing amongst all structural components assigned to an architectural object. While the absence of walls does not necessarily have a negative impact on the functionality of a building, the absence of a roof does. The following section works out **why the roof has a special standing in the tropics and identifies the main problems vernacular roofs face**?

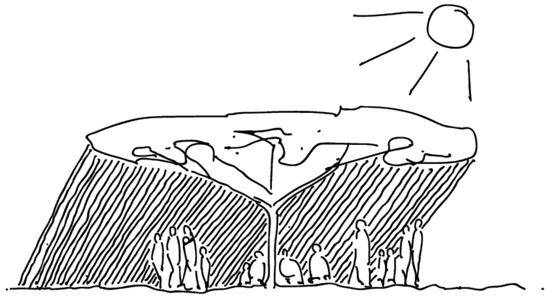
Hereby the locally well-known Acacia tree serves as an example to support this assumption valid for African rural villages. With its widely protruding crown of eight to ten meters the Acacia tree is capable to fulfil a lot of climatic functions as illustrated with the sketches on the following page. Considered as a natural roof it is not only protective against the sometimes heavy rains, but offers the urgently needed shadow for the people living under the hot sun of Africa. Underneath the tree crown there is constant ventilation which makes it a popular space for members of the rural communities to come together. Hence the tree fulfils a social, interactive function as it acts as a natural roof for the community. It represents some sort of public centre without being an architectural object at all.

As a first conclusion the climate condition in the Lake Victoria Region has two sides: The people need protection from the rain and seek shade from the bright sun. This represents the status quo of the rural areas in the Lake Victoria Region.
Nevertheless the roof should obviously also operate as a means to collect the rainwater during the rainy seasons and make use of the intense sun as a postfossil resource to generate energy. This approach has already been

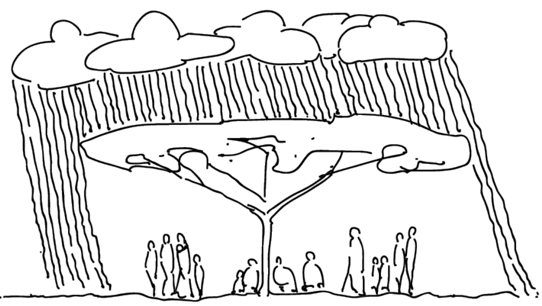
STRUCTURAL COMPONENT: ROOF



Acacia tree as meeting point for the community.



Acacia tree providing a shadow place underneath.



Acacia tree as protection from heavy rains.

Fig. 1.19: Sketches of the Acacia tree as multilayered component of the community

STRUCTURAL COMPONENT: ROOF

incorporated into operations and activities in the western world, however there is still a long way to go until it reaches all rural areas of Lake Victoria Region. Considering energy production, the roof in tropical climate zones inherits a multilayered area of responsibility and architecture could be one of the fields to find practical ways to respond adequately to this condition. The German Emeritus Professor Dirk Althaus who is researching on postfossil resources emphasizes this scenario deliberately exaggerated in *Zeitenwende: Die postfossile Epoche. Weiterleben auf dem Blauen Planeten*:

„In the long run, there will be a migration of the industry into solar zones followed by advanced civilizations. Culture follows resources, most probably to Africa, where you can find most land underneath the sun.“ (Althaus, 2007)

Althaus argues that the sun as postfossil resource will be of a high importance for the world‘s energy supply. Due to our careless handling of fossile resources, we will have to obtain energy aboveground in the future. As the Lake Victoria Region just like the whole continent is benefitting from its location *underneath the sun*, especially local architecture should be encouraged to incorporate these thoughts.

Summing up the first findings on a purely technical level results in the conclusion that the roof holds an important position amongst all structural components for its decisive and versatile ability to react on the prevailing climate influences. In a simplified and abstract way it offers protection from the rain, the sun and the heat as typical climate aspects.

„Langfristig wird eine Migration der Industrie und nachfolgend der Hochkultur in solare Zonen erfolgen. Kultur folgt den Ressourcen, wahrscheinlich nach Afrika, wo am meisten Land unter der Sonne ist.“

Prof. em. Dirk Althaus, 2007

STRUCTURAL COMPONENT: ROOF

Complemented by the socio-cultural aspect, a roof provides space to gather in public without having a boundary in the form of walls. Research part II elaborates the socio-cultural aspects in depth from the perspective of one case study village called Okana (West-Kenya).

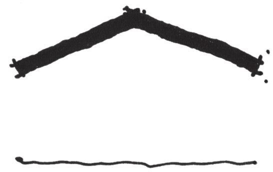
To what extent vernacular roofs show problems in responding to the climate adequately is analysed in the following section.

Fig. 1.20: The roof as shelter.

LOCAL CONSTRUCTION: ROOF

Despite its recognized importance as shelter and future means for energy production in tropical climate zones, both literature and field research indicate that there is still a certain amount of problems experienced with local roofs.
During interviews with local community members of the rural areas, it becomes clear that the materials and principles used for construction do not necessarily meet the needs of the users inside the buildings. Figures 1.21 and 1.22 show sketches of the vernacular roofs which are most common in the rural areas.

Structural Component: Roof



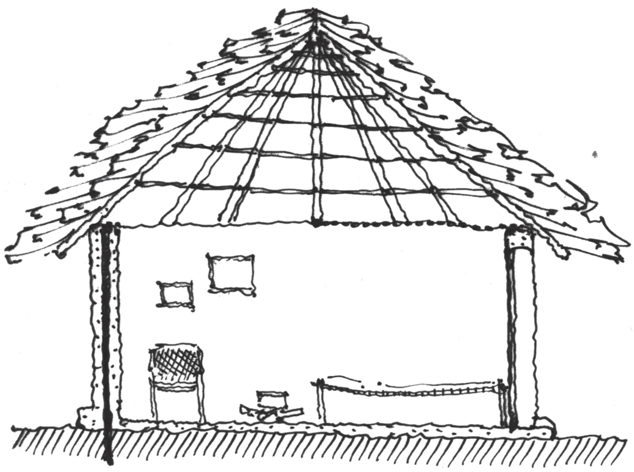


Fig. 1.21: Sketch of section through traditional round straw hut

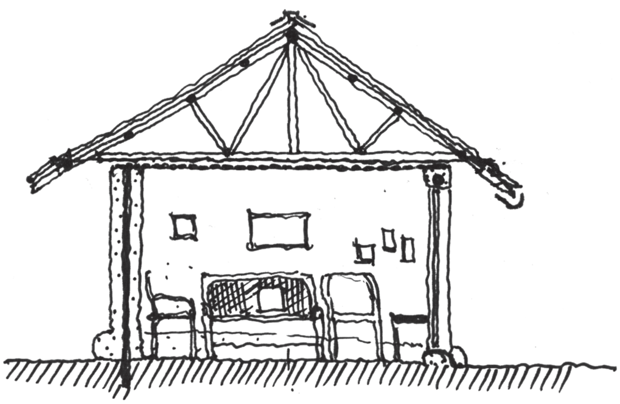
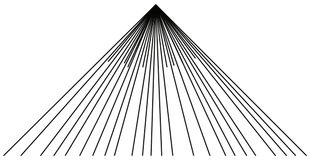


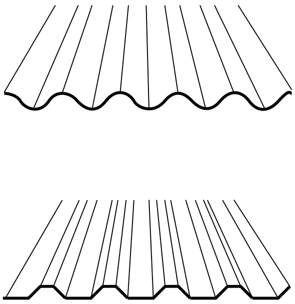
Fig. 1.22: Sketch of section through traditional raditional rectangular hut

LOCAL CONSTRUCTION: ROOF

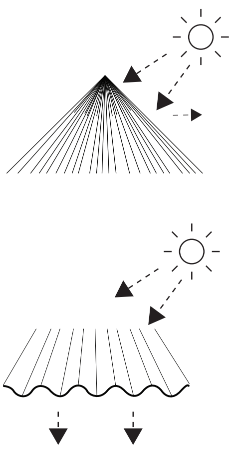
Roofing: straw



Roofing:
corrugated iron sheets



Solar radiation



The two sections show that the principle for the roof construction varies between the round and rectangular huts. Families who build their homes themselves mostly use a lattice girder for the rectangular huts and a tent-shaped roof construction for the round huts, both made of eucalyptus poles 5-7 cm in diameter. Thinner and shorter eucalyptus branches are used as secondary construction layer on top.
This layer is used as the basis for the roofing material. There is again two different ways of how the last layer is executed in practice. The first is straw put in packages of several layers on top of the secondary construction overlapping one another to prevent water from entering and held together with ropes. The second option is corrugated iron sheets fixed to the secondary construction with the help of screws. These two roof versions have benefits and disadadvantages for the comfort inside the huts.

Placing the straw packages on the round huts is quite time-consuming as they have to overlap each other resulting in a thick roof layer of 30-40 cm. Although water is not entering the interior, the straw packages absorb quite some water which encourages the growth of micro-organisms in the straw. Therefore the roofs have to be replaced every two years resulting in a high level of maintenance.
However straw roofs have a huge advantage in terms of their thermal properties. They protect the inside from heat thanks to their mass and reduce the noise level traced to the heavy rains.

This advantage in turn represents a definite disadvantage of the corrugated iron sheets: Without any layer of insulation between construction, secondary construction and iron

LOCAL CONSTRUCTION: ROOF

sheets, the radiation heat from the sun accumulates underneath the roof resulting in an unbearable thermal condition during the day and at night. Moreover, this roof version makes it impossible to communicate properly during heavy rains as the iron sheets even increase the noise level.
Nonetheless, lots of local families prefer using iron sheets as roofing material thanks to their water resistance, little time needed for installation, their low level of maintainance and last but not least the modern and western character they reflect.

To help themselves regarding the thermal comfort inside, the local community has developed several strategies: One structural measure is to lift the roof around 20 cm above the walls and therewith improve the ventilation inside to prevent overheating of the huts. As a result, however, animals such as bats, birds or insects can enter the hut easily, in turn posing a health risk to the inhabitants due to their excrements.
As this strategy is not able to solve all problems, what the people did is to install a thin layer of papyrus mats on the height of the walls. At least this keeps the birds, bats and insects in the space underneath the roof and out of the living and sleeping areas of the family.

Having a look at the ability of the roofs to collect rainwater, vernacular architecture often features rain gutters attached to the eaves of the huts. The corrugated iron sheets quickly lead the water towards a storing system. However, in the case of the round straw huts, the form makes it impossible to install a well-functioning rain gutter on the eaves and the water quality suffers from the bacteria on the surface of the straw.

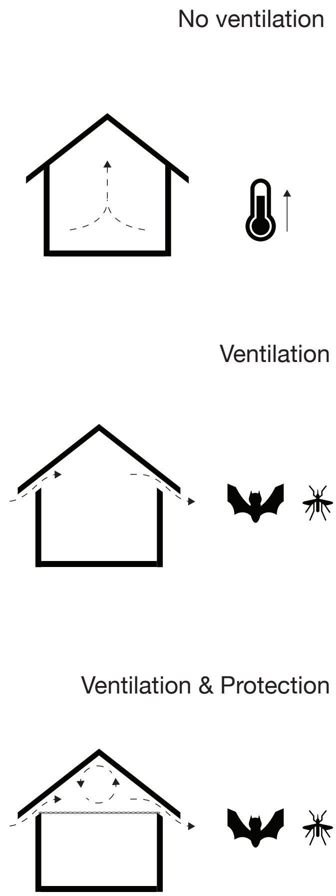


Fig. 1.23: Diagrams showing the problems of different roofs and construction principles

LOCAL MATERIALS: EUCALYPTUS

The locally growing eucalyptus is used for the construction of almost every building in the rural areas, be it for walls or for the roof structure. People have even started growing eucalyptus in their backyards to use it for construction or sell it. For a moment this might seem reasonnable as it is locally produced and a fast-growing wood, though considering the long-term impact of using eucalyptus as constructon material is not a sustainable solution for several reasons.

Fig. 1.24: Photo documentation of local eucalyptus tree

Eucalyptus demonstrably harms the soil around as it consumes a high demand of water and exhausts the humidity destabilizing the hydrologic cycle. Moreover it absorbs a vast amount of nutrients generating a great deficit for other plants around. For species of the local fauna planting eucalyptus is desert nourishing and the reason by which those tend to dissapear.
Used as structural component in walls, eucalyptus poles expand and shrink due to changing levels of humidity. This has severe impacts on the different layers of adobe put in between the poles and on top of the horizontal eucalyptus branches. After just one to two months the walls display the first cracks, water is entering and even worsens the structure of the inner layers.

In the case of eucalyptus, the research comes to the conclusion that eucalyptus is not sustainable the way it is used. It should therefore not be considered as an appropriate construction material and its cultivation not be promoted as it harms the natural soil and flora and fauna around. Subsequent to these findings, the thoughts about solutions address the search for alternative construction materials which are locally available, sustainable and accepted wihtin the community.

B RESEARCH I

LOCAL MATERIALS & SUSTAINABLE CYCLES

Generally speaking, the use of materials often goes hand in hand with familiar construction principles. Both understandably depend on the availability and suitability of local materials for the execution of structural components. However, as shown with the previous analysis of problems, some of the local materials should be modified or replaced in terms of sustainable aspects.

The chance of this research part is to **come up with alternatives to improve the characteristics of materials used** in order to increase their environmental footprint as well as their esteem as construction material. The goal is to make the local community aware of sustainable solutions and the potentials of local materials although they are taken from the place itself and were not imported from outside.
In the end it will be of the utmost importance that the suggestions made are understood and convince the people to ensure their continuation in the future. Only then, the idea to encourage sustainable cycles can be implemented in the long run.

One of the first observations made during the field trip refers to the fact that for the construction of buildings people take what nature offers in the close vicinity. This implies that other factors miss out sometimes.
To take the example of the soil, it is used well-compacted as flooring for its thermal benefits and easy availability, yet without a water resistant layer to protect the inside from rising moisture. The people use it as it is cheaper than concrete, nevertheless they would always prefer to use concrete as a modern building material.

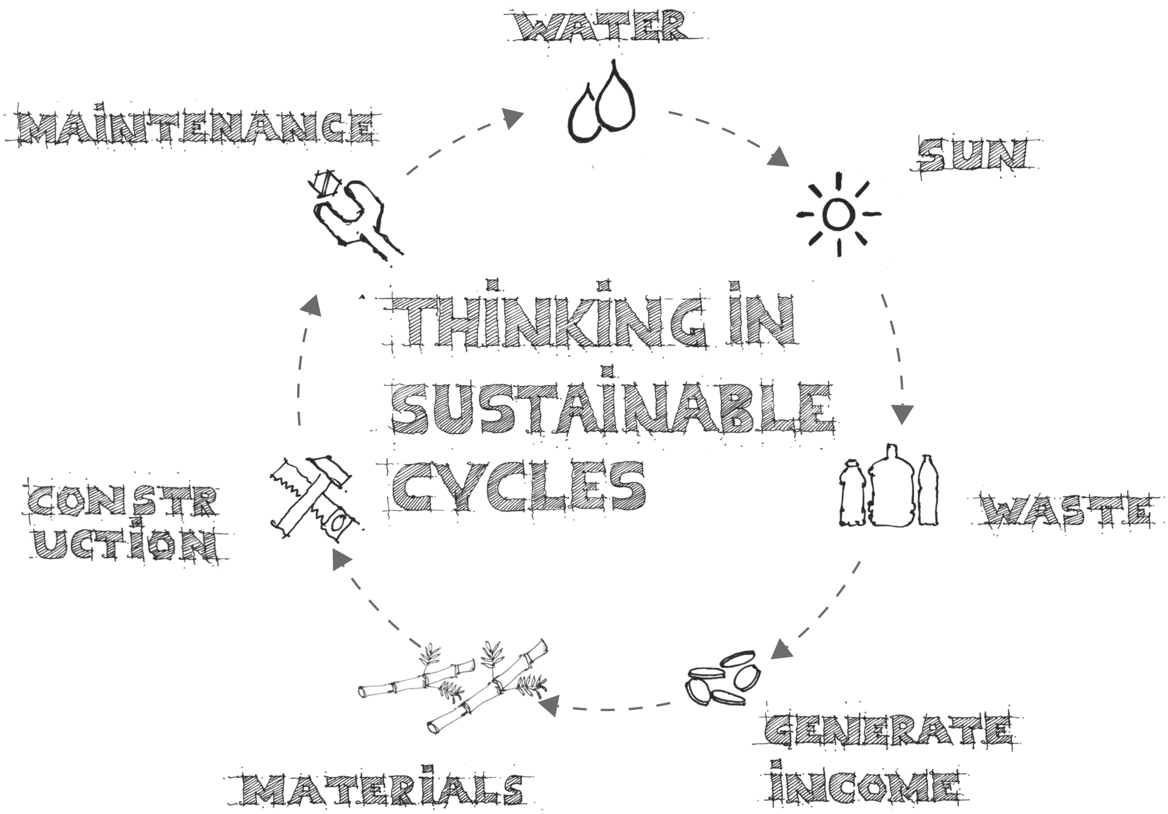


Fig. 1.25: Drawing of elements forming part of the Sustainable Cycles

The approach to Think in Sustainable Cycles has proved to be helpful in thinking comprehensively in many directions attached to the research. It helps to maintain an overview on other aspects like the ability to generate income, minimum waste production or applicability in construction processes to consider everything to be part of a cycle.

In particular, examining which materials and why they qualify for the different structural components and the tropical rainforest climate zones is a crucial aspect.

B RESEARCH I

BAMBOO AS INNOVATIVE MATERIAL FOR LVR

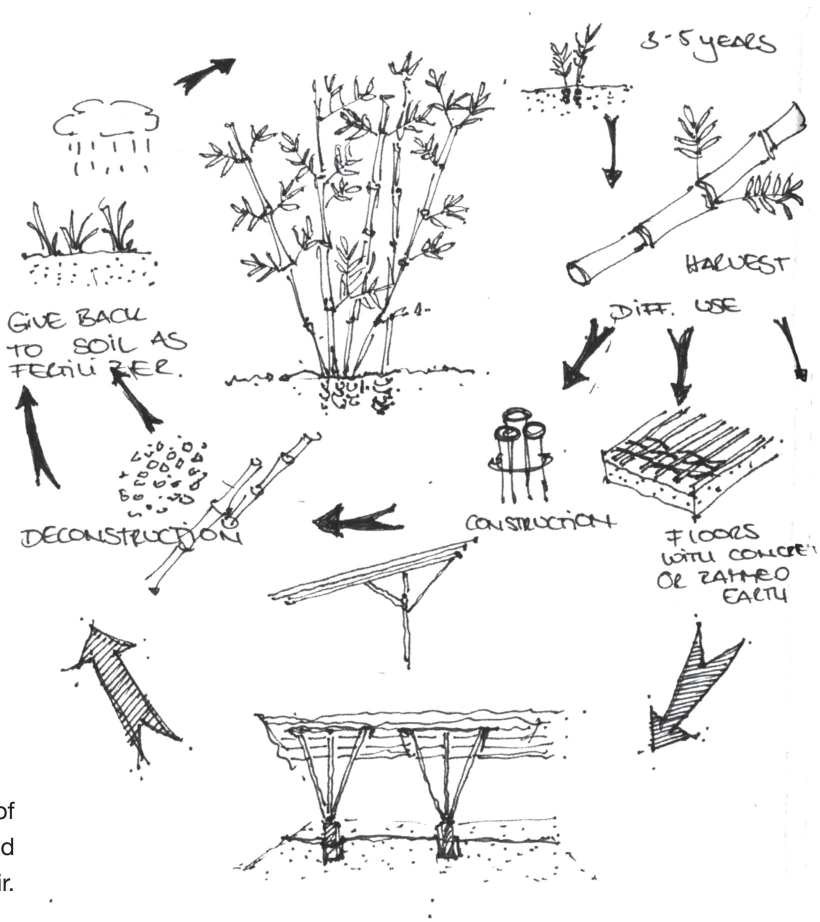
Wide strong root system - prevents erosion of the ground.

Lightweight construction material.

Releases 30% more oxygen into the atmosphere, absorbs more carbon dioxide than other plants.

Low cost of maintainance.

High capacity to store water - preserves



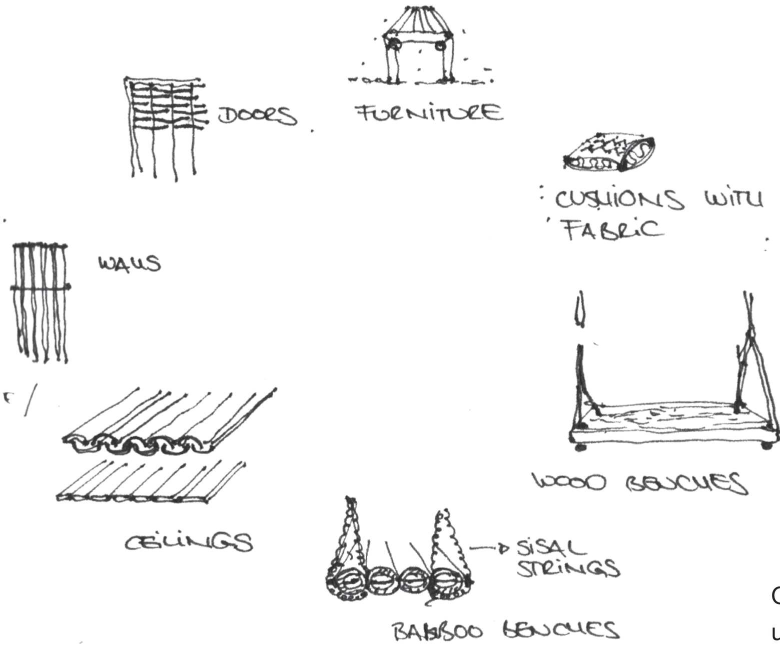
Decreases amount of greenhouse gases and cleans the air.

Ideal material for seismic-resistant constructions.

Stronger than steel in tension, more resistant than concrete in compression.

Preserves tropical rain forests - solving soil erosion & deforestation.

No need of fertilizers. Discarded leaves provide all nutrients when decomposing.



Easy to cut, handle, care, reposition, maintain.

Reaches maturity after only three to five years.

One bamboo pole can be used for many purposes - from construction to doors, floors, furniture.

The fastest growing plant.

Highest biomass productivity of all land plants.

Fig. 1.26: Diagrams showing the problems of different roofs and construction principles

B RESEARCH I

BAMBOO AS INNOVATIVE MATERIAL FOR LVR

The remoted rural areas in the Lake Victoria Region often lack regular water and energy supply. Together with the self-imposed requirement to focus on sustainable and locally available alternatives as construction materials, it is pointless to fall back on western materials like concrete or steel which are in need of machine-intensive processing on site. The search for alternative construction materials and principles therefore concentrates on natural and sustainable resources that are less time- and energy-consuming - such as bamboo.

Fig. 1.27: Sketch of local bamboo

The following research part is not supposed to go into depth of mechanical properties, characteristics or ways of cultivation, treatment and construction with bamboo. Abundant sources in literature and experts in the field like Simon Vélez, Jörg Stamm, Jules Janssen or Johan van Lengen have already been dealing with these specifics.
Instead, this part focuses on identifying the reasons **why bamboo depicts an alternative construction material to replace the common eucalyptus poles** used for construction in the Lake Victoria Region. Moreover, it elaborates positives long-term impacts the cultivation of bamboo can have on the socio-economic well-being of the Victoria Lake Region as a whole and even beyond.

Whereas different kinds of wood have a hard time to surprise architects, civil engineers or constructors in the Western World as everyone in the field is familiar with their mechanical properties, bamboo still does - especially the ones who never got in touch with it as construction material.

Bamboo is an astonishing, versatile raw material. Figure 1.26 names and illustrates some of the most striking advantages bamboo has - implemented in whatever form. Next to all the positive properties such as growing rapidly and being a sustainable, natural and endless resource, bamboo is foremost appreciated by architects and constructors in the Asian world for its tensile strength comparable to steel and its compressive strength even higher than concrete while being pretty lightweight.

Bamboo continues to gain recognition on the African continent as a whole and even in the Western World, but particularly poorer or isolated regions where steel and concrete are not affordable or applicable could benefit from using it.

The reason behind this is the slowly increasing awareness that forests are important for „economic development, environmental services, social and cultural values" (KEFRI, 2007). Due to rising numbers of human population and unsustainable forestry, a lot of forest area had been destroyed within the last decades ending in a widening gap between supply and demand of raw materials. Moreover, clearing woodlands for cash crops in agriculture represents another major cause for environmental degradation. (KEFRI, 2007)

Though, there are organizations such as the Kenyan Forestry Research Insitute (KEFRI) that are actively promoting, supporting and enhancing the protection of the local forests and a sustainable use of its products. Against this background, it seems even more reasonnable to think of introducing bamboo as construction material in the rural areas of Lake Victoria Region and increase its appreciation amongst the society.

B RESEARCH I

BAMBOO AS INNOVATIVE MATERIAL FOR LVR

As shown in the analysis of the *Local Construction Principles,* the community members mainly use eucalyptus for the construction of their buildings although it harms the environment. Introducing the use of the versatile bamboo in the Lake Victoria Region instead is an alternative thanks to following benefits:

> Bamboo grows rapidly within three to five years and represents an endless source of raw material.
>
> Bamboo helps to preserve the natural tropical rainforests as it solves soil erosion (extensive root system), deforestation and water scarcity (high water storing capacity).
>
> Bamboo neither needs a lot of maintenance nor any fertilizers provided that there is a certain amount of precipitation. Discarded leaves will nourish the plant itself.
>
> Bamboo is a versatile raw material that can be used 100% without producing any waste. Even the smallest parts can be used for making furniture or other interiors and encourage income generation.

Despite the forest degradation within the last decades, the tropical rainforests in Kenya, Tanzania and Uganda shown in Figure 1.28 still provide optimal climate conditions for the cultivation of bamboo. By recognizing the potentials and benefits of the bamboo, its appreciation could be raised and have in turn positive impacts on the preservation of bamboo forests.

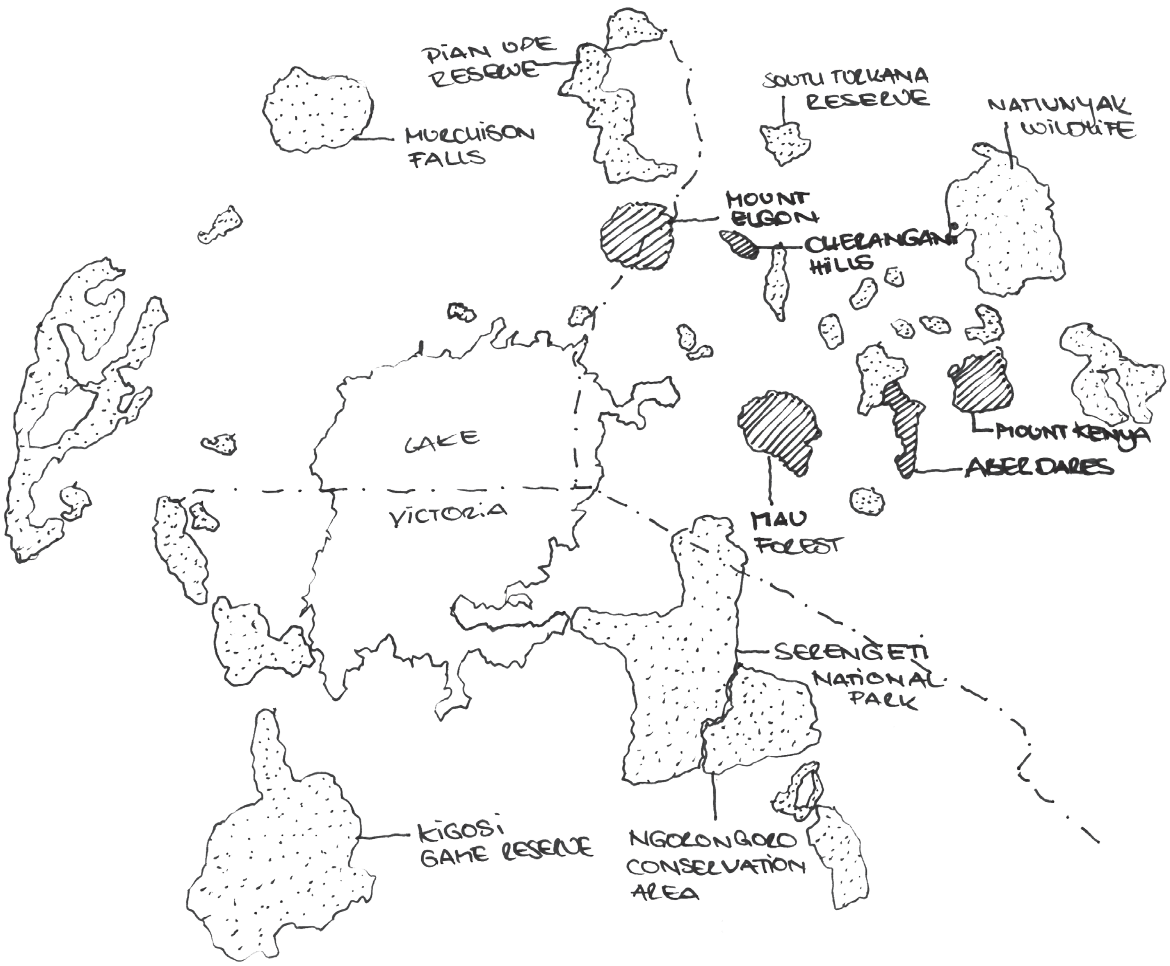


Fig. 1.28: Sketch showing rainforests with indigenous bamboo plantations

B RESEARCH I

SUMMARY OF FINDINGS

To summarise the findings, it seems reasonnable to look back at the research question formulated in the beginning of the paper and the subquestions which have been raised to find answers to the introductory question. The findings will be discussed and contrasted in this chapter with the objective to end with valuable strategies in terms of their future application in architecture.

How do structural components of buildings have to perform in the future in order to qualify for rural areas around Lake Victoria?

Subquestions:

1. Which climate parameters influence the performance of the structural components and in what ways?
   - Which strategies for architecture can be derived from the climate parameters?

2. What are the problems & potentials of structural components found in vernacular architecture of the Lake Victoria Region?
   - Why does the roof have a special standing?
   - What are the problems vernacular roofs face?

3. Does bamboo depict an alternative material to help improve problems linked to structural components and why?
   - What are the benefits from using bamboo as construction material for the LVR?

SUMMARY OF FINDINGS

The first research part concentrates on finding out **which specific climate parameters influence the performance of the buildings in the tropical rainforest climate zone and which building strategies can be derived from them**.

This zone is characterized by an equatorial, fully humid climate with a mean temperature of at least 18°C and precipitation rates that never drop below 60mm per month (Köppen, 2006: 259-263). Temperatures mainly stay between 17°C and 31°C year-round. Consequently, buildings do not have to provide a thermal insulation layer, though high temperatures require walls with a thermal mass able to regulate the interior temperature when needed.
The most rain falls from March to May the while as much water as possible should be stored for drier periods following this season. The function of the roof as a source to harvest rain water explains its outstanding role for tropical climate zones.

The intensively shining sun is omnipresent the whole year round which means that protection from it as well as exploitation of its potentials are needed. With reference to Dirk Althaus, Africa should try to benefit from its postfossil resource to the fullest for being favourably located at the equator. In consequence of the prevailing high air humidity the whole year round, walls with the ability to absorb moisture and regulate the climate inside become a decisive factor for the thermal comfort. While the risk of storms can be neglected in the Lake Victoria Region, floods occuring in the Kano Plane and seismic activities evolving occasionally from the Rift Valley should be seriously taken into account.

B RESEARCH I

CLIMATE STRATEGIES FOR LAKE VICTORIA REGION

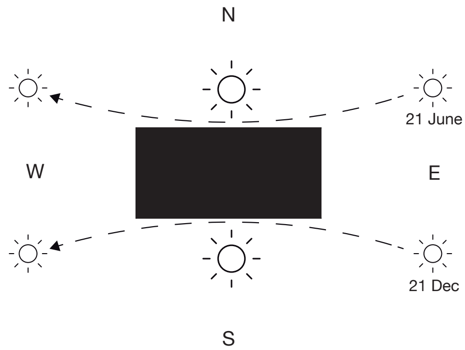
When designing for Lake Victoria Region, architects should bear in mind that the climate parameters influence the location, orientation, form and structure of a building to a high degree. The findings from the second research part provide insights **which problems and potentials occur in vernacular architecture of the Lake Victoria Region**.
Subsequently, the **following strategies have been derived from the findings and translated into simple architectural diagrams.**

Starting with the orientation of the volume, the research demonstrates that the most intense sun shines at 12:00 pm at a high angle of maximum 65°. The first diagram therefore suggests that the shorter sides of buildings should face east and west to prevent too much direct sunlight, while the sole presence of a roof provides optimal shade at noon.

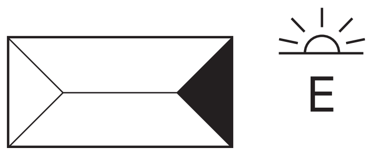
Placing solar panels on slightly sloped roofs facing east makes them most efficient without too much interference of clouds or mist.

With the help of these insights, verandas and backyards should be oriented accordingly. For verandas, the direction and speed of the wind also play a decisive role.

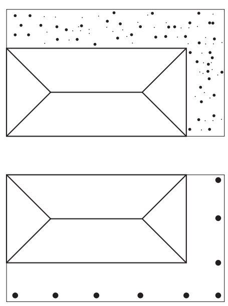
Orientation of volume



Solar radiation:
Solar Panels

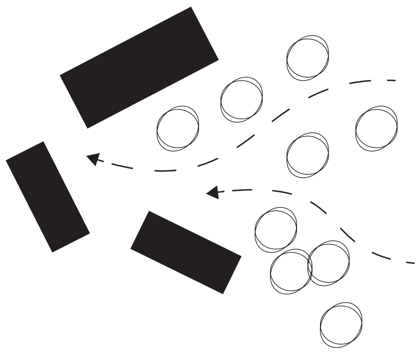


Orientation:
verandas & backyards

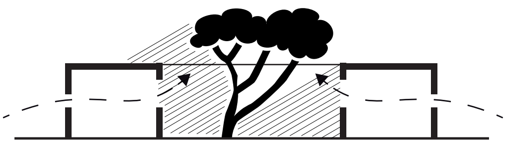


CLIMATE STRATEGIES FOR LAKE VICTORIA REGION

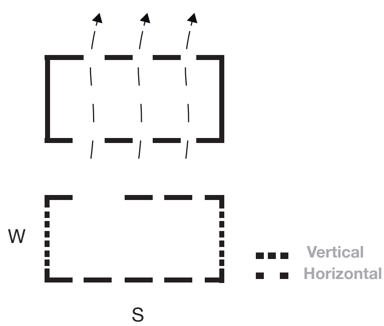
Composition environment:
ventilation funnel breeze



Ventilation:
Inner Courtyards



Ventilation: Cross-Ventilation
through perforation



Regarding the relation between the overall composition and ventilation, research has shown that the main wind direction is south west and placing individual components such as buildings or trees most favourably can increase the ventilation funnel breeze. The diagram for the composition of the environment in relation to the main wind direction illustrates this effect.

As shown in the diagram on the left, inner courtyards that are cooled down with the help of trees - evaporating through the solar heat - are able to stimulate natural ventilation of the interiors thanks to the natural pursuit to compensate different temperatures.

Concerning additional cross-ventilation of interiors, openings should be placed facing the main wind direction and on the opposite site to lead used air out of the rooms. To increase the ventilation, vertical openings are ideally placed to the west, horizontal openings to the south. This assumption can be traced back to the sun path. Slit windows reach most efficiency while placed south or west.

The fact that animals such as bats, birds or insects are likely to enter the interiors has to be taken into account and leads to the suggestion to place thin, aluminium gratings in the openings to prevent them from nesting.

B RESEARCH I

CLIMATE STRATEGIES FOR LAKE VICTORIA REGION

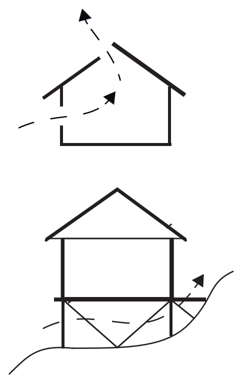
High ceilings or attics opened up and walls with low openings contribute to an increased natural ventilation - the so-called stack effect. Inside temperatures can additionally be regulated by raising the floors.
This in turn has positive impacts on the resistance to flooding and an occuring high humidity level of the floor.

Due to intense solar radiation, most houses display only few and small openings providing cooler, but dark and humid interiors. This is solved by an adequate ventilation system of openings efficiently placed to the right direction and walls with a thermal mass.

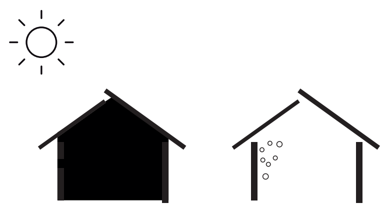
The roof as an important structural component in the tropics, provides the urgently needed shadow on the facade and the spaces inside. Its effects are greatest while executed east or west where the sun shines at a low angle.

With regard to the materials used for roofing, thatched roofs have the characteristic to insulate the interior well against noise or heat. Corrugated iron sheets in turn, have a low thermal capacity, accumulate hot air and during heavy rains, the noise exposure is too high. Consequently, the stragegy for roofing incorporates a combination of a light, noise-insulating layer underneath a water-resistant, light and bright roof surface.

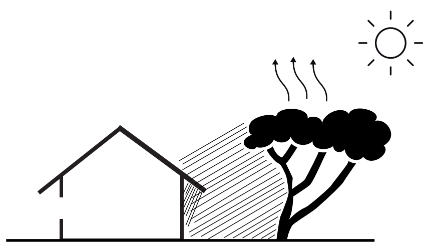
Ventilation / Risk of floods



Thermal comfort inside:
Enlight rooms, prevent humidity



Shadow through roof
overhangs & acacia trees



CONCLUSIONS

Fig. 1.29: Series of analytical drawings showing strategies to react on the tropical climate zone

Within the scope of the second subquestion, **problems and potentials found in relation to structural components in vernacular architecture** are identified with a special focus on the roof.
The roof holds an important position amongst all structural components for its decisive ability to react on the prevailing climate influences. On the one hand, it offers protection from the rain, the sun and the heat for the users. On the other hand, it proofs to have the potential to act as an extremely versatile structural component making maximum use of the tropical climate parameters by being shaped and sloped adequately to catch water and sun.
All findings linked to the subquestion have been incorporated into the previous results of CLIMATE STRATEGIES FOR LAKE VICTORIA REGION. Therewith, recommendations are formulated for the practical improvement of the material characteristics and construction principles.

Having a look at the subquestion **what are the benefits from using bamboo as construction material for the Lake Victoria Region?** leads to the last part of the reserach.

According to the findings, cultivating bamboo and promoting its use not only as construction material but for other architecture related purposes, definitely makes sense. The reasons behind are multilayered and touch both the constructional and the socio-cultural side. To take but one example, the map in figure 1.28 shows all rainforests in the region with natural plantations of the indigenous species of bamboo. The bamboo populations have diminished extensively throughout the last years as economy has not realized yet which potential bamboo disposes of.

B RESEARCH I

CONCLUSIONS

By increasing its overall appreciation, bamboo could preserve the last tree populations which are unsustainably cleared at the moment.

Research results show that as a matter of fact, the rural areas around Lake Victoria have a suitable climate to grow bamboo - no matter if in big plantations in the wetlands that naturally surround many villages or in small amounts in individual backyards.
Cultivating bamboo empowers the community members to use bamboo themselves, sell it as seedlings or raw material and even processed in the form of furniture, doors, ceilings to generate their own income.
This is a chance to decrease the people‘s dependency on the less competitive cash crops like rice or corn. As bamboo improves the soil nutrient cycle, other plants around would benefit from its cultivation. Kenyan horticultural products such as beans, avocados, mangoes or passion fruit have become popular within the last years. A great potential to diversify those export products is connected indirectly with the cultivation of bamboo.

While some rules for constructing with bamboo have to be respected, it opens up new chances to enhance the socio-economic development of the whole region and even beyond if exports are included. Fostering the use of the multipurpose bamboo in its whole variety of forms - from construction to decoration - could grant it a higher status within society and turn into a valuable timber subsitute in the future.

CONCLUSIONS

In order to finally state how buildings have to perform in rural areas in the tropical rainforest climate zone in East-Africa, the problems of their individual structural components must be clarified.

Firstly, the research has shown that the use of unsustainable materials for construction continues without reflection. Architecture has to react on this development by showing new ways of designing buildings which are sustainable for society on a whole even beyond the own building.

Secondly, one can observe a tendency among the local communities to preferably use materials with a *western* character like steel or concrete, although they are often inapproriate and to use local materials would be more suitable for the respective context instead. Buildings which incorporate the unknown versatile possibilities of local materials such as adobe on purpose can help to change the people‘s mindset by exhibiting its possibilities in practice.

Thirdly, climate parameters are insufficiently incorporated into many components in local architecture, be it due to the missing knowledge or means for implementation. Understanding the specific climate first is therefore an indispensable prerequisite. Besides, an in-depth knowledge about local construction and the materials used is important to recognize problems. However, merely taking in account some simple construction principles derived from these insights improves local architecture significantly and therewith the daily lives of the community members using the buildings.
In the case of the Lake Victoria Region, it is just some links which have to be established to tap unused potentials.

B RESEARCH I

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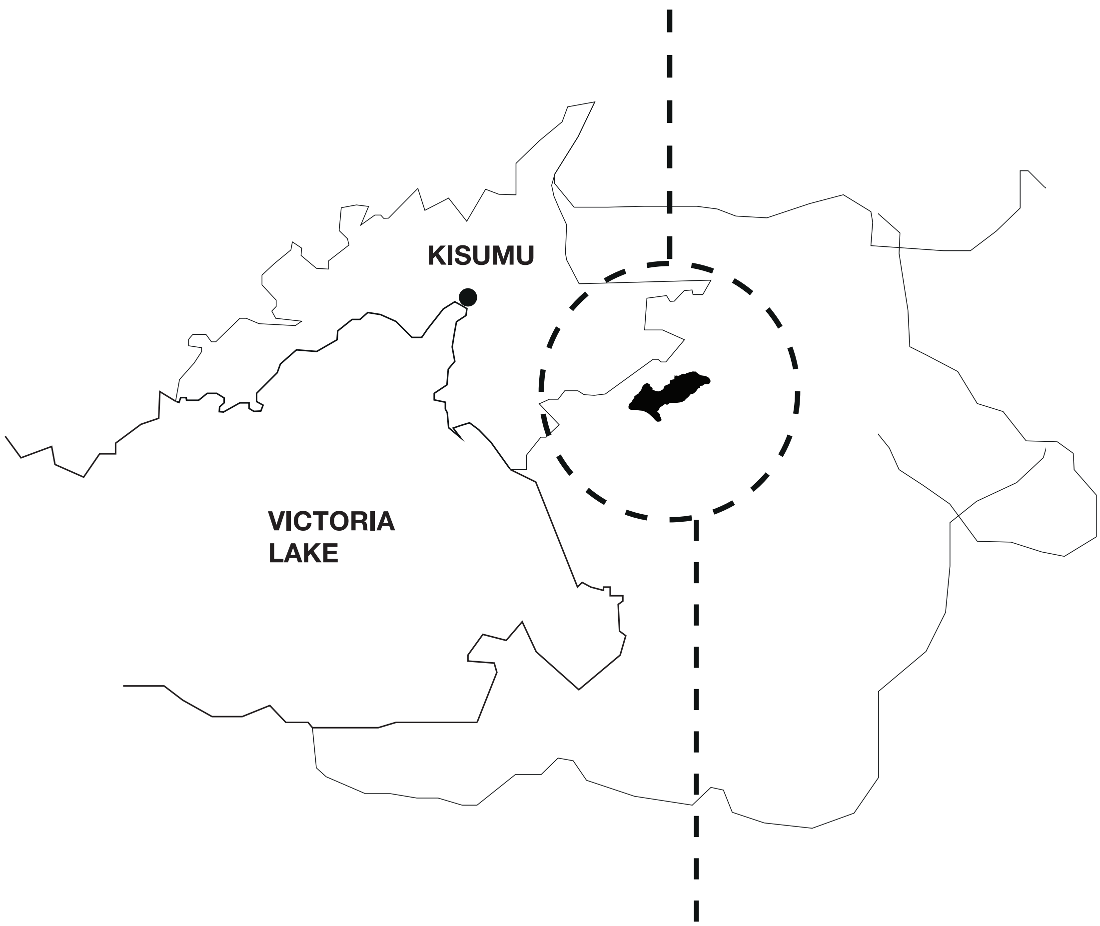
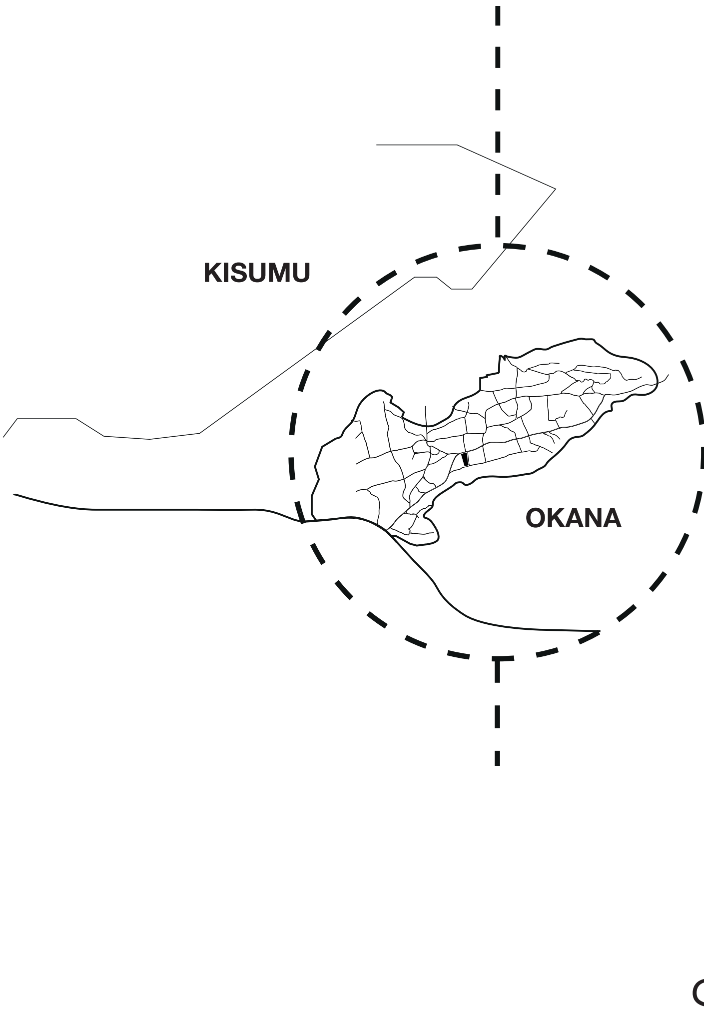
LIST OF FIGURES



SCALE 5:

OKANA & SURROUNDING



SCALE 6:
OKANA

B OKANA

SWOT ANALYSIS

Okana is a small rural village located 12km west of the third largest city in Kenya, Kisumu. The village inhabits approximately 5000 people, from which the majority belong to the Luo tribe and live along the Luo traditions.

Most of the people speak Kiswahili and Dholuo, the local language, and primarily the youth and higher educated people have the skills to communicate in English.

SWOT ANALYSIS

The SWOT analysis highlights many aspects dealing with youth, future changes and poverty.

Like in most rural villages in the surrounding the poverty and unemployment rate are high.

The main economic activity of the people is agriculture. People cultivate mainly crops that can be harvested often as maize, rice, millet, sugarcane and vegetables and keep if they can afford it cows, chickens, sheep or goats. During the dry season, problems arise after a few months of drought, when the vegetable harvest fails and the food supply in the entire areas is less.

B OKANA

SWOT ANALYSIS

Most people are self-supplying and cultivate similar crops, a poor harvest affects the whole community and results in a shortage of products and famine.
Water is a major problem in the region. The area, called Kano plains leads from the higher hills to Lake Victoria. The region known for the wetlands is often flooded during rainy season, in strong contrast with the dry season when water is scarce.

In Okana the number of youth is high, 40% of the inhabitants are younger than 20 years. Though education levels are still low, the number of children attending primary and high school increased enormously over the past years, especially the number of girls. From the first years on, schools teach English. The challenge is to encourage parents the importance of education for their child.
'Each child represents a future, the future of the community, the country, and indeed the future of the whole world.' (Jowi Otieno, Interview 12 May 2015)
The wish for change in education is visible and the government works on the installation of utilities and services at schools. The village deals with a lack of services, facilities and utilities are underdeveloped in the village. The mud houses, often in a poor condition are not connected to the sewage, drainage and electricity system, resulting in low security at night on the streets.

Many inhabitants deal with health issues. Due to the floods it is a malaria prone area and HIV/AIDS has affected many people. Lack of protection, knowledge, facilities and poverty are the reason that these circumstances do not improve.

OKANA

SWOT ANALYSIS

Although Okana is a rural village surrounded by wetlands, the proximity of the town Ahero and city Kisumu have a positive influence, while it offers facilities, products and job opportunities.

RESEARCH II

How does the cultural pattern of the Luo influence the built environment and daily life of the people in the rural village of Okana?

B RESEARCH II

CULTURAL PATTERNS

Traditions and culture have a strong influence on the traditional and present built environment and cannot be seen separately from the wider pattern of human social behaviour, traditions and history. To design a building in a new context, knowledge of the built environment, housing patterns and local people is needed as a basis to preserve qualities and to react on local circumstances.
Every place is dealing with uniqueness, recognisability, individuality and the identity of the place itself. Given the fact that the design will be feasible for the context of Okana, this leads to the following research question:

How does the cultural pattern of the Luo influence the built environment and daily life of the people in Okana?

Luo is an African ethnic group inhabiting areas of western Kenya, Sudan, Ethiopia, Uganda and Tanzania. It is the third largest ethnic group in Kenya with 13% of the entire population and constitutes the majority of inhabitants in the area around Kisumu. The Luo arrived in Kenya around five hundred years ago and built their settlements around the Victoria Lake where fishing and farming were the main livelihoods. The Luo culture includes many habits and behavioural rules, which are the standards and ideas they have in common. It is a way of life that makes them and generations identical and recognizable.
The cultural pattern of the Luo can be seen as everything that connects the members of the community, refines and represents them. Cultural patterns can ‘affect the spatial arrangements, form, plan and orientation’ of the built environment (Rapoporto, 1969: 84). The goal is to find out what these cultural patterns, developed through a society’s

CULTURAL PATTERNS

perception, consist of and how the people give meaning to their created places.

Okana is a small village in the rural areas twenty kilometres eastwards of Kisumu. The majority of the inhabitants in Okana and its surroundings belong to the Luo tribe.

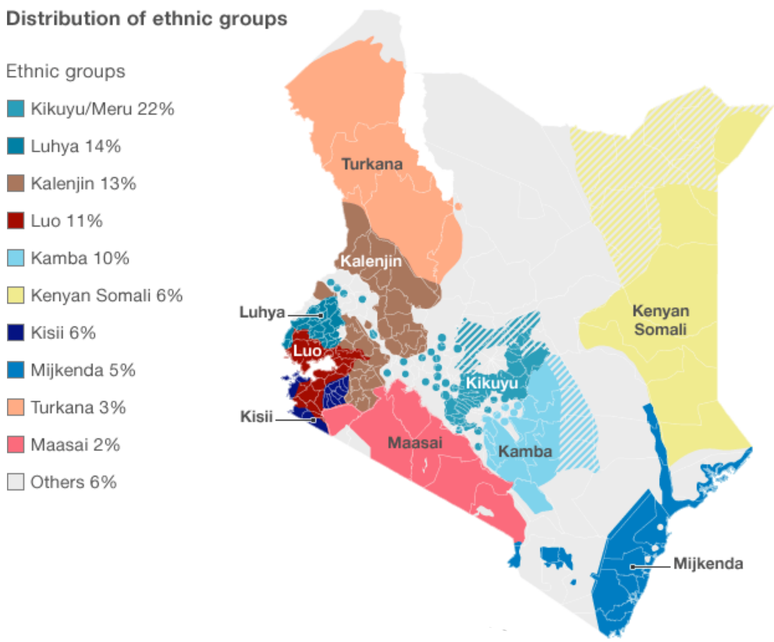
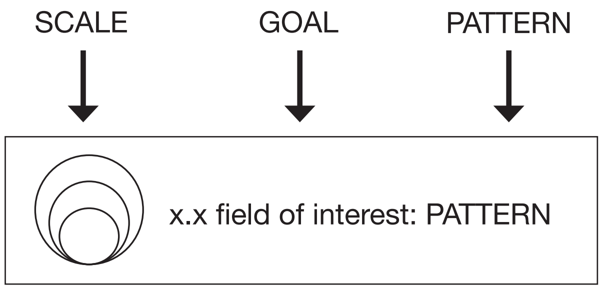


Fig. 2.1: Diagram of distribution of ethnic groups (http://www.knbs.or.ke, Kenya National Bureau of Statistics: retrieved: 1 May 2015)

B RESEARCH II

CULTURAL PATTERNS

By decomposing the context into different patterns, the goal is not to reduce the cohesion and complexity of the context but to give a clear overview, explanation and focus of the different topics that can serve as guidelines in further design steps. The following three scale levels: village / home / people are introduced to understand the separate layers, which are linked to fields of interest and subdivided into different cultural patterns.
The coding system on every page shows the pattern in relation to the scale and field of interest.



VILLAGE
- 1.1 Context
- 1.2 Built structure
- 1.3 Gathering places

HOME
- 2.1 Typical Luo home
- 2.2 Activities

PEOPLE
- 3.1 Okana
- 3.2 Community life

The next pages give an overview of patterns related to scale that will be explained further into detail with the use of descriptions, photographs and sketches.

CULTURAL PATTERNS

Fig. 2.2: Wetlands

Fig. 2.5: Network of roads

Fig. 2.8: Building type: Shops

Fig. 2.3: Waterways

Fig. 2.6: Frequency of movement

Fig. 2.9: Building type: Shools

Fig. 2.4: Vegetation

Fig. 2.7: Building type: Private house

Fig. 2.10: Selling points

B RESEARCH II

CULTURAL PATTERNS


Fig. 2.11: Served - servant spaces


Fig. 2.12: Valuable asset


Fig. 2.13: Activity hotspots


Fig. 2.14: Gathering places


Fig. 2.15: Self-supllying


Fig. 2.16: Gathering places


Fig. 2.17: Gathering places


Fig. 2.18: Community members


Fig. 2.19: Community members

VILLAGE

Okana is a small village, located in the rural areas of Western Kenya and twelve kilometres east of the city Kisumu, consists of approximately 5000 inhabitants. Okana is located within the Kano plains, a swampy area well known for its annual floods. The geographical feature of Okana is perfectly suited for a settlement, located on higher soil than the surrounding wetlands. Wetlands have great potential for multiple uses; agricultural purposes, grazing areas and an important sources of water.

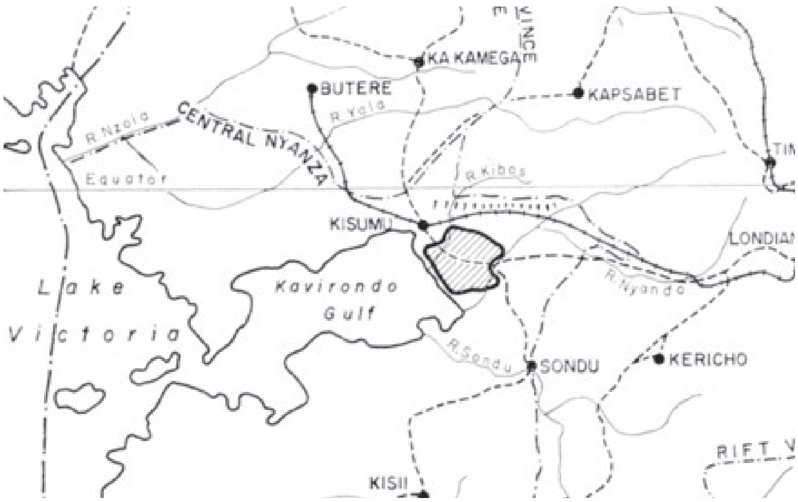


Fig. 2.20: Map showing Kano Plains in their regional (Millman, 1973; 182)

The choice to research this specific location derived from collaboration with ‘Sustainable Rural Initiatives’ (SRI), an NGO that operates in Western Kenya with the aim to improve the quality of life for rural communities. SRI is located in the heart of Okana and landowner of a 5-acre plot along the main road. Patterns related to context, the built structure and gathering places will be analysed and explained on the following pages.

VILLAGE

VILLAGE

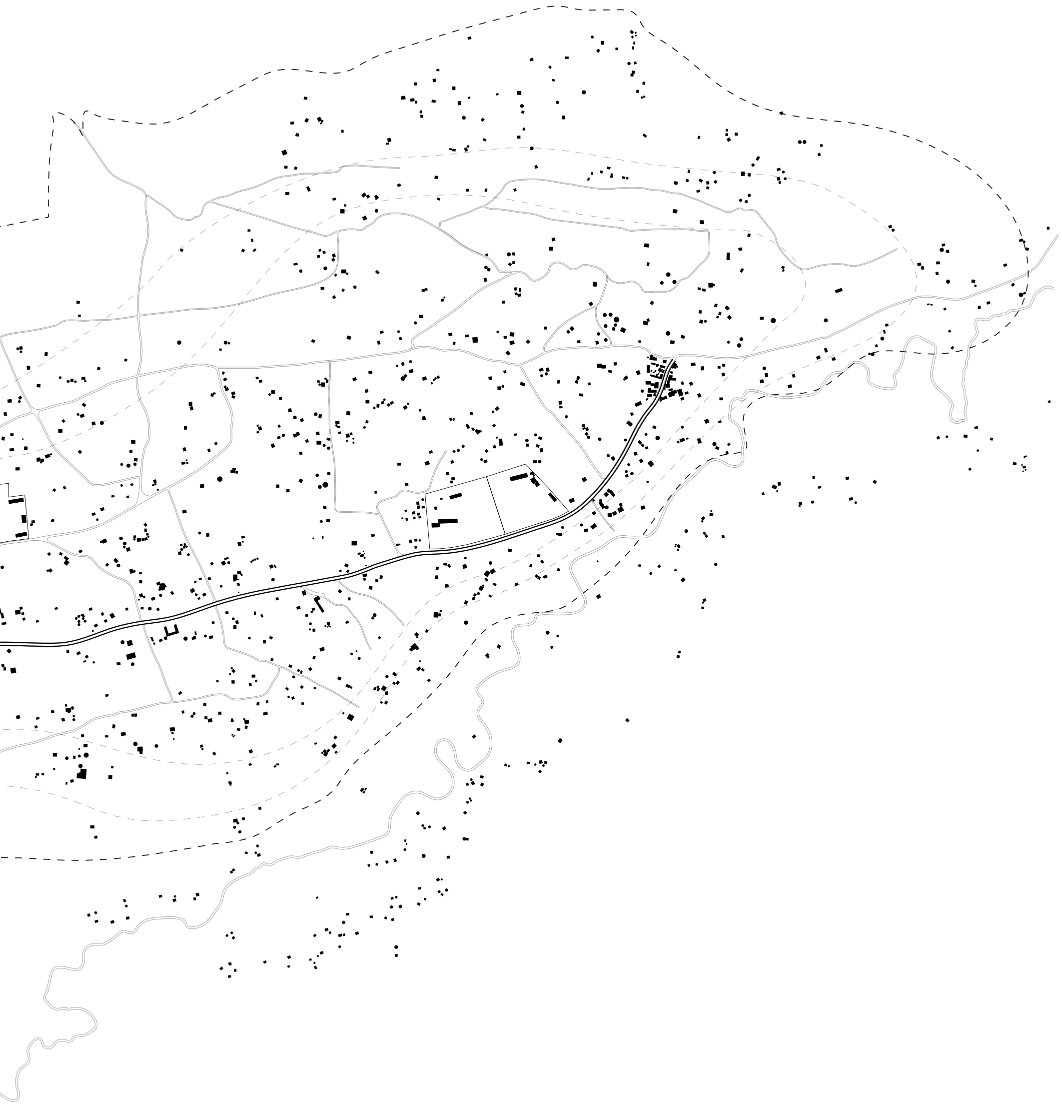


Fig. 2.21: Map of Okana village

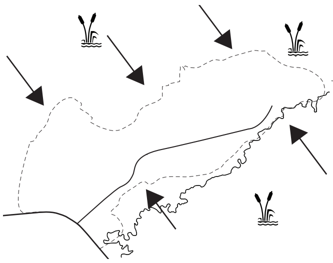
B RESEARCH II

VILLAGE

1.1 Context: Height lines

Okana is located close to Lake Victoria within the Kano plains, a swampy area with fertile ground and is well known for its annual foods. Okana's position is slightly higher than the wetlands, which define the natural borders of the village.

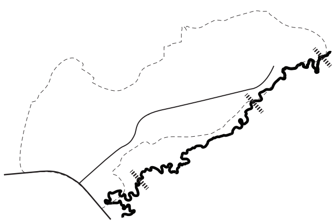
Fig. 2.22: Fertile wetlands
Fig. 2.23: Child, collecting water in the wetlands
Fig. 2.24: Diagram of Okana surrounded by wetlands



1.1 Context: Waterways

The river Nyando starts in the hills, further inland, and passes along Okana. During dry season there is practically no water in the river, while in rainy season the high amount of water results in floods. Last year a system of dykes has been developed to protect Okana for flooding, but at the same time it has a negative impact on the agriculture in the wetlands, where the land is a lot dryer than usual.

Fig. 2.25: Overflowing Nyando river during rainy season
Fig. 2.26: Geographical location of the Nyando river



VILLAGE

1.1 Context: VEGETATION

The vegetation suitable for this area has to deal with extreme dry and extreme wet periods. Depending on the time of year the area looks fertile or arid, except from the swampy area around the village.

Trees - Every home has a shadow tree, to have a protected place against the weather conditions. The Acacia tree is a very common specie.

Eucalyptus - People plant red and white eucalyptus trees in their garden to use the wood as construction material for new houses. Eucalyptus trees provide little shadow and have the negative characteristic that they extract a lot of water from the soil which makes it impossible for other vegetation to grow around.

Achak - The most seen vegetation in the village is the a-chak (Fig. 2.27), a straw that can reach a height of 4 meter and is green all year. People plant this straw at their plot boundary to mark the compound. Vegetables - On every private piece of land, sorghum, maize and corn are cultivated and harvested twice a year. Papyrus, sisal and cacti are suitable for the climate and can be used for many purposes. The thin stems of the papyrus are bound together and used as ceilings to act as barrier for mosquitos. Sisal is used for ropes and carpets.

Fig. 2.27: Flowering achak
Fig. 2.28: Sisal
Fig. 2.29: Cactus plant

B RESEARCH II

VILLAGE

1.1 Context: Circulation

Okana is located along a side road of the highway between Kisumu and Ahero. The side road is dead-ending, which means that all people and traffic both enter and leave the village at the same place. Only a very few people have a car in Okana and there is no public transport. People have to walk or take a piki-piki to the highway, which is a motorcycle, from where they can take a matatu, a small bus.

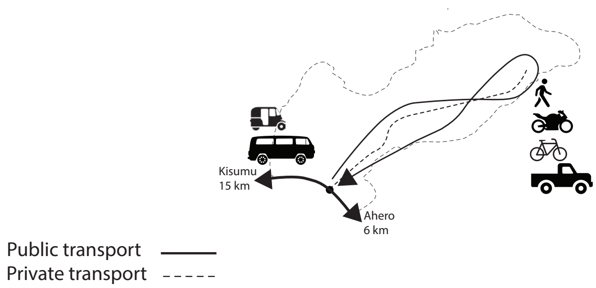


Fig. 2.30: Diagram of the private and public circulation and transport

1.1 Context: Network of roads

All roads in Okana are unpaved and in bad condition. In dry season there is less grip on the road and a lot of dust, while at times in rainy season the roads are inaccessible after heavy rainfall causing flooded holes. All people make use of the Okana road and take the smaller roads and paths as short cut to their destination.

Fig. 2.31: Soil of Okana road
Fig. 2.32: Soil of the side road

VILLAGE

1.1 Context: Frequency of movement

Most of the people walk or cycle to their destinations, long distances as well. It takes 1:40h to walk from the beginning till the end of the Okana Road.

The most frequently used street is the Okana Road, connecting all paths of the village. In the morning after sunrise at around 06:00 the first children, women and men walk on the street. When the sun goes down around 18:00, it becomes less crowded and especially for children and young women it is unsafe to walk after 20:00 on the pitch-black streets.

Fig. 2.33: Darkness at the main road at 17.00 pm

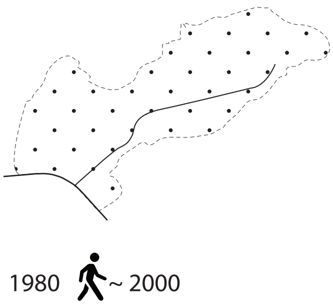
1.2 Context: ELECTRICITY

A transmitting mast for wireless telecommunication and three energy generators are located along Okana road. Just very few shops and houses in the village are connected to the electricity network, most people use charcoal for cooking and heating.

VILLAGE

1.2 Built structure: DENSITY

In the past families owned great areas of land spread over the village. Along the traditions of the Luo tribe is it customary to give all sons a piece of land when they get married. Due to the wetlands that define the natural border of Okana this has resulted in denser plots in the village and this process will continue in the coming years since families have many children and often stay in their home village.



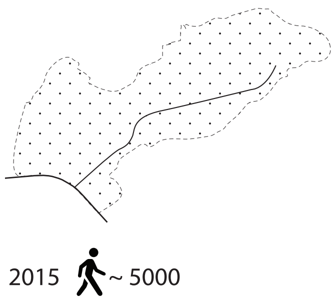


Fig. 2.34: Diagram of the density growth 1980
Fig. 2.35: Diagram of the density growth 2015

More prosperous people prefer to live next to the main road because it is easier accessible during rainy season and by car. With the exception of shops and public buildings, the built structure is always built at a certain distance from the road.

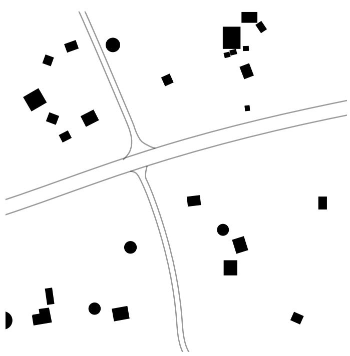


Fig. 2.36: Drawing of clustered market area
Fig. 2.37: Drawing of scattered built structure

VILLAGE

1.2 Built structure: Building type

Schools, houses and shops can be differentiated by their recognizable built structure. Common factors are the applied construction materials and the fact that no building is higher than one storey.

Private houses are varying between 20-40 m2 and can be subdivided into two different types. The rectangular and squared houses are made of mud walls with two-sided sloped iron sheet roofing and the round houses are made of mud walls and straw roofing.

Iron sheets are more suitable for creating straight forms, which is the reason that the shape of many houses changed in the last couple of year to rectangular forms.

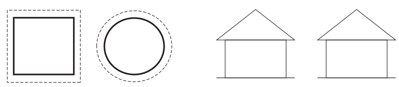


Fig. 2.38: Private house: mud walls with straw roof

Fig. 2.39: Drawing of building type: private houses

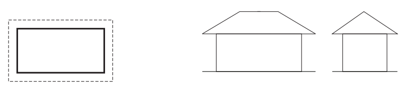


Fig. 2.40: Private house: mud walls with iron sheet roof

Fig. 2.41: Drawing of building type: private houses

B RESEARCH II

VILLAGE

Shops are recognisable by a one-sided sloped roof. Permanent shops are made of iron sheets and have a small indoor space in front of the sales point that can be closed. Temporary shops are made of eucalyptus constructions, the sellers daily bring their products to these market stands located along Okana road.

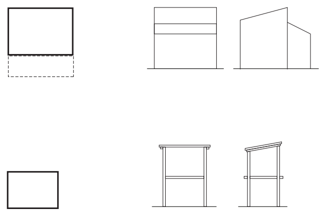


Fig. 2.42: Temporary shop
Fig. 2.43: Permanent shop
Fig. 2.44: Drawing of building type: shops

Schools exist of multiple connected classrooms in a row, providing openings at opposite two sides for light and ventilation. A overhanging roof protects the classrooms where possible against the heat. If it is too hot in the classroooms the lessons move to shady places outside. Rain on the iron sheet roof causes a lot of noise and the lessons have to be interrupted as the teacher and children can not hear each other anymore.

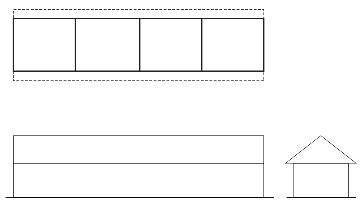


Fig. 2.45: Overhanging roof
Fig. 2.46: Classroom used by 40 children
Fig. 2.47: Drawing of building type: school

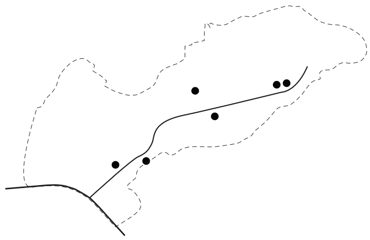
VILLAGE

1.2 Built structure: SOCIAL public institutions

Okana offers a few social public institutions. For most services, people are focussed on the closest towns Ahero and Kisumu that offer a wider range of facilities.

The village contains 5 primary schools and 2 secondary schools teaching 2000 children, more than twenty churches and every week a doctor visits the village. All social public institutions are located along the main road.

Fig. 2.48: Diagram showing the social public institutions



1.2 Built structure: SELLING POINTS

At the beginning and end of the Okana road there are small markets selling soda`s, chapatti, fish, vegetables, clothes and meat daily between 17:00-20:00. The reason for this time relates to the fact that many people have to look for jobs and money during the day, which they can then spend. Small selling points for vegetables and fish are located along the Okana road.

Fig. 2.49: Quiet market during day time

Fig. 2.50: Sketch of selling points

B RESEARCH II

HOME

George Ochuka, 50 years is the owner of this typical Luo home and lives here together with his wife Elisatbeth and their six children: Dorothy, Ireen, Michelle, Jack, Ken and Jorrit aged between one and fifteen years old.

‚Home' is the collective word for all buildings on the building plot of one family, the word ‚house' defines only the main building on the plot that accommodates the living and bedroom of the parents. A visit on a weekly day at noon showed a part of the families' daily life in relation to its built environment. Although the plot is located directly next to the main street, the high trees and vegetation give a protected feeling.

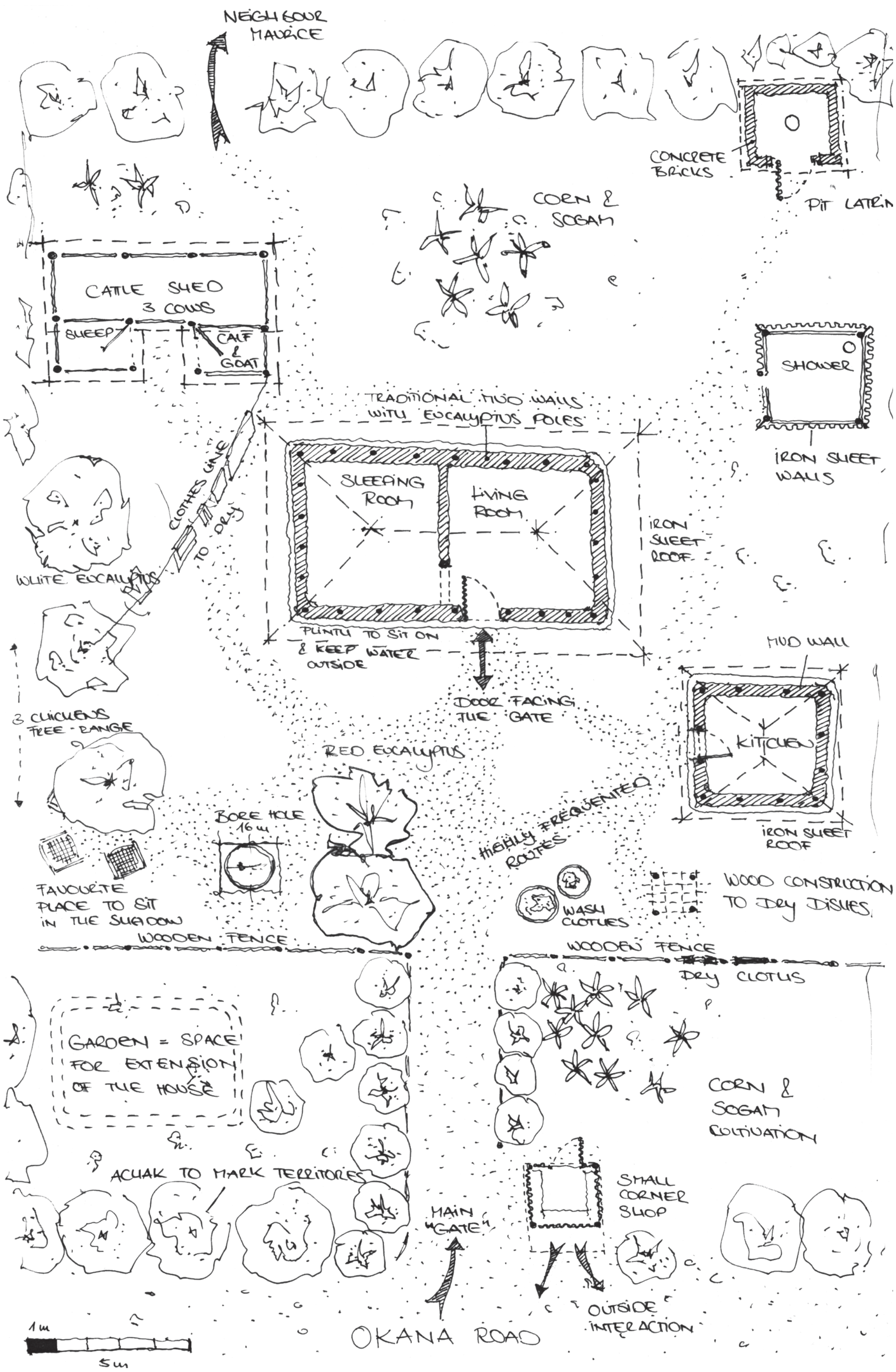
Many activities took place during noon, mainly around the kitchen and outside in the courtyard, the void space in front of the house that overviews the plot as well as the activities on the road. Elisabeth was cutting wood to prepare traditional lunch, consisting of rice, green grams, beans and the typical ugali (corn meal). Dorothy and Ireen had a lunch break from school and while waiting for lunch they took a shower in the courtyard by taking water out the well with buckets. Michelle and Ken stayed at school during lunchtime.

With a temperature of 35 degrees in sun, it is more comfortable to sit in the shadow. Lunch was served underneath the trees, while the one-year old Jorrit was crying on the lap of George, infected with malaria, which is an enormous problem during the rainy season. Sounds from the street, animals walking around and all daily activities around the water source made the courtyard a lively and never-quiet place.

This typical home is used as base of reference for the explained patterns related to the scale of a home.

Fig. 2.51: Home of George Ochuka, his wife Elisabeth and their six children

HOME



NEIGHBOUR MAURICE
CONCRETE BRICKS
PIT LATRI
CORN & SOGAM
CATTLE SHED
3 COWS
SHEEP
CALF & GOAT
SHOWER
TRADITIONAL MUD WALLS WITH EUCALYPTUS POLES
IRON SHEET WALLS
SLEEPING ROOM
LIVING ROOM
CLOTHES LINE TO DRY
IRON SHEET ROOF
WHITE EUCALYPTUS
PLINTH TO SIT ON & KEEP WATER OUTSIDE
MUD WALL
DOOR FACING THE GATE
KITCHEN
3 CHICKENS FREE - RANGE
RED EUCALYPTUS
HIGHLY FREQUENTED ROUTES
BORE HOLE 16 m
IRON SHEET ROOF
WOOD CONSTRUCTION TO DRY DISHES
WASH CLOTHES
FAVOURITE PLACE TO SIT IN THE SHADOW
WOODEN FENCE
WOODEN FENCE
DRY CLOTHS
GARDEN = SPACE FOR EXTENSION OF THE HOUSE
CORN & SOGAM CULTIVATION
ACHAK TO MARK TERRITORIES
SMALL CORNER SHOP
MAIN "GATE"
OUTSIDE INTERACTION
OKANA ROAD
1 m
5 m

HOME

2.1 Typical Luo home: TRADITIONAL SETTLEMENT PATTERN
The traditional settlement patterns used by the Luo people can be seen in more African settlements. A settlement consists of a common area meant for social activities and grazing cattle protected from the outside. Many other activities can be linked to the common area that acts as an informal meeting place for the family and elderly and as playground for children.

‚The whole compound may be centered around an excisting tree which often provides the central point, or focus, for those activities which are closely linked with daily village life‘ (Andersen, 1977: 18) If there was no tree, they planted it especially for this purpose.

The Luo home and house have a traditional spatial lay-out and accommodate two generations. In this situation the man has serveral wifes, which still occurs but is becoming less common. Nowadays men and women sleep together in the main house and the sons live in their own house according to the same rules.
The compound is protected with an euphorbia hedge and has some trees, providing shadow. Cattle kraal is located in the centre due to the importance given to cattle.

Two different types of Luo houses can be described; in one type the overhanging eave of the roof is not enclosed creating an open veranda to the outside, while in the other type a closed wall is positioned underneath the roof creating a narrow circular room around the inner central room.

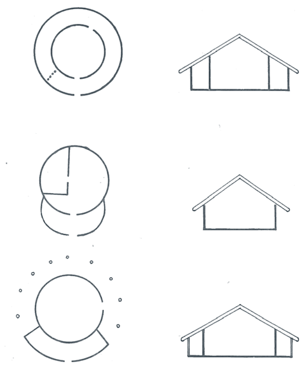


Fig. 2.52: Traditional Luo House with enclosed space. (Andersen, 1977; 144,145)

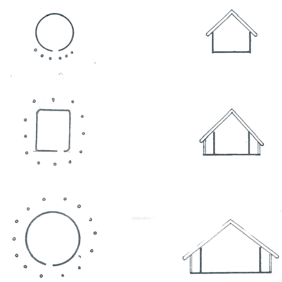


Fig. 2.53: Traditional Luo House with open veranda. (Andersen, 1977; 144,145)

HOME

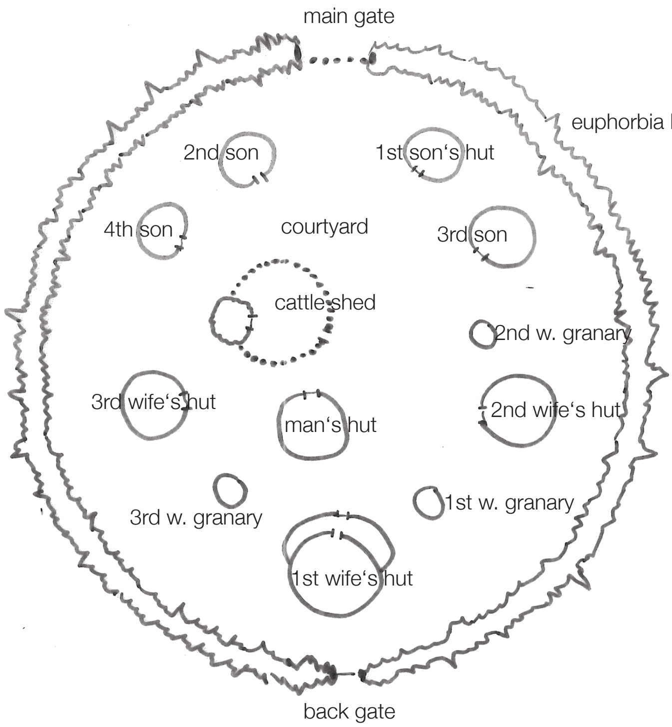


Fig. 2.54: Traditional Luo Home of the past

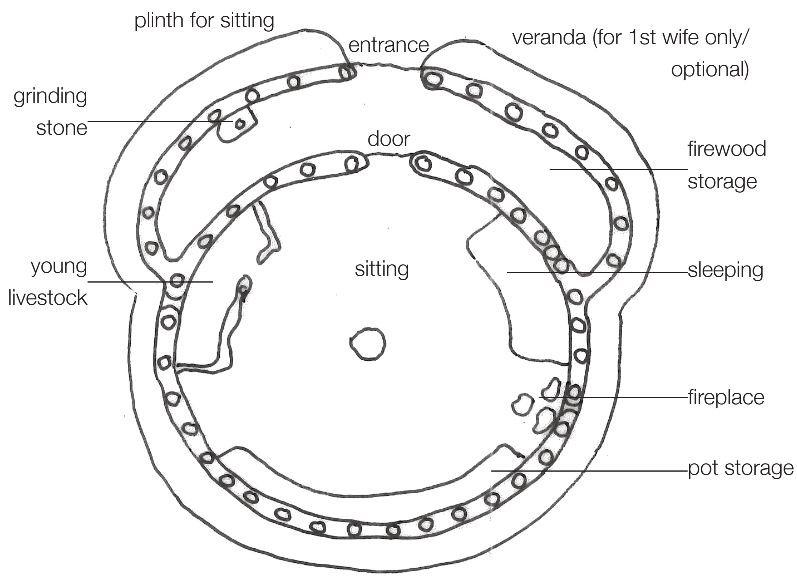


Fig. 2.55: Traditional Luo House of the past

B RESEARCH II

HOME

2.1 Typical Luo home: PLOT BOUNDARIES

Most people plant the Achak straw that is green all year around the plot boundaries, as the main purpose of this straw is to define the borders. The front door of the plot owner always has to face the 'gate', which means a path without fencing connects the street in line with the door. Only the luxury houses, which are rare in Okana have a fence/gate and a guard.

Fig. 2.56: Sketch of Achak

2.1 Typical Luo home: Figure ground

A typical Luo home consists of many separate buildings. The solid structure represents the covered indoor space and is very little compared to the outdoor area.

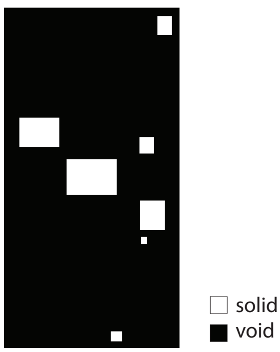


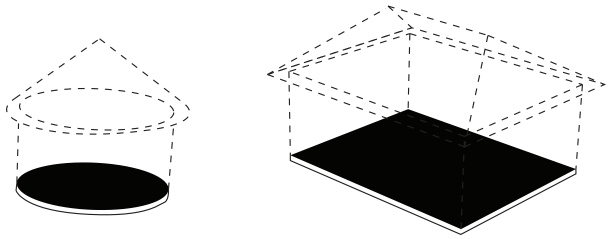
Fig. 2.57: Drawing of the solid-void relation

HOME

2.1 Typical Luo home: SHAPE

Traditional Luo houses are round shaped and have a straw roof. Nowadays people prefer iron sheet roofing nowadays, as this has a higher status and needs less maintenance compared to straw roofs, therefor the shape of the home changed to rectangular.

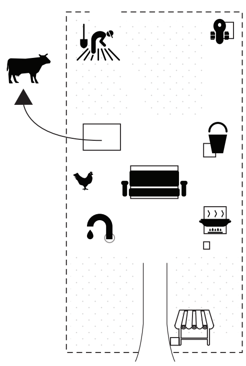
Fig. 2.60: Diagram of traditional home (round) and a modern home (rectangular)

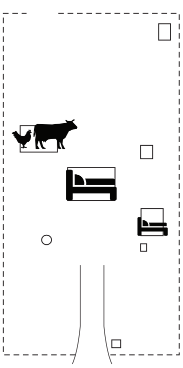


2.1 Typical Luo home: FUNCTIONS

Every different function is situated in an individual building. The kitchen is always separated from the main house. The indoor spaces have a multipurpose use depending on daytime or night time. At night, the main house and the kitchen change into bedrooms.

Fig. 2.58: Diagram functions daytime
Fig. 2.59: Diagram functions nighttime





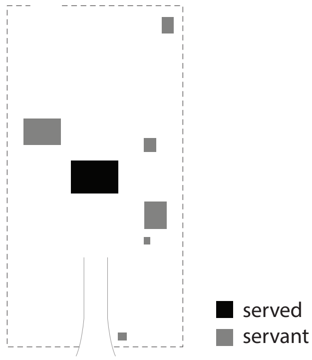
B RESEARCH II

HOME

2.1 Typical Luo home: Served - servant spaces

The main house with the living room and bedroom of the parents and young children belongs to the served zone. All other buildings such as the kitchen, toilet, shower, cattle and shop belong to the servants.

Fig. 2.61: The main house, the served space
Fig. 2.62: Diagram with served and servant spaces



2.1 Typical Luo home: VALUABLE ASSET

In the traditional Luo home the cattle was the most valuable asset. Cattle sheds where usually positioned in the middle of the home using the euphorbia plant and thorn bush branches for extra protection. Nowadays the plots are smaller and the cattle, if a family can afford it, is relocated next to the house but still protected by different types of plants.

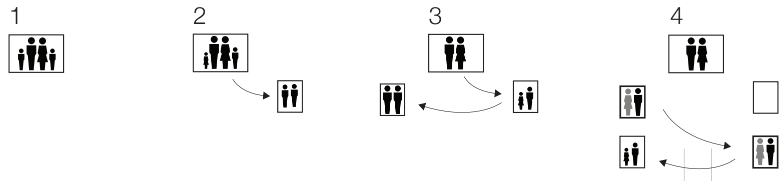
Fig. 2.63: Cattle shed

HOME

2.1 Typical Luo home: FAMILY GROWTH

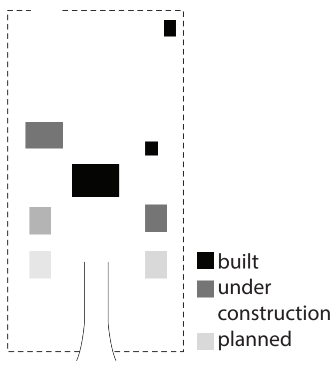
Children of a Luo family that reach the age of twelve are not allowed to sleep in the main house anymore. Daughters will sleep in the kitchen or at their grandmothers' place and a new house, either on the left or right side of the main house, has to be built for each son reaching this age. The sons will stay in this house to a short period after marriage and when the newly wed couple moves to a new plot where the same process will take place again.

Fig. 2.64: Diagrams showing family growth scenario



The remaining house of the married son that moved with his wife to a new plot has to be demolished according the traditions and the son is not allowed to sleep at his parents' home anymore.

Fig. 2.65: Expansion steps of a home



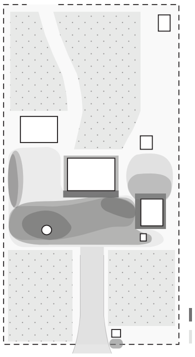
B RESEARCH II

HOME

2.2 Activities: activity hotspots

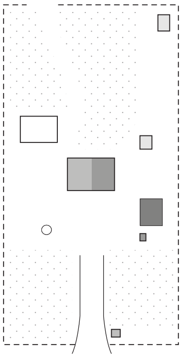
Women spend a lot of time on washing and cooking; therefore most activities take place in and around the kitchen and the water source. The pleasant outdoor climate underneath the trees and the refreshing water source make the courtyard as the most frequently used space.

Fig. 2.66: Inner courtyard
Fig. 2.67: Drying rack kitchen
Fig. 2.68: Outside activity hot- spots (high frequency darker)



There is very little light penetrating the small rooms, as small windows protect the people against insects and heat. It is common to have a table in the middle of the living room surrounded by as many chairs as possible covered with white rugs. The walls are decorated with coloured rugs, calendars and portraits.

Fig. 2.69: Living room
Fig. 2.70: Kitchen
Fig. 2.71: Inside activity hotspots (high frequency darker)

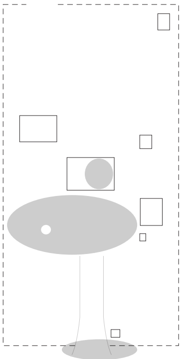


HOME

2.2 Activities: GATHERING PLACES

Family, neighbours and friends often gather in the courtyard, the busiest area where most activities take place around the kitchen and water source. All doors of the buildings are orientated towards the courtyard, resulting in a frequency of movement.

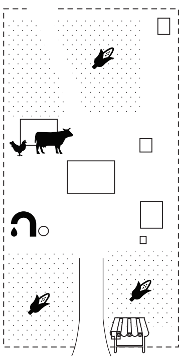
Fig. 2.72: Gathering places
Fig. 2.73: Courtyard of the home.



2.2 Activities: self-supplying

Besides the built structure, the land is used for crops, cattle and house extensions. The harvest of the vegetables is primarily intended for private use, the surplus will be stored for the dry season or sold to neighbours.

Fig. 2.74: Diagram showing the self-supplying activities
Fig. 2.75: Cattle shed

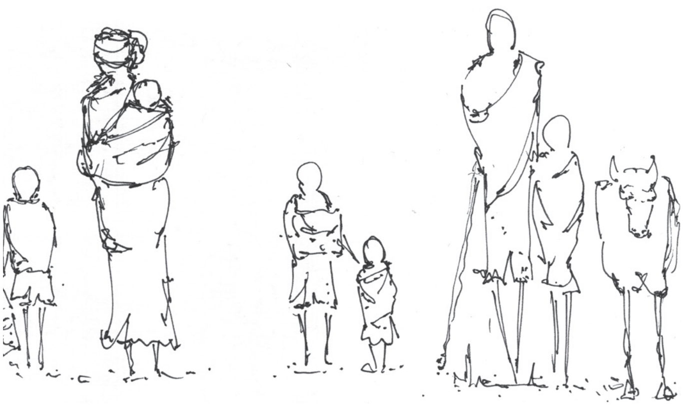


B RESEARCH II

PEOPLE

Okana is a fast growing village. The majority of the community are youth; 2000 children are attending 5 primary and 2 secondary schools in the village. Families have many children; children stay synonym for welfare even though the families live in poor financial circumstances it means that they have someone who can take care of them in the future. Many parents do not have enough financial recourses to pay the school fees for the secondary school of their children, which causes many drop-outs. A positive change that has developed in recent years is the fact that most girls attending school, at least primary school.

In this chapter the daily life of the inhabitants will be explained through the daily pattern of Elisabeth, a housewife and Harold, a student at the Ranjira mix. secondary school, to get an impression of their daily routine and time-consuming activities.



‚When I look at the percentage of people who are ICT literate, is very low‘ George Ochuka

‚Getting books is also a nightmare in this village‘ George Ochuka

The future for us is to invest in the young people, to give them opportunities that will enable them realize their potentials‘ James Jowi Otieno

‚Families have very tight budget, they can not even afford food all the time‘ James Jowi Otieno

‚It would be my wish to buy a cow, if I would have more money‘ Correti, 23 years old, mother of three children

*Citations of local people, field trip May 2015

Fig. 2.76: Sketch of local people

PEOPLE

3.1 Okana: POLITICAL SYSTEM

The political system of Okana has a hierarchical structure. Okana village is subdivided into fourteen small areas, called villages of approximately 500 people. Each village has a clan elder, who is the representative and contact person for issues. Every Friday afternoon, the Chief subha raza takes place underneath a tree, where the Chief meets his fourteen clan elders. Topics as education, security, development and health are publically discussed and everyone is allowed to attend this meeting.
Among other things they have reached is Okana's own security post which is daily manned and makes it feel much safer.

The Chief is responsible for the sub location of Okana, which is part of the bigger region of East Kochieng and a division of the district Kisumu.

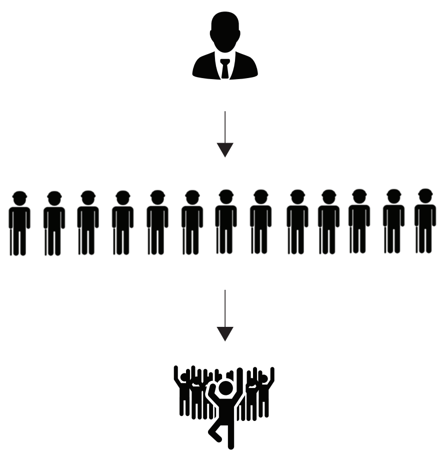


Fig. 2.77: Diagram of the political system with the Chief, 14 clan elders and the Okana community

B RESEARCH II

PEOPLE

3.2 Community life: Gathering places

‚Communal living can be explained in terms of the extended family system on which most African societies are based.‘ (Andersen, 1997; 17) The community feeling in Okana is very strong and refers to the past, when village life offered protection amongst ethnic groups and wild animals. One of the reasons for the strong community feeling is the fact that the village only counts 5000 inhabitants often staying in the village throughout their lives. It is uncommon to leave your hometown and family especially as guy.

Another important reason for the strong community feeling is the fact that people deal with many concerning issues related to education, health and development bringing them more closely together. Life is more uncertain and makes the people mutually dependent.

In the Luo culture it is common to take care of each other. You are expected to help your family, far relatives and even other members of the community. Many families take care of children from their siblings, who are deceased or have other problems. James Jowi Otieno, born in Okana mentioned:

‚Our society, especially in the rural area still very much communal. We share a lot of things, we share our hapinness, we share our grief with everybody, with the whole community‘

In the less hectic lifestyle associated to time and the high unemployment rate the number of people that spend large part of the day outside and together is high. The biggest problem is the lack of job opportunities; more employment needs to be created in the rural areas in a way that people stay in the rural areas.

PEOPLE

Fig. 2.78: Gathering place around the water source

Fig. 2.79: Gathering placing underneath trees

At funerals, which take places in the weekends close to the wetlands the whole community gathers. During this two-days celebration the village chief presents the latest news of the village, people dance on music and spend time together. The majority of the people is Christian and goes on Sundays to church, Okana counts more than twenty churches.

Women spend most of the time in and around the house, washing clothes and preparing food for the family. All these activities take place in the same common area, the courtyard of the home with the refreshing water source.
Women see each other outside their homes on the street and at the market. On Sundays women gather in so-called ‚women groups‘, a group of befriended woman discussing about life and collecting money for disadvantaged community members. These meetings occur in homes, often too small for the number of people, or outside in shady places. Men gather usually on the street or in the pubs located at the market place.
At school children and teachers often gather in large groups underneath trees during the break or relocate the classrooms underneath a tree where the climate is more comfortable than inside the intolerable classrooms.

Given the fact that Okana has no official public meeting place and a climate ideal for being outside, shady places are the most common used meeting places protected from the bright sun and heavy rainfalls

B RESEARCH II

PEOPLE

3.2 Community life:COMMUNITY MEMBERS

Name	Elisabeth Ochuka
Age	40
Occupation	Housewife
Home	Living with her husband and 6 children

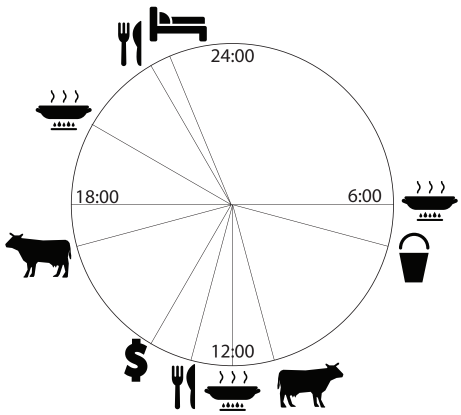
Fig. 2.80: Elisabeth Ochuka

Weekday

Elisabeth wakes up when the sun rises and starts preparing breakfast for her family. After some hours of housekeeping, she brings the cattle to the land of her mother in law, where the animals can graze in the field.

In the afternoon after lunch she runs her small business and sells food in the small shop. The cattle has to be brought back before darkness and after this she starts preparing dinner.

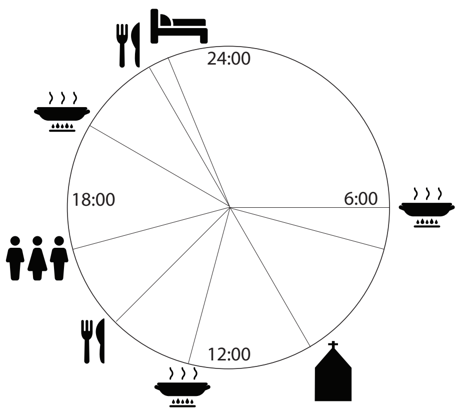
Fig. 2.81: Weekday activities



Sunday

Sunday is a resting day, although she has to prepare breakfast, lunch and dinner. Her oldest son Jack is around and takes care of the cattle. Like every other Sunday she goes to church together with her husband and children, which plays an important role in their lives. In the afternoon she meets with her women group in someone‘s home exchanging ideas and discussing problems.

Fig. 2.82: Sunday activities



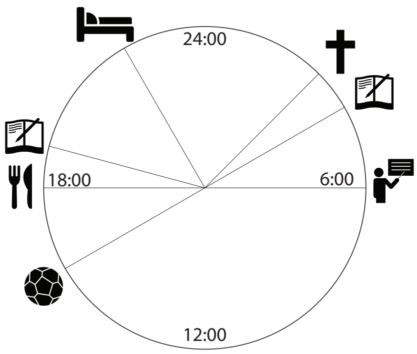
PEOPLE

3.2 Community life:COMMUNITY MEMBERS

Name	Harold Freizzer
Age	18
Occupation	Student form II
Home	Living with his grandfather and grandmother

Fig. 2.83: Harold Freizzer

Fig. 2.84: Weekday activities

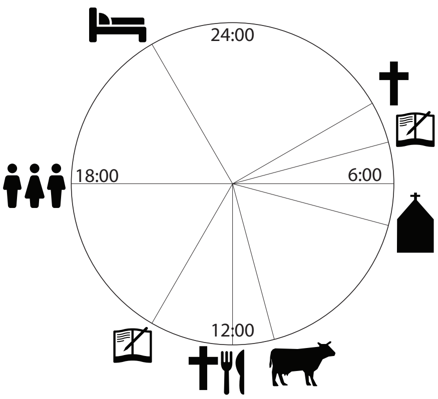


Weekday

Harold always wakes up very early in the morning and starts his day with one hour of praying. He prepares his subjects at home before going to school.

At the end of a school day he walks home, where his grandmother prepared dinner for him. Before going to bed he makes his homework for the next day.

Fig. 2.85: Sunday activities



Sunday

Also in the weekend Harold wakes up very early. He starts his day with praying and studying. In the morning he goes to church together with his grandparents. In the afternoon he has to watch the cattle, prepare lunch, pray and study. Around six in the evening he has time to meet friends to play football or to talk.

B RESEARCH II

CONCLUSIONS

By analysing the patterns, the goal of this research was to find out *how the cultural patterns of the Luo influence the built environment and daily life of the people in Okana.* How do they use their created spaces and give meaning to it?
All patterns are interrelated and have an impact on the broader system, influencing the smaller as well as the bigger scale. Working trough the different layers gives the extra dimension to discover the connections and to understand how and why it works in that specific way.

The *composition* of the built structure in Okana is equally spread and exists of many small houses, defined by Luo traditions. Guys who have reached the age of 12, are not allowed to sleep in the main house anymore, they have to live in their own ‚new' house, positioned and defined by a set of rules. This compositional ordering results in a growth scenario in which a *new building is added* instead of enlarging the existing buildings on the plot. Although the growing scenario takes place along a set of given rules; the position of the individual houses looks sometimes *randomly* from top view. The scattered and increased density on the plot results in an *equally increased density* on the bigger scale and smaller family plots.

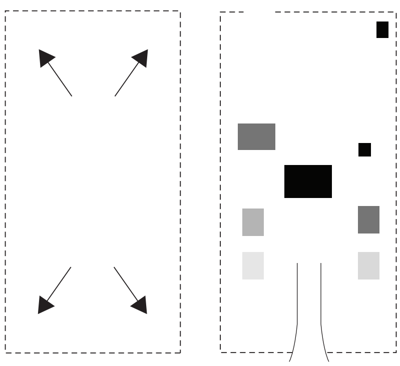
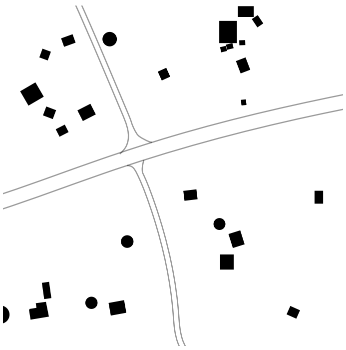


Fig. 2.86: Growth on plot within defined borders
Fig. 2.87: Scattered increased density defined by rules

CONCLUSIONS

The wetlands surrounding three sides of the village define the natural borders and influence the village structure, consisting of the Okana road linking together the two markets. The few social public institutions and facilities, such as schools, the market, selling points, security and the dispensary are all *located alongside the five kilometre Okana road*. For most services, for example an internet cafe or a supermarket people are focussed on the closest towns Ahero and Kisumu.



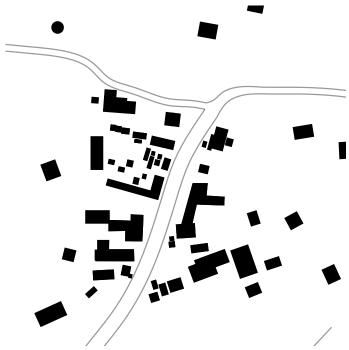
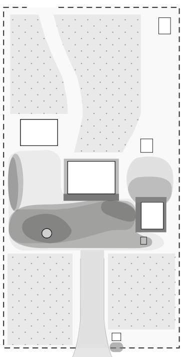


Fig. 2.88: Diagram of scattered private homes
Fig. 2.89: Diagram of clustered shops

Private homes are always *positioned towards the road* while the main door has to face the gate. They are usually *distanced* from the road while shops and social public institutions are *located alongside the road* and do not have to face the gate with the main door.

Fig. 2.90: Diagram of frequently used spaces



Zooming in on the scale of the individual home, one sees separate functions positioned around a courtyard oriented towards the street. The courtyard is the most frequently used and important place of the home thanks to the water source utilised for cooking, washing and showering and the fact that the houses are rather small and dark, which results in people preferring the outside spaces. Every home has a shadow tree to sit underneath during the hottest hours of the day. The *visual connection* to the street, friends and relatives passing by and neighbours using the land for shortcuts make

CONCLUSIONS

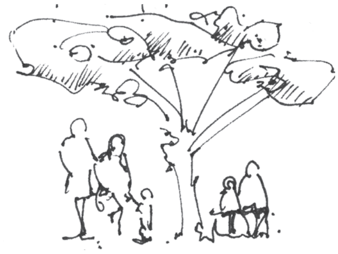


Fig. 2.91: Sketch of the centre of the settlement

the *courtyard more than a part of the individual home* but an important *meeting place* for people and different activities.
Building settlements around an existing tree, as central point for activities closely linked with daily village life, derived from *past traditions*. The *center* of the settlement was the most protected and safe place.
Most families are *self-supllying* and cultivate a major part of their food on the land around their house. All people grow vegetables primarily intended for private use. While everyone grows similar vegetables, little variety in products causes severe famine after a bad harvest.

African societies are *based on community life*, referring to the past, when village life offered protection amongst ethnic groups and wild animals. Nowadays the community feeling is still very strong, especially in the *rural areas*. People in Okana help and take care of each other if they are able to do so. Everyone in the village knows each other and they deal with many concerning issues related to education, health and development bringing them more closely together. Family, children and belief connect the members of the community.

The majority of the community are youth; 2000 children are attending 5 primary and 2 secondary schools in the village. The biggest concern is that many parents do not have enough financial recourses to pay the school fees for the secondary school of their children, which causes many *drop-outs*. Job opportunities needs to be created that can motivate these young people providing an income for their families.
Due to the low level of education, a high unemployment rate and a lack of job opportunities the number of people that spend a large part of the day outside and together is high.

CONCLUSIONS

Given the fact that Okana has *no official public meeting* place and a climate ideal for being outside, shady places are the most common used meeting places protected from the bright sun and heavy rainfalls. Community members see each other during funerals and on Sundays in church, the Christian faith has a major role in their lives. Other meeting places include the main road, small shops, women groups and the pub.

Looking to the daily pattern of people, their home and village, it can be noted that the people still live very traditional. In self-made houses without running water and electricity is livestock, mainly cattle their most valued property and gives a measure of social status. *‚It would be my wish to buy a cow, if I would have more money‘ (Correti, 23 years old, mother of three children)*

Fig. 2.92: Sketch of local people walking with their cattle

As explained in the previous text traditions and culture of the Luo have a strong influence on the built environment and daily life of the people in Okana. Old Luo traditions are still applied in every home, influencing the spatial arrangement and orientation of the houses around the meeting place and the composition of the total built environment on the bigger scale.
The patterns in this research shape the specific context and connect the individual people of Okana to a community.

B RESEARCH II

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Otieno, J. J. *About Okana Village. Retrieved 5 September 2015, from http://www.srikenya.org/about-okana-village/*

B RESEARCH II

LIST OF FIGURES

LIST OF FIGURES

LIST OF FIGURES

SITE

-0.14634800° 8´ 46.85´´ S

34.874759534° 52´ 29.13´´ E

1155.86 m

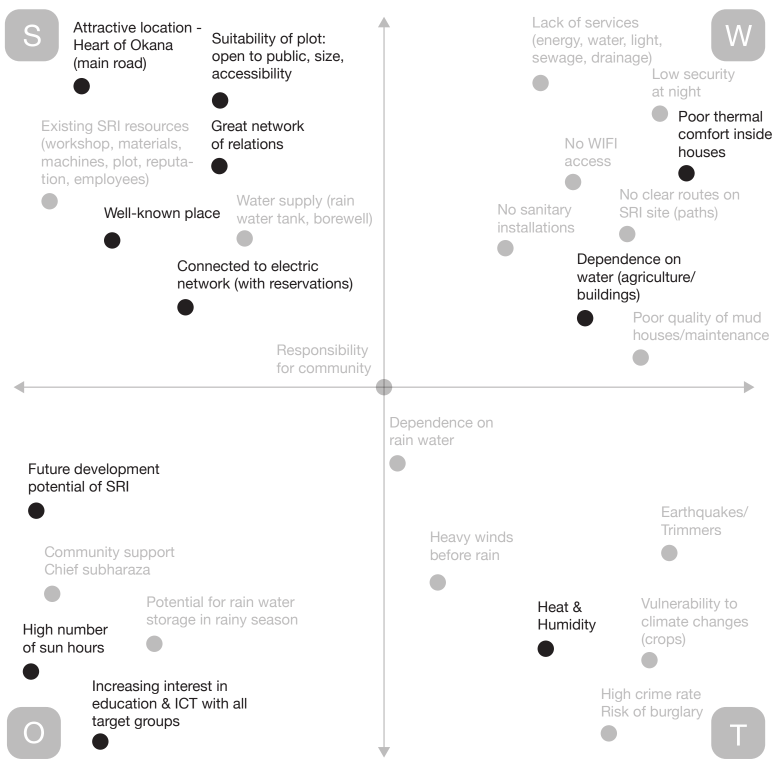
B SITE

SWOT ANALYSIS

In the heart of Okana, the NGO 'Sustainable Rural Initiatives' (SRI) is located along the unpaved main road. SRI is a local NGO that operates in Western Kenya with the aim to improve the quality of life for rural communities, focusing thereby on agriculture and environment, skills and entrepreneurship, education support, health and youth in action. SRI is the landowner of a 5-acre-plot, half of which is made available for supporting activities of the NGO. On the most public part located along the road, a wood-workshop, guesthouses and temporary office space are located surrounded by land with agriculture. Future plans incorporate the construction of a community centre that will accommodate a library, ICT facilities, a tailoring workshop, office spaces and a place for the community to gather, celebrate, learn and discuss.
The site is like 1 of the few places in the villages connected to the electricity network, making it possible to use machines and later on computers and to enlighten the site in night to improve safety.
Water is collected on the roof of the workshop building and stored in a water tank. During the dry season, when the agriculture is dependent on water supply, the 40m deep bore well provides enough water.

SWOT ANALYSIS

The site of the NGO is an attractive location in the village, has highly developed facilities as water supply through water catchment, the bore well and the connection to the electricity network. The chairman of the NGO is well known in Okana and has a great network that offers the chance to reach a great scope of the proposed target groups and to improve the quality of life in the village.



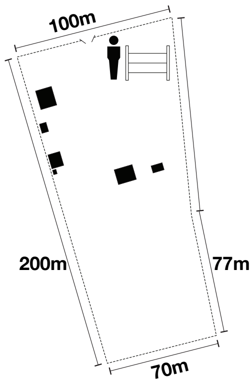
B SITE

SITE ANALYSIS

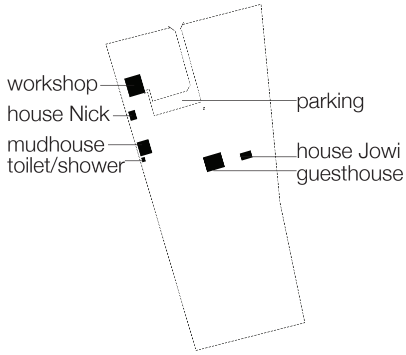
SITE B

SITE ANALYSIS

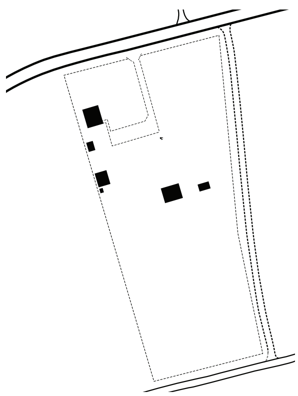
Site measurements



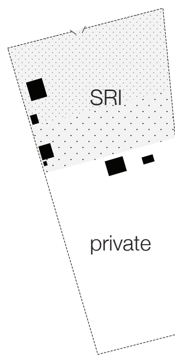
Functions



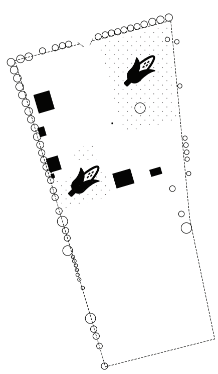
Network of roads



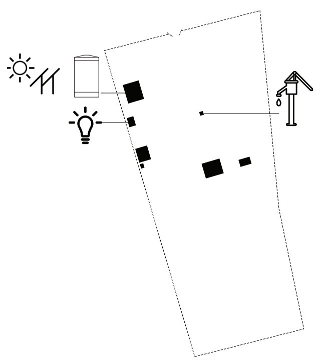
Zoning: levels of privacy



Vegetation



Facilities

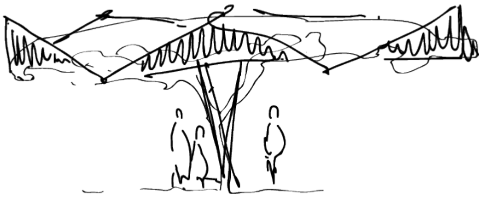


APPENDIX 1:
PROJECT PLAN

C APPENDIX

PAVILIONS for OKANA

A pilot roofscape design for the community



If you want to go fast, go alone.
If you want to go far, go together.

-African Proverb-

Laura Straehle & Ellen Rouwendal

C PROJECT PLAN

What if students were able to make a change for poorer regions of the world with a small-scale intervention in architecture?

The answer to this question has the potential to trigger far-reaching changes by using architecture as a means to share knowledge hence providing the background to initiate the Design-Build-Studio **‚PAVILIONS for OKANA‘.**

A Design-Build-Studio focuses on combining a research and design phase with the implementation of the project. All steps and processes are carried out by the designing students themselves together with the local community. The advantages lie within applying architecture as a means to help poorer regions of the world by thinking of creative solutions while gaining practical experiences. Taking part and being responsible for all related project steps of an architectural design adds another dimension to a project. It encourages an integral way of thinking leading to a significant advantage for a new generation of architects.

Designers & Motivation

We are Ellen Rouwendal & Laura Straehle, two master students currently graduating in Architecture at Delft University of Technology (NL). *PAVILIONS for OKANA* represents our one-year graduation project at Explore Lab, a studio at the Faculty of Architecture that offers its students the possibility to elaborate their own theoretic research and design approach according to a specific fascination. The idea to graduate with this project arose through the influence of several events. **Laura Katharina Straehle** first finished a bachelor of International Management in Heidelberg followed by a four-years bachelor in Architecture at Technical University Munich (Germany), where she participated in various Design-Build-Studios in Zambia and Kenya. „To combine and take responsibility for both design and construction processes is a great chance to learn for life and apply your knowledge in a meaningful way“. **Ellen Rouwendal** participated in a three-month internship in Kenya to stimulate ecotourism in the Mount Kenya region as part of the NGO Help Self Help Centre. The idea to work as a team is influenced by an intensive collaboration during the three-month MSc2 course ‘Habitat Design Studio’ in India. Fascinations, experiences, thoughts and ambitions made both paths cross each other.

Having seen to what extent a Design-Build-Studio influences students’ motivation and experienced the great impact it can have on its context encouraged us to set up our own Design-Build-project. After the graduation in January 2016, we will continue this project as volunteers for four months to build the project and to fulfil our goals.

PROJECT PLAN C

Mission

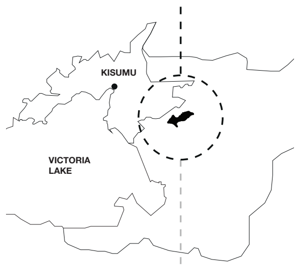
Our goal is **to design a roofscape of pilot pavilions for multifunctional public use in the rural areas around Lake Victoria and build the first one as community centre in Okana (West-Kenya).**

Project Planning & Supervision

The graduation year started in February 2015 and it includes a research and design phase that will be finished in January 2016. After having graduated, a three-month building phase will start in March 2016.
During the graduation year the project is mainly supervised by Prof. Thijs Asselbergs, Ass-Prof. Nelson Mota, and Dr.-Ing. Marcel Bilow. These mentors have a vast experience in the field of architecture, design and architectural engineering. Moreover the project is supported by experts in the fields of construction (Dipl.-Ing. Peter Oed), integration of the local community (Prof. Tom Avermaete / James Otieno Jowi), developing a sustainable building (Frits van Loon).

Project Location

The developed pilot design will be suited for the rural areas around **Lake Victoria.** The first one will be build in **Okana**, on the site of Sustainable Rural Initiatives (SRI), an NGO that operates in Western Kenya with the aim to improve the quality of life for rural communities.
SRI is located in Okana, a small village with approximately 5.000 inhabitants, situated 12 kilometres southeast of Kisumu. In the heart of the village, along the unpaved main road, SRI is the landowner of a 5-acre-plot with a wood-workshop, guesthouses, agriculture and a temporary office space. On this plot an area of 2500m2 is made available for the planned community centre.



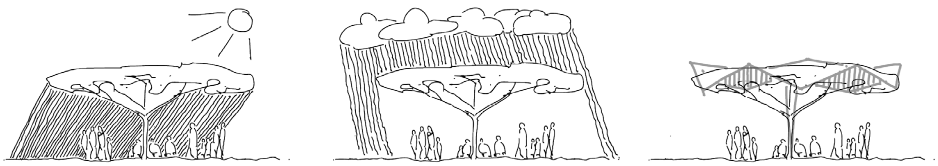
Purpose & Relevance of the project

The purpose and relevance of the project arose from the necessary integration of a generic and a specific approach to create a universal building system on the one hand and an individual building for the community on the other hand.

<u>Generic approach: A reproducible pilot.</u>
The pilot is designed to be reproducible and both simply and sustainably constructed by local people reinterpreting the use of local materials in the Lake Victoria region. This region deals with the tropical rainforest climate with heavy rainfalls during the rainy season, followed by a dry season with many sun hours. The objective is to find answers of how climate, local methods and materials can be brought together with smart and understandable construction principles and an appealing design.

C PROJECT PLAN

Specific approach: The Okana community centre.
The specific approach deals with the local culture and incorporates the communities' need into the design. In Okana the building will be used as community centre. Community life plays an important role in peoples' life and there are few official gathering places at the moment except for two street-markets and some smaller corner shops.
In Okana the highest percentage of the inhabitants is represented by the youth, people whose future still lies ahead of them. However, the gaps in numbers of children going to school, to high school or university are extremely big and there is a low chance to continue education. Without having obligatory ICT courses at school, a shortage on books and an Internet café 12 kilometres further, it is hard to get in touch with ICT and study in a learning-friendly environment.
In order to help solving these problems, the community centre will act as a platform; offering ICT facilities for basic skills, a mini-library with school and leisure books, office space for SRI, tailoring workshops and a shadowed community space for social interaction where people can gather, learn, discuss and celebrate. Although the main focus lies on youth, the centre will serve as a place for the whole community.



The architectural roofscape is inspired by the local acacia tree. It is a popular meeting point for the whole community where people are protected from the sun and heavy rainfalls. The roof becomes the building - being the leading design approach for this project. While the roofscape represents the generic part of the design, the spatial program underneath gives each pavilion another individual character.

Goals

Our design goal is to find answers of how climate, local methods and materials can be brought together with smart and understandable construction principles and an appealing design taking into account the culture and needs of the specific context.

Pilot system

* The pilot can be **implemented** into several areas around Lake Victoria

- Solutions and building techniques incorporated into the design should be communicated to the local people, **accepted,** adopted and further developed
- The building should **create awareness** of rainwater and solar energy collection
- Introduction of **bamboo** as building material / Reinterpretation of adobe
- The first pilot project in Okana will serve as inspiration for other communities.
- The building system will show how to incorporate sustainable cycles into architecture.

Community Centre:

* The community centre is supposed to **fulfil a social function** therewith reacting on socio-cultural and economic problems of the region.
 • The community centre **acts as platform**, a place to meet, discuss and celebrate to enhance the community in several ways.
 • It provides **opportunities and facilities for youth and women** who have the ambition to develop.

* The community centre will be **self-sustaining.**
 • Generating income by selling products produced on site.

* Acceptance, usage and **continuity** of the community centre are important factors.
 • Workers have knowledge of the building system and facilities in order to **maintain** it.

Strategy

An integral approach is needed to achieve the previously mentioned project goals.
To design a building in a new context, a deep understanding of the traditional environment and housing patterns are needed as a basis to preserve qualities, skills and knowledge of traditional housing and local materials. An earlier stay of three months in Kenya and a fieldtrip last May to Okana gave the designers many insights into the way of living through intensive contact with the villagers, interviews and many interesting discussions with local people and experts.

A handbook with understandable drawings is currently being developed and will communicate step by step how the system is built up and how it works. It will be handed out to the community members and will be available within the community centre itself to use as guidance during the building phase and for maintenance afterwards. For the future, the aim is to inspire the local people to use the principles and local materials for their own houses and projects.

For the acceptance and use of the building is it important to involve the local community and to make them part of the project. They will have a large impact during the construction phase with their attendance, skills and crafts. The community centre provides construction jobs, pays local people for contributing and thereby enhances ownership and responsibility to their buildings.

The centre can only operate if it is used and maintained properly. Thinking in sustainable cycles throughout the whole design process is therefore of the utmost importance and has in turn influence on architecture. Next to its revenue from paid ICT courses or the internet café, the sale of agricultural products, seedlings from an integrated tree nursery and furniture from the wood workshop will generate income to pay the maintenance cost and workers. Some current workers of ‘Sustainable Rural Initiatives’ will form part of the staff.

C PROJECT PLAN

Collaboration with local parties

With the help of the Delft student organisation Students4Sustainabilty (S4S), the contact with the NGO Sustainable Rural Initiatives (SRI) was established during the beginning of the graduation year and resulted in a close collaboration. SRI - being the landowner of the plot in Okana - will be the ultimate owner of the community centre. In this inspiring cooperation the freedom was given to establish this project and discuss the plans through intensive email contact and regular meetings with the NGO and James Otieno Jowi, the chairman of SRI who often travels to the Netherlands due to his work for ANIE – the African Network for Internationalisation of Education and a close collaboration with TU Delft and University of Twente (both NL).

Accountability & Compensation

In order to realize the project in Kenya, a group of 20 volunteers from different study disciplines and 20 local workers will work together on the construction site between March and May 2016.
We are therefore looking for socially-engaged companies to help us make it happen by providing financial support, material donations, advice and expertise. All financial support to build the community centre in Okana directly benefits the project for having a non-profit purpose and forming part of the non-profit organization Students4Sustainability. During the whole process the donors will be updated every two weeks on the projects' website and an evaluation report with a clear overview of the expenses is handed over after finishing the project.
If desired, both names and logos of all donors will be placed on the website. Moreover, the supporters' names will be imprinted on a wall in the heart of the community centre in Kenya. The overall marketing goal is to spread the word about the built project and get publications in several architecture blogs and magazines such as *archdaily.com, dezeen.com, detail.de.*

Budget and Finance

The cost estimation of the project is set out in the annex and gives an overview of the expenses to develop and build the project that has a non-profit purpose and is calculated with local prices and worker rates leading to the following total project costs:

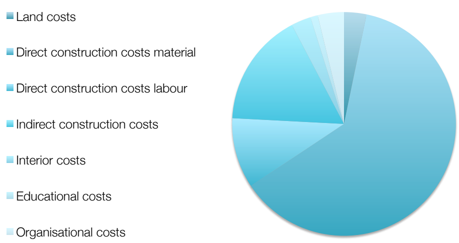
Estimated Costs of **Community Centre (five pavilions):**

Land costs	€ 2.887	KES 339.061
Direct construction costs	€ 64.823	KES 7.612.459
Indirect construction costs	€ 14.699	KES 1.726.131
Interior costs	€ 2.564	KES 301.042
Educational costs	€ 950	KES 111.562
Organisational costs	€ 3.381	KES 397.044
Required budget	**€ 89.304**	**KES 10.487.300**
Gross floor area	300 m2	
Outside community space	240 m2	

*A (more) detailed cost estimation can be requested (set out in the annex).

Different expenses

The land costs include preparations on site before the construction phase can begin. SRI provides 2500m2 of land for the community centre and the surrounded generating income facilities, which results in a relatively low land costs expense. Direct construction costs incorporate the materials to build a 1:2 prototype in Delft, material costs for the community centre and labour costs of the Kenyan workers. A group of 25 volunteers from TU Delft and other universities, permanent employees of SRI and the local community will carry out a large part of the work on the construction site. Indirect construction costs cover the unexpected costs made during the construction phase. The interior costs include the furniture and facilities that make the building usable for its purpose. Educational costs cover the costs to inform the volunteers and the publication of the handbook that explains all taken steps to built one pavilion. The organisational costs refer to the transport costs on site and the accommodation for the volunteers.



As the community centre exists of multiple pavilions, it is possible to start building, also in case of unexpected setbacks. However, the costs of the first pavilion are already covered by Students4Sustainability, M&P GmbH, Broshuis BV and the StuD fund. Additionally, Kenyan and European organizations are currently showing great interest in the project; negotiations are in progress. A crowdfunding campaign on several platforms will be launched soon to acquire private donors to support the project.

If you want to get involved in the project and support us financially, please refer to the following account of Students4Sustainabilty (S4S). S4S has the Dutch ANBI status and is recognized as a non-profit organisation.

Bank:	ABN-AMRO
Account no.:	60.76.98.004
In the name of:	Stichting Students 4 Sustainability
IBAN:	NL 21 ABNA 0607698004
BIC:	ABNANL2A
Stating:	Pavilions for Okana/name/e-mail address

Financial Future Plan

The first Pilot Pavilion is located in Okana as community centre, but it can be easily copied to other communities. A combination of the generic pilot system and a business model specifically created for the site and activities in Okana will guarantee that the community centre can operate in the coming years without external support and donations from Europe.

The future goal of the project is to act according to the African proverb *„give a man a fish and you feed him for a day; teach a man to fish and you feed him for a lifetime“.*
The project has the potential to act as a platform for exchanging knowledge, creating a basis for eduction and supporting the local community cohesion which is deeply rooted in the local culture.
As a *bank of ideas*, the building itself will be a rolemodel and a catalyst for change in poorer regions of the world.

Contact information

Please feel free to get in touch with us or ask for more detailed information on the project. We look forward to answer your questions and provide you with further information by email, phone or in a personal presentation.

email	info@pavilions-for-okana.org
website	http://www.pavilions-for-okana.org
facebook	https://www.facebook.com/Pavilions-for-Okana

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Laura Katharina Straehle
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2611 VD Delft
+31 (0)621124721
mail to: L.K.Straehle@student.tudelft.nl

Take just a few more minutes and watch the attached pitch movie to get a better impression of the project or visit our website that shares the latest news and developments on all parts of the project.

Thank you very much for your time. We look forward to hearing from you.

Kind regards,

Ellen Rouwendal & Laura K. Straehle

C

APPENDIX 2:
COST ESTIMATION

C COST ESTIMATION

Cost Estimation / Pavilions for Okana

Project data

Project leaders:	Laura Straehle & Ellen Rouwendal
Construction team:	25 volunteers
	25 Kenyan workers
Construction phase	February '16 - May '16
Currency rate 17-11-2015	€1 = KES 109,00
Gross floor area	300 m²
Outside community space	240 m²

Total costs*

	€	KES
Investment costs		
Land costs	**€ 8.769**	**KES 982.128**
Direct construction costs		
6 pavilions	€ 69.720	KES 7.808.590
functions	€ 20.531	KES 2.299.517
Total Direct costs	**€ 90.251**	**KES 10.108.106**
Indirect construction costs	**€ 20.464**	**KES 2.292.020**
Interior costs	**€ 8.106**	**KES 907.816**
Educational costs	**€ 950**	**KES 106.400**
Organisational costs	**€ 33.647**	**KES 1.984.304**
Total costs		
Required budget	€ 162.187	KES 16.380.775

* Sustainable Rural Initiatives' provides:
2500m2 land, 30 computers,
20 sew machines, 80 solar panels

Investment costs

A/ Land costs

Update: 04.12.16	
currency rate 2016-01-04	
€ 1	KES 112

item	description	m	m2	m3	quantity	tools	cost / unit	MATERIAL COSTS €	MATERIAL COSTS KES	worker	days	wage	LABOUR COSTS €	LABOUR COSTS KES	TOTAL COSTS €	TOTAL COSTS KES
Land																
Plot costs	SRI*		400				€ 0,00	€ 0								
Construction permit					1		€ 50,00	€ 50								
Infrastructural facilities	skilled worker									1	12	€ 7,00	€ 84			
	unskilled worker									20	12	€ 3,50	€ 840			
Land clearing			400				€ 2,00	€ 800								
Landscaping / vegetation	plant / trees				80		€ 2,00	€ 160								
	chicken farm				1		€ 1.100,00	€ 1.100								
	chickens				25		€ 8,00	€ 200								
	SRI / tree nursery*		30				€ 0,00	€ 0								
	SRI / agriculture		1000				€ 1,65	€ 1.650								
	Biogas digester				1		€ 1.260,00	€ 1.260								
	community space		240				€ 10,00	€ 2.400								
Electricity cables	connection net	100					€ 0,75	€ 75								
	PV to control unit	100					€ 1,50	€ 150								
Total land costs								**€ 7.845**	**KES 878.640**				**€ 924**	**KES 103.488**	**€ 8.769**	**KES 982.128**

1

C COST ESTIMATION

B/ Direct construction costs / 2. Pavilion

item	description	m	m2	m3	quantity	tools	cost / unit	MATERIAL COSTS €	MATERIAL COSTS KES	worker	days	wage	LABOUR COSTS €	LABOUR COSTS KES	TOTAL COSTS €	TOTAL COSTS KES
Preparation																
Scaffolding					1		€ 60,00	€ 60								
Ladders					1		€ 45,00	€ 45								
Tools bamboo, sew, sanding machine							€ 1.250,00	€ 1.250								
Total preparation								€ 1.355	KES 151.760							
Foundation																
Foundation Lay-out		180					€ 0,25	€ 45								
Excavation			27				€ 5,00	€ 135								
Strip foundation	concrete			5			€ 100,00	€ 500								
Pile foundation	concrete			0,75	8		€ 100,00	€ 600								
Total foundation								**€ 1.280**	**KES 143.360**							
Floor																
Compressed clay soil t=0,10 m				8,5			€ 12,50	€ 106								
Fleece mat			85				€ 1,55	€ 132								
Hardcore t=0,15m					2	truck	€ 120,00	€ 240								
Rammed earth t=0,18m					2,5	truck	€ 80,00	€ 200								
Hardwax t=0,002m				0,2			€ 109,00	€ 22								
Total Floor								**€ 700**	**KES 78.378**							
Load bearing structure																
Bamboo poles Ø 12-14 cm	columns 1,0 m				14		€ 3,50	€ 49								
	columns 4,0 m				14		€ 14,00	€ 196								
	columns 4,5m				8		€ 15,75	€ 126								
	columns 5,0 m				6		€ 17,50	€ 105								
	reciprocal frame 6,0 m				12		€ 21,00	€ 252								
	beams 4,0 m				12		€ 14,00	€ 168								
	beams 6,0 m				12		€ 21,00	€ 252								
Transport	truck				2		€ 50,00	€ 100								
Treatment	treatment bad				1		€ 200,00	€ 200								
Chemicals borax, boric	chemicals 25kg bag, borax				6		€ 80,00	€ 480								
Joint material type 1 (reciprocal)	joints				8		€ 10,00	€ 80								
Joint material type 2 (bolts + nuts)	50 bolts + nuts				50		€ 2,50	€ 125								
	48 bamboo sticks	3			1		€ 10,50	€ 11								
Bracing	steel / bamboo	12					€ 10,90	€ 131								
Bamboo offcuts	bamboo				15%			€ 341								
Total load bearing structure								**€ 2.615**	**KES 292.930**							
Wall (bamboo protection)																
Wall (10.4 m)	gabions (natural stone)		36,4				€ 14,00	€ 510								
	frame		72,8				€ 1,10	€ 80								
	steel construction 3,5m				16		€ 14,20	€ 227								
	plaster		72,8				€ 4,00	€ 291								
Total wall								**€ 1.108**	**KES 124.105**							

2

COST ESTIMATION C

item	description	m	m2	m3	quantity	tools	cost / unit	MATERIAL COSTS		worker	days	wage	LABOUR COSTS		TOTAL COSTS	
								€	KES				€	KES	€	KES
Roof structure																
Secondary wood structure	wood 6x2"				207		€ 1,00	€ 207								
	wood 6x1"				640		€ 0,40	€ 256								
Waterproofness layer			60				€ 1,55	€ 93								
Roof Skin	fabric		60				€ 1,10	€ 66								
	chicken wire		60				€ 1,10	€ 66								
	ferro cement t=2,5cm		70				€ 6,50	€ 455								
Total roof structure								**€ 1.143**	**KES 128.016**							
Solar cells																
SRI / Solar cells*			10				€ 0,00	€ 0								
Peripheral equipment					10		€ 10,00	€ 100								
Batteries					1		€ 400,00	€ 400								
Invertor					1		€ 600,00	€ 600								
Cables		15					€ 1,50	€ 23								
Total solar cells								**€ 1.123**	**KES 125.720**							
Water system																
Gutter roof			42				€ 4,70	€ 197								
Channel		9					€ 4,70	€ 42								
Gutter floor			42				€ 4,70	€ 197								
Storage tank 5000L					5000		€ 0,09	€ 450								
Total water system								**€ 887**	**KES 99.355**							

item	description	m	m2	m3	quantity	tools	cost / unit	MATERIAL COSTS		worker	days	wage	LABOUR COSTS		TOTAL COSTS	
								€	KES				€	KES	€	KES
Labour costs																
Construction site	volunteers									20	15	€ 0,00	€ 0			
	skilled worker									2	15	€ 7,00	€ 210			
	unskilled worker									18	15	€ 3,50	€ 945			
Bamboo selection + treatment	skilled worker									2	4	€ 10	€ 80			
	unskilled worker									4	1	€ 3,50	€ 14			
Electrician / Solar cells	skilled worker									1	3	€ 20	€ 60			
Ferro cement expert	skilled worker									1	5	€ 20	€ 100			
Total labour cost													**€ 1.409**	**KES 157.808**		
TOTAL COST DIRECT CONSTRUCTION								**MATERIAL COST**					**LABOUR COST**		**TOTAL COST**	
Total costs 1 Pavilion								**€ 10.211**	**KES 1.143.624**				**€ 1.409**	**KES 157.808**	**€ 11.620**	**KES 1.301.432**
Total costs 6 Pavilions								**€ 61.266**	**KES 6.861.742**				**€ 8.454**	**KES 946.848**	**€ 69.720**	**KES 7.808.590**

* These costs are sponsored by Sustainable Rural Initiatives

3

C COST ESTIMATION

B/ Direct construction costs / 3. Functions

item	description	m	m2	m3	quantity	tools	cost / unit	MATERIAL COSTS €	MATERIAL COSTS KES	worker	days	wage	LABOUR COSTS €	LABOUR COSTS KES	TOTAL COSTS €	TOTAL COSTS KES
Office SRI (36 m²)																
Walls	fired brick 42 m		150				€ 17,00	€ 2.550								
Openings	door, steel				2		€ 90,00	€ 180								
	window, steel				3		€ 70,00	€ 210								
Electricity	socket + light				3		€ 10,00	€ 30								
Total								**€ 2.970**	**KES 332.640**							
(ICT) training room (54 m²)																
Walls	fired brick 52 m		183				€ 17,00	€ 3.111								
Openings	door, steel				1		€ 90,00	€ 90								
	door, wood				2		€ 72,00	€ 144								
	window, steel				6		€ 70,00	€ 420								
Electricity	socket + light				30		€ 10,00	€ 300								
Total								**€ 4.065**	**KES 455.280**							
Internet cafe (18 m²)																
Walls	fired brick 17 m		60				€ 17,00	€ 1.020								
Openings	door, steel				2		€ 90,00	€ 180								
	window, steel				1		€ 70,00	€ 70								
Electricity	socket + light				8		€ 10,00	€ 80								
Total								**€ 1.350**	**KES 151.200**							
Mini library (36 m²)																
Walls	fired brick 40 m		140				€ 17,00	€ 2.380								
Openings	door, wood				2		€ 72,00	€ 144								
Electricity	socket + light				3		€ 10,00	€ 30								
Total								**€ 2.554**	**KES 286.048**							
Toilets / Kitchen (36 m²)																
Floor	concrete			0,6			€ 156,00	€ 94								
Walls	fired brick 35 m		123				€ 17,00	€ 2.091								
Openings	door				5		€ 50,00	€ 250								
Electricity	socket + light				4		€ 10,00	€ 40								
Total								**€ 2.475**	**KES 277.155**							
Shops (18 m²)																
Walls	fired brick 30 m		105				€ 17,00	€ 1.785								
Openings	window, steel				6		€ 70,00	€ 420								
Electricity	socket + light				4		€ 10,00	€ 40								
Total								**€ 2.245**	**KES 251.440**							

COST ESTIMATION C

item	description	m	m2	m3	quantity	tools	cost / unit	MATERIAL COSTS €	MATERIAL COSTS KES	worker	days	wage	LABOUR COSTS €	LABOUR COSTS KES	TOTAL COSTS €	TOTAL COSTS KES
Water source																
Drainage water channel			2		2		€ 4,70	€ 19								
Filters					2		€ 100,00	€ 200								
Storage tank 2000L					2000		€ 0,09	€ 180								
Pump					1		€ 1.300,00	€ 1.300								
Total								**€ 1.699**	**KES 190.266**							
Community space (240 m²)																
Walls	stone 18m		54				€ 17,00	€ 918,00								
Electricity	solar lamps				10		€ 10,00	€ 100,00								
Total								**€ 1.018**	**KES 114.016**							
Labour costs	skilled worker									4	22	€ 7,00	€ 616			
	unskilled worker									20	22	€ 3,50	€ 1.540			
Total													**€ 2.156**	**KES 241.472**		
TOTAL DIRECT CONSTRUCTION COSTS FUNCTIONS								**€ 18.375**	**KES 2.058.045**				**€ 2.156**	**KES 241.472**	**€ 20.531**	**KES 2.299.517**

RECAP:

Total direct construction costs functions	MATERIAL COST €	MATERIAL COST KES	LABOUR COST €	LABOUR COST KES	TOTAL COST €	TOTAL COST KES
Office SRI (36 m²)	€ 2.970	KES 332.640				
(ICT) training room (54 m²)	€ 4.065	KES 455.280				
Internet cafe (18 m²)	€ 1.350	KES 151.200				
Mini library (36 m²)	€ 2.554	KES 286.048				
Toilets (12 m²)	€ 2.475	KES 277.155				
Shops (18 m²)	€ 2.245	KES 251.440				
Water source	€ 1.699	KES 190.266				
Community space (240 m²)	€ 1.018	KES 114.016				
Total costs Functions	**€ 18.375**	**KES 2.058.045**	**€ 2.156**	**KES 241.472**	**€ 20.531**	**KES 2.299.517**

C COST ESTIMATION

C/ Indirect construction costs

item	percentage	direct construction costs	REAL DIRECT COST	
Construction + execution costs	7,00%	€ 90.251	€ 6.318	KES 707.567
General costs	6,00%	€ 96.569	€ 5.794	KES 648.940
Risk	4,00%	€ 102.363	€ 4.095	KES 458.585
Further to detail	4,00%	€ 106.457	€ 4.258	KES 476.928
Total indirect construction costs			**€ 20.464**	**KES 2.292.020**

Total indirect construction costs **€ 20.000**

D/ Interior costs

item	description	m	m2	m3	quantity	tools	cost / unit	MATERIAL COSTS €	MATERIAL COSTS KES	worker	days	wage	LABOUR COSTS €	LABOUR COSTS KES	TOTAL COSTS €	TOTAL COSTS KES
Gate																
Furniture	chair				1		€ 12,00	€ 12								
	desk				1		€ 24,00	€ 24								
Total								**€ 36**	KES 4.032				**€ 0**	KES 0	**€ 36**	KES 4.032
Office SRI (36 m²)																
Labour	skilled worker									1	0,25	€ 7,00	€ 2			
Furniture	desk				6		€ 24,00	€ 144								
	chair				14		€ 12,00	€ 168								
	lockable storage				2		€ 40,00	€ 80								
Facilities	SRI / computer*				2		€ 0,00	€ 0								
	software*				2		€ 0,00	€ 0								
Total								**€ 392**	KES 43.904				**€ 2**	KES 196	**€ 394**	KES 44.100
(ICT) training room (54 m²)																
Labour	skilled worker									1	2,5	€ 7,00	€ 18			
Furniture	desk				40		€ 40,00	€ 1.600								
	chair / bench				40		€ 12,00	€ 480								
	SRI / computer*				20		€ 0,00	€ 0								
Facilities ICT	software*				30		€ 0,00	€ 0								
	blackboard				1		€ 50,00	€ 50								
	extension cord / power strip	30					€ 2,00	€ 60								
Facilities tailoring	SRI / sewing machine*				20		€ 0,00	€ 0								
Total								**€ 2.190**	KES 245.280				**€ 18**	KES 1.960	**€ 2.208**	KES 247.240
Internet cafe (18 m²)																
Labour	skilled worker									1	0,75	€ 7,00	€ 5			
Furniture	desk				7		€ 24,00	€ 168								
	chair				7		€ 12,00	€ 84								
	SRI / computer*				6		€ 0,00	€ 0								
	software*				6		€ 0,00	€ 0								
Facilities	internet				1		€ 80,00	€ 80								
	SRI / scanner*				1		€ 0,00	€ 0								
	printer				1		€ 50,00	€ 50								
Total								**€ 382**	KES 42.784				**€ 5**	KES 588	**€ 387**	KES 43.372
Mini library (36 m²)																
Furniture	bookcase (40/m)	15					€ 10,00	€ 150								
	desk				3		€ 24,00	€ 72								
	chair				5		€ 12,00	€ 60								
	book blocks				35		€ 15,00	€ 525								
	hammock/seats				5		€ 10,00	€ 50								
Facilities	community / books				500		€ 4	€ 2.000								
Total								**€ 2.857**	KES 319.984				**€ 0**	KES 0	**€ 2.857**	KES 319.984

* These costs are sponsored by Sustainable Rural Initiatives

C COST ESTIMATION

item	description	m	m2	m3	quantity	tools	cost / unit	MATERIAL COSTS €	MATERIAL COSTS KES	worker	days	wage	LABOUR COSTS €	LABOUR COSTS KES	TOTAL COSTS €	TOTAL COSTS KES
Toilets / Kitchen (36 m²)																
Labour	skilled worker									1	1	€ 7,00	€ 7			
Sanitary	sink				4		€ 50,00	€ 200								
Kitchen					1		€ 750,00	€ 750								
Total								**€ 950**	KES 106.400				**€ 7**	KES 784	**€ 957**	KES 107.184
Shops (18 m²)																
Furniture	chair				4		€ 12,00	€ 48								
	table				3		€ 24,00	€ 72								
Total								**€ 120**	KES 13.440				**€ 0**	KES 0	**€ 120**	KES 13.440
Community space (240 m²)																
Furniture	benches / chairs 40m		16				€ 17,00	€ 272		10	5	€ 3,50	€ 175,00			
Facilities	beamer				1		€ 700,00	€ 700								
Total								**€ 972**	KES 108.864				**€ 175**	KES 19.600	**€ 1.147**	KES 128.464
TOTAL INTERIOR COST								**€ 7.899**	**KES 884.688**				**€ 207**	**KES 23.128**	**€ 8.106**	**KES 907.816**

RECAP:

Total interior costs		
Gate	€ 36	KES 4.032
Office SRI (36 m²)	€ 394	KES 44.100
(ICT) training room (54 m²)	€ 2.208	KES 247.240
Internet cafe (18 m²)	€ 387	KES 43.372
Mini library (36 m²)	€ 2.857	KES 319.984
Toilets (12 m²)	€ 957	KES 107.184
Shops (18 m²)	€ 120	KES 13.440
Community space (240 m²)	€ 1.147	KES 128.464
Total costs functions	**€ 8.106**	**KES 907.816**

E / Educational costs

item		m	m2	m3	quantity	tools	cost / unit	MATERIAL COSTS €	KES
Education material									
Information events	bamboo workshop, lectures				25		€ 15,00	€ 375	KES 42.000
Print costs handbook	readers				50		€ 4,00	€ 200	KES 22.400
Print costs work plans (A1,3.25)	packages				25		€ 15,00	€ 375	KES 42.000
Total educational costs								**€ 950**	**KES 106.400**

F / Organisational costs

item		m	m2	m3	quantity	tools	cost per unit	MATERIAL COSTS €	KES
Travel costs									
Flight 2 persons	Amsterdam - Kisumu				2		€ 850,00	€ 1.700	
Fuel (30km O-K)					1000		€ 0,90	€ 900	
Trailer rent 3 months					3		€ 500,00	€ 1.500	
Total Travel cost								**€ 4.100**	**KES 459.200**
Accommodation									
Guesthouse 2 persons					2		€ 650,00	€ 1.300	
Accomodation 25 persons					25		€ 425,00	€ 10.625	
Matrasses					15		€ 18,00	€ 270	
Total Accommodation cost								**€ 12.195**	**KES 1.365.840**
Food and drinks 2 persons									
Breakfast, lunch dinner, drinks	90 days, 2 persons				180		€ 7,90	€ 1.422	
Total food & drinks cost								**€ 1.422**	**KES 159.264**
Food and drinks									
Breakfast	90 days, 20 persons				1800		€ 0,70	€ 1.260	
Lunch	90 days, 40 persons				3600		€ 1,20	€ 4.320	
Dinner	90 days, 20 persons				1800		€ 3,00	€ 5.400	
Drinks	90 days, 20 persons				1800		€ 2,75	€ 4.950	
Total food & drinks cost								€ 15.930	KES 1.784.160
TOTAL ORGANISATIONAL COSTS									
Without food & drinks								**€ 17.717**	**KES 1.984.304**
With food & drinks								**€ 33.647**	**KES 3.768.464**

* These costs are sponsored by Sustainable Rural Initiatives

APPENDIX 3:
GRADUATION PLANNING

C GRADUATION PLANNING

PROJECT PLANNING // EXPLORE LAB

Week	Dates	WEEKLY GOALS: RESEARCH	WEEKLY GOALS: DESIGN	WEEKLY GOALS: ORGANISATION	APPOINTMENTS: MEETINGS / INTERVIEWS
WEEK 3.1-3.10					
7 / 3.1	09.02.15 - 15.02.15	Formulating project goal		Searching for mentors	13.02.15 09.30 Meeting Nelson Mota
8 / 3.2	16.02.15 - 22.02.15	**Defined project goal**			
9 / 3.3	23.02.15 - 01.03.15	Formulating research questions Literature study		**Mentor team**	23.02.15 11.00 Meeting Esther Blom TBM 24.02.15 11.00 Meeting Max Verhoeven, Juan Carlos 25.02.15 12.00 Meeting Thijs Asselbergs 26.02.15 11.00 Meeting John Heintz
10 / 3.4	02.03.15 - 08.03.15	Workshop groups		Looking for partners / location	04.03.15 14.00 Meeting Maarten Duijnisveld, Students4Sustainability 05.03.15 09.30 Meeting Nelson Mota
11 / 3.5	09.03.15 - 15.03.15				10.03.15 14.30 Meeting Kristel de Krijger, Chairman NGO Stichting SamenScholen 10.03.15 16.00 Meeting Thijs Asselbergs, Marcel Bilow 11.03.15 12.30 Joining lunch lecture Students4Sustainability
12 / 3.6	16.03.15 - 22.03.15			**Choosing NGO / project location**	17.03.15 17.00 Meeting Wouter Neisingh, YES!Delft Students
13 / 3.7	23.03.15 - 29.03.15	**Research questions** **Research proposal** **Graduation plan** Booking flights Preparing fieldtrip **Workshop proposal**			23.03.15 Meeting Students4Sustainability 24.03.15 11.30 Meeting Nelson 27.03.15 12.30 Visiting project market Students4Sustainability
14 / 3.8	30.03.15 - 05.04.15			**P1**	30.03.15 12.15 - 12.45 **P1 presentation** 01.04.15 10.00 - 10.30 **P1 presentation**
15 / 3.9	06.04.15 - 12.04.15	Literature study Research Organisational activities workshop			15.04.15 16.00 Meeting Hugo Hagedooren, Students4Sustainability (Contract) 16.04.15 12.00 Meeting Thijs Asselbergs, Marcel Bilow 17.04.15 12.00 Meeting Pieter Stoutjesdijk 17.04.15 19.00 springFESTdeCeuvel, 'Architecture in Development' 18.04.15 16.00 Meeting James Otieno Jowi, Chairman NGO SRI 19.04.15 11.00 Meeting Marco Koekkoek
16 / 3.10	13.04.15 - 19.04.15				20.04.15 12.30 Meeting Ernst Schutte 21.04.15 14.00 Meeting Jaap van Kemenade 21.04.15 16.00 Meeting Johan Smorenburg 24.04.15 11.00 Meeting Nelson Mota 24.04.15 13.00 Meeting Gabriel Hirlav
WEEK 4.1-4.11					
17 / 4.1	20.04.15 - 26.04.15				
18 / 4.2	27.04.15 - 03.05.15	**Planning + meetings** **Fieldtrip focuspoints** **Maps**			30.04.15 13.00 Meeting Thijs Asselbergs, Marcel Bilow
19 / 4.3	04.05.15 - 10.05.15	Field trip KENYA			06.05.15 21.40 flight to NAIROBI 08.05.15 Interview Tina Wentink (SRI)
20 / 4.4	11.05.15 - 17.05.15		Formulating concept	Documenting information	09.05.15 Interview Japheth Odhiambo Owidi, Kowi Farming & Trading 11.05.15 Interview Evelyn, teacher Ranjira secondary school + students 12.05.15 Interview Lucaa Aoro, Dick Machani, Okana primary school 16.05.15 Interview Gordon Ouru, SRI board member 19.05.15 Interview Coretti, Celine 21.05.15 Interview Kenya Forestry Research Institute 22.05.15 Interview George
21 / 4.5	18.05.15 - 24.05.15				12.05.15 Interview students, Okana primary school 12.05.15 Interview Elisabeth (George) 14.05.15 Interview Edwin, Susan, Harriet, engineering students Moi University 22.05.15 Meeting Chief Subharaza 23.05.15 Interview Material Lab Kisumi 25.05.15 Interview James Otieno Jowi
22 / 4.6	25.05.15 - 31.05.15	**Back in the Netherlands**	Design steps		14.05.15 Interview Cox Sitters, Prof. civil engineering Moi University 26.05.15 Interview Verah Atieno Owiti 28.05.15 13.15 arrival in AMSTERDAM
23 / 4.7	01.06.15 - 07.06.15	Fixing the workshop date			04.06.15 10.00 Meeting Nelson Mota 04.06.15 13.00 Meeting Thijs Asselbergs, Marcel Bilow
24 / 4.8	08.06.15 - 14.06.15			**Drawings / maps** **movies / pictures**	09.06.15 14.00 Meeting Thijs Asselbergs 09.06.15 16.00 Meeting Nelson Mota
25 / 4.9	15.06.15 - 21.06.15			**P2**	19.06.15 10.15 - 12.30 **P2 presentation Go / No Go**
26 / 4.10	22.06.15 - 28.06.15	Formulating graduation & 1:1 project goal			23.06.15 12.30 Giving the Lunchlecture: Natuurlijk bouwen kun jij ook: NATURAL BUILDING IN DEVELOPING COUNTRIES 23.06.15 16.00 Meeting James Otieno Jowi, Chairman NGO SRI, Utrecht
27 / 4.11	29.06.15 - 05.07.15	Research report Limitations / expectations Planning up to P5	Design steps		09.07.15 11.00 Meeting Nelson Mota, Thijs Asselbergs, Marcel Bilow 09.07.15 15.30 Meeting Tom Avermate
WEEK 5.1-5.8					
28 / 5.1	06.07.15 - 12.07.15	**Goals / Planning**			
29 / 5.2	13.07.15 - 19.07.15	Holiday			
30 / 5.3	20.07.15 - 26.07.15	**Holiday**			25.07.15 9.30 Skype meeting workshop group Explore Lab

GRADUATION PLANNING C

31 / 5.4	27.07.15 - 02.08.15					Movie (sponsors, concept)						
32 / 5.5	03.08.15 - 09.08.15		Promotion activities workshop				Costs analysis Building phase planning					
33 / 5.6	10.08.15 - 16.08.15					**Promotion movie**		Organisation volunteer team				
34 / 5.7	17.08.15 - 23.08.15			**Design: (floor)plans 1:200 1:100 Buildingtechnology / sections Climate concept**		Sponsor list / enquiries Promotion activities sponsors / volunteer team			20.08.15	10.00 Meeting Thijs Asselbergs		
35 / 5.8	24.08.15 - 30.08.15				Study model				25.08.15 27.08.15	10.00 Meeting Thijs Asselbergs, Marcel Bilow 11.30 Meeting Michiel Smits		
WEEK 1.1-1.10												
36 / 1.1	31.08.15 - 06.09.15			Design: (floor)plans Buildingtechnology Sections / elevations Materiality, Climate			**Budget**		04.09.15	12.45 Meeting Hugo Hagedooren + minor group 2015/2016 International Entrepreneurship & Development		
37 / 1.2	07.09.15 - 13.09.15								07.09.15 10.09.15 13.09.15	11.00 Meeting Nelson Mota 13.00 Meeting Thijs Asselbergs, Marcel Bilow 12.30 Meeting James Otieno Jowi, Chairman NGO SRI, Utrecht	13.09.15	15.30 Meeting Jowi + minor group 2015/2016 IE&D
38 / 1.3	14.09.15 - 20.09.15		**Workshop**		Watching render movies	Website	Building phase planning		17.09.15 17.09.15	11.00 Meeting Nelson Mota, Thijs Asselbergs, Marcel Bilow Organised Workshop Explore Lab -Changfang Luo, Juan Carlos, officie Carpe Via		
39 / 1.4	21.09.15 - 27.09.15						**Detailled building phase planning**		21.09.15 23.09.15 25.09.15	15.00 Meeting Juan Carlos 10.00 Peter de Jong 11.00 Meeting Thijs Asselbergs	26.09.15	9.00 - 17.00 Workshop Earthplaster, by Arie van Ziel (Architect, TUDelft)
40 / 1.5	28.09.15 - 04.10.15						Organisational activities building phase Materials		29.09.15	10.00 Meeting Marcel Bilow		
41 / 1.6	05.10.15 - 11.10.15				**Model**			**Volunteer team**	01.10.15 05.10.15 06.10.15 10.10.15	Deadline promotion movie, project plan, cost estimation 11.00 Meeting S4S Hugo Hagedooren, Daan Gorsse 12.30 Meeting Thijs Asselbergs, Frits van Loon 09:00 - 15:00 Meeting Construction Dipl.-Ing. Peter Oed / Prof. Manfred Eisele / Dipl.-Ing. Donatz / Dipl.-Ing. Joachim Straehle	06.10.15	14.00 Meeting Nelson Mota
42 / 1.7	12.10.15 - 18.10.15	**Handing in Draft version research report**		**Design: plans, details 1:100 - 1:20**				**P3**	14.10.15 16.10.15	10.00 Meeting Marcel Bilow 11.00 - 12.00 **P3 presentation** Nelson Mota, Thijs Asselbergs		
43 / 1.8	19.10.15 - 25.10.15	Project report		Design: (floor)plans Buildingtechnology Sections / elevations Materiality, Climate Energy cycles		Promotion activities for sponsors Website updates		Informing volunteers. Contract, presentations, workshops	20.10.15 22.10.15 23.10.15	13.00 Meeting Ernst Schütte, intern SRI / solar energy 14.00 Meeting Hugo Hagedooren, contract sponsormoney 08.45 Meeting Frits van Loon, Thijs Asselbergs		
44 / 1.9	26.10.15 - 01.11.15											
45 / 1.10	02.11.15 - 08.11.15								06.11.15	14.00 Meeting Thijs Asselbergs		
WEEK 2.1-2.10												
46 / 2.1	09.11.15 - 15.11.15				**Renderexpert**				09.11.15 10.11.15 13.11.15	15.30 Meeting Esther Blom TBM 14.00 Meeting Nelson Mota 13.00 Meeting Marcel Bilow		
47 / 2.2	16.11.15 - 22.11.15		Handbook construction steps						17.11.15 19.11.15 19.11.15	13.00 Skype meeting BIS, Martine Stoppelenburg 12.00 - 12.30 Meeting Tom Avermaete 14.00 Meeting Arie van Ziel	20.11.15	15.00 Meeting James Otieno Jowi
48 / 2.3	23.11.15 - 29.11.15				Model				23.11.15 24.11.15	14.00 Meeting Nelson Mota Meeting Thijs Asselbergs		
49 / 2.4	30.11.15 - 06.12.15			**Design: plans, details 1:5 1:1**				**P4**	03.12.15 03.12.15	10.30-13.00 **P4 presentation Go / No Go** 15.00 Meeting Vincent Gruis		
50 / 2.5	07.12.15 - 13.12.15				Building 1:2 prototype Bucky Lab							
51 / 2.6	14.12.15 - 20.12.15				**1:2 prototype**				15.12.15 16.12.15	10.00 Meeting Thijs Asselbergs 13.30 Meeting Nelson Mota		
52 / --	21.12.15 - 27.06.15			Elaborating drawings Preparing final presentation		Promotion activities for sponsors	Organisational activities building phase		21.12.15	12.30 Meeting Marlies van Geenen, Charles van Voorst Vader		
53 / --	28.06.15 - 03.01.16											
1 / 2.7	04.01.16 - 10.01.16	Printing book / posters							07.01.15 08.01.15	09.00 Meeting Nelson Mota 14.00 Meeting Thijs Asselbergs		
2 / 2.8	11.01.16 - 17.01.16				**Renders**				20.01.15 20.01.15	10.00 Meeting Michael Jonker 14.00 Meeting Marcel Bilow		
3 / 2.9	18.01.16 - 24.01.16	**Project report / posters**		**Final presentation**	**Models in different scales**			**P5**				
4 / 2.10	25.01.16 - 31.01.16	**P5 PRESENTATION**							**29.01.15**	**P5 presentation** Continuing with further detailing / drawings and preparations for the building phase in March, April and May on site.		