Project Amaka is a multidisciplinary project by Aalto University students exploring integrated solutions to the water issues facing the Katanga settlement in Kampala, Uganda. The project is a part of the Sustainable Global Technologies Studio course provided by Aalto University School of Engineering. The project is enabled by Problem Based Learning East Africa and funded by The Ministry of Foreign Affairs of Finland.

PROJECT AMAKA
Final Report by Jarrod Luxton,
Stephanie Kluz, Pettiina Niiranen,
Maimuna Syed, Nehal Jain

WAT-E2070 Sustainable Global Technologies Studio
Aalto University School of Engineering

PBL East Africa

From a Surviving to Thriving Katanga

Project Amaka Final Report

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Stephanie Kluz
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IMAGE 1
A child in Katanga plays with water and plastic water bottles

ABSTRACT

Project Amaka is a multidisciplinary project by five Aalto University students exploring integrated solutions to the water issues facing the Katanga settlement in Kampala, Uganda. The project is a part of the Sustainable Global Technologies Studio course provided by Aalto University School of Engineering. The project is enabled by Problem Based Learning East Africa and funded by The Ministry of Foreign Affairs of Finland.

The aim of this project is to develop sustainable and functional solutions related to water, sanitation and hygiene (WASH) outcomes within the community, while addressing environmental pollution issues. The project was driven by the vision to enable Katanga to move from surviving to thriving. Project Amaka consisted of field research and community engagement activities to inform the suggested design outcomes. The chosen focus group for research and engagement was families living in Katanga, although this project addresses all residents indirectly. The project utilised both qualitative and quantitative research techniques including desktop assessments, field investigations, community workshop and interviews.

Several significant findings were established. Firstly, challenges to achieving WASH outcomes in an informal settlement like Katanga are complex and involve layered groups of stakeholders. Hence, implementation of new solutions requires careful coordination and collaboration. Secondly, impacts of water resources and solutions go beyond WASH aspects, as they can have a strong effect on the economic, mental and social wellbeing of the community, individuals and local businesses. Thirdly, in addition to improved water solutions, the residents of Katanga aspire for improved private spaces, whether it was related to sanitation or living space overall. In the concept design phase, Project Amaka delivered a suite of integrated water solutions that could enable the community and broader stakeholder group to pursue the vision for Katanga. The concept design addresses water supply, water quality, sanitation, drainage and environmental issues along with short and long term suggestions for successful implementation.

Project Amaka is integrated with Emu ku'emu – a low cost modular housing concept for Katanga developed by a team of six students from Makerere University, Uganda. Together these projects form a vision forward for Katanga and its vibrant community that is sustainable and inclusive.

ACKNOWLEDGEMENTS

Thank you...

Community in Katanga, the Chairman and community volunteers for your warmth, collaboration and for sharing your beautiful visions with us.
Makerere University student team – Warren, Eriya, Marvin, Ivy, Ima, Amelia – for giving us inspiration, motivation, friendship and restless support.
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Nankya for your hospitality.
Experts who helped us along the way.
PBL East Africa Uganda 2019 team, Aalto Sustainable Global Technologies Programme, Aalto Global Impact and Ministry of Foreign Affairs of Finland.

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IMAGE 2
A house in Katanga

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ABBREVIATIONS

AGI Aalto Global Impact
AU African Union
CBO Community based organisation
CEDAT College of Engineering, Design, Art and Technology
EUR Euro
GDP Gross domestic product
GNI Gross national income
KCCA Kampala Capital City Authority
MAK Makerere University
MLHUD Ministry of Lands, Housing, and Urban Development
NGO Non-governmental organisation
NPDP National Physical Development Plan
PBL Problem Based Learning
SGT Sustainable Global Technologies
UDDT Urine diverting dry toilet
UN United Nations
UNDP United Nations Development Program
UNSUS Uganda National Slum Upgrading Strategy
UGX Ugandan Shilling (1 EUR = 4 098.10 UGX)
USD United States dollar
WASH Water, sanitation and hygiene

01

INTRODUCTION

IMAGE 3
Jerry Cans on rooftop of a house in Katanga

Project Amaka is a multidisciplinary project by Aalto University students exploring integrated solutions to the water issues facing the Katanga settlement in Kampala, Uganda. The project is a part of the Sustainable Global Technologies Studio course provided by Aalto University School of Engineering. The project is enabled by Problem Based Learning East Africa and funded by The Ministry of Foreign Affairs of Finland.

Through a collaborative design process informed by literature review, field investigations and community engagement, Project Amaka has compiled a suite of complementary water solutions for the Katanga settlement and created a high-level integrated conceptual plan for a small pilot area within the community. Our team has worked to integrate Project Amaka with Emu ku'emu – a low cost modular housing concept for Katanga developed by a student team from Makerere University, Uganda. Together these projects form a vision forward for Katanga and its vibrant community that is sustainable and inclusive.

Sustainable Global Technologies Studio

Sustainable Global Technologies (SGT) Studio provides an opportunity for students to "carry out projects linked to global development challenges" in Africa, Asia and Latin America (Aalto SGT, 2018). Designed for master level and doctoral students, SGT Studio engages students in co-creation and multidisciplinary teamwork with partners from academia, industries, governments and civil society. SGT Studio is a part of the SGT Programme provided by Aalto University School of Engineering, which invites students to "study the diverse connections between sustainability, technology, cultural and societal challenges." (ibid)

SGT Studio Responsible Professor:
Olli Varis, Aalto Professor, Matti Pursula Professorship: Water resources management, Aalto School of Engineering

SGT Programme Manager:
Matleena Muhonen, Lecturer in Landscape Architecture, Aalto School of Arts, Design and Architecture

IMAGE 4
Street art at Katanga Settlement

PBL East Africa

Problem Based Learning (PBL) East Africa is a joint initiative between University of Dar es Salaam, University of Nairobi, Makerere University and Aalto University, with a goal to promote research and education in the field of sustainable social innovation. PBL East Africa is an umbrella project under a project-based education framework facilitated by Aalto Global Impact (AGI), which also includes PBL South Asia and involves students from Sustainable Global Technologies, Creative Sustainability and International Design Business Management educational programmes. PBL East Africa is funded by the Ministry of Foreign Affairs of Finland. (Aalto Global Impact, n.d.)

Funding partners

The project is enabled by PBL East Africa and funded by the Ministry of Foreign Affairs of Finland. According to its development policy goals (n.d.), the Ministry of Foreign Affairs engages in diverse forms of development cooperation with a geographical focus on Africa.

Makerere University

Our project is done in collaboration with a student team at Makerere University (MAK). Located in the capital of Uganda, Kampala, MAK is the largest institution for higher education in the country and one of the oldest universities in Africa. The university has 10 colleges covering fields from environmental sciences, medicine and technology to humanities and arts, among others. (Makerere University, 2020) Project Amaka's partner college is the College of Engineering, Design, Art and Technology (CEDAT).

Makerere Student Team and Emu ku'emu Concept

The partnering student team from MAK was chosen through a multidisciplinary design competition. The University held a competition with the theme of working towards a better livelihood in peri-urban communities with a focus on food, water and sanitation, waste, housing and energy solutions for these communities.

The winning team, representing expertise in architecture, civil engineering, quantity surveying and art design, created a housing development plan for the Katanga settlement in Kampala. Their housing concept, Emu ku'emu, is a modular design focused on improving the quality of living in Katanga by decongesting the space and providing better living space both indoor and outdoor, more functional commercial spaces, as well as open spaces for recreation, especially for children who are the largest demographic group in Katanga.

The six students comprising the team from MAK are Warren Econi (Architecture), Eriya Khauka (Architecture), Marvin Tugume (Architecture), Amelia Ainebabazi (Civil engineering), Ooga Ivy Arembe (Quantity Surveying) and Immaculate Nabakiibi (Art Design). The team is supported by their chief mentor, Dr. Stephen Mukiibi and other MAK mentors.

Our role and the team

The Emu ku'emu concept developed by MAK student team designated our project focus to the Katanga Settlement. Our role in the collaborative project has been about exploring solutions to the water issues facing the community by including and engaging the local residents in the planning and development process of housing, living and related water solutions in Katanga. With expertise in Water Engineering, we have developed a concept design that introduces functional solutions with implementation suggestions.

Our concept design supplements and draws inspiration from the Emu ku'emu design, all while the designs have been strongly informed by the ideas and opinions of the residents of Katanga. If fully implemented, our designs aspire to empower the people of Katanga in their daily living and move the community from surviving to thriving.

Our team consists of five students: Nehal Jain, Stephanie Kluz, Jarrod Luxton, Pettiina Niiranen and Maimuna Syed. The team is supported by Aalto University mentors and coordinators Johanna Laaksonen, Matleena Muhonen and Helena Sandman.

Maimuna Syed
Maimuna is a software developer from Bangladesh and Saudi Arabia. She is currently a student at Aalto University majoring in Mobile Computing and Security and in addition minoring in Game Production, HCI and Creative Sustainability.

She has experience working as a coding mentor in development programs in Finland, Saudi Arabia, Mozambique and South Africa. She wishes to apply her computer science know-how in humanitarian computing and development projects in the future.

Nehal Jain

Nehal is a strategic designer from India. She is pursuing an M.A. in Collaborative and Industrial Design at Aalto University, in the second year. She envisions herself as a designer who is not restricted to one field, specific project briefs or continental boundaries, one who dons different roles in a project ready to juggle responsibilities and work towards using a society-centred approach to bring positive impact in the society. She is currently working with this approach of design in her thesis where she is exploring the role of design in transforming the practices of policy-making.

Stephanie Kluz

Stephanie is a civil engineer from the United States. She is now completing a Nordic Master's degree in Environmental Engineering specialising in Water Resource Management with the first year at Aalto University. Before returning to her studies, she worked as a civil engineer for renewable energy projects. She has previous experience in international projects from leading an Engineers Without Borders project in Guatemala. She hopes to pursue a career in water engineering and management to improve the sustainability of cities and continue working on development projects for areas vulnerable to climate change.

Jarrod Luxton

Jarrod is an engineer from Melbourne, Australia with a passion for developing interdisciplinary solutions to complex problems. He is currently studying his M.Sc. of Water and Environmental Engineering at Aalto University. A creative thinker, Jarrod has a particular interest in nature-based solutions, water sensitive cities and integrated water management.

Pettiina Niiranen

Pettiina is a sustainability specialist from Finland. She is currently completing a master's degree in Creative Sustainability at Aalto University School of Business with a minor in Urban Studies and Planning. Before pursuing her master's studies, she completed a bachelor's degree in International Business with a focus on sustainable business and corporate environmental responsibility and worked in ethics and compliance consultancy. She has a special interest towards sustainability transitions in urban communities and businesses as well as international sustainability cooperation.

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BACKGROUND

IMAGE 5

Wall Decor in Uganda Museum

IMAGE 6
Boat in the middle of Lake Victoria, Jinja

Uganda and capital Kampala

Uganda is an East-Central African country home to a population of 43 million people (World Bank, 2019). The country is bordered by Kenya to the east, South Sudan to the North, the Democratic Republic of the Congo to the west, and Rwanda and Tanzania to the south. Uganda's capital, Kampala, is located on the shores of Lake Victoria and has a population of around 1.5 million (Omulo et al, 2017).

Political history

Uganda has a turbulent political history, dating back to pre-colonial times with the Kingdoms of Buganda, Bunyoro-Kitara, Busoga, Ankole and Toro. By the 19th century, the Kingdom of Buganda rose to ascendancy and in 1896 Uganda was colonised by the British. By 1955, half of the ruling ministers were local and in 1962 Uganda became self-governing. (Commonwealth Secretariat, 2020)

The following years saw the local kingdoms abolished and national power centralised within the government, until in 1971 Idi Amin staged a coup d'état to gain power.

CENTRAL AFRICAN REPUBLIC

SOUTH SUDAN

ETHIOPIA

DEMOCRATIC REPUBLIC OF CONGO

UGANDA

KENYA

LAKE VICTORIA

RWANDA

BURUNDI

TANZANIA

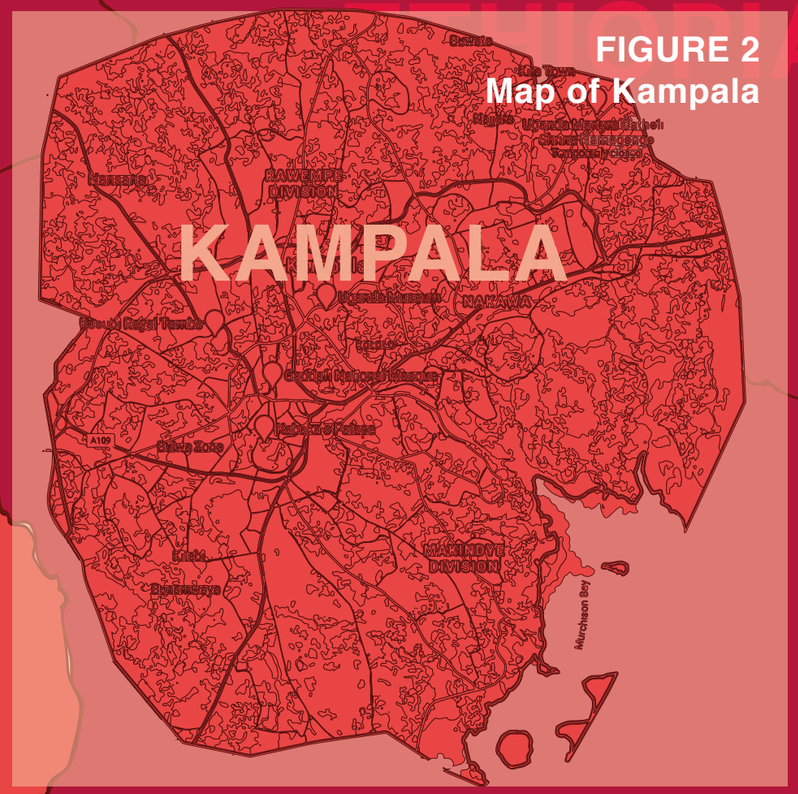

FIGURE 2
Map of Kampala

FIGURE 1
Geographical Context of Uganda

Amin quickly moved into brutal authoritarianism; expelling minority groups and foreigners; seizing property, and hoarding individual wealth. The years under Amin were rife with terror and destruction, until the dictator declared war on neighbouring Tanzania in 1978. The neighbouring army quickly swept through the country and removed Amin from power. (Kapuscinski, 2002)

The 1980s proved turbulent, with regular power struggles and changes in political leadership. The country endured a bloody civil war, resulting in the establishment of the current ruling president Yoweri Museveni and his party, the National Resistance Movement. This brought some stability to the southern regions of the country. Conflict in the north continued until 2007, when the Ugandan government began peace talks with the Lord's Resistance Army for a transition towards long-term peace and stability. (The New Humanitarian, 2007)

Currently, Uganda enjoys relative peace and a democratically elected parliament. However incumbent President Yoweri Museveni, who has been in power since 1986, looks set to remain in power – with a recent constitutional amendment to remove an age limit for presidential candidates.

Allegations of intimidation of parliamentarians during associated debates have been condemned by some voices in the media. A social divide seems to persist between the north and south of the country, with allegations of repression and brutality at protests. (Human Rights Watch, 2019)

Economics and development status

Gross domestic product (GDP) growth in Uganda has slowed since the turn of the century to around 5% over the last 5 years. This has been partly attributed to a burgeoning public debt. Domestically, Uganda's budget is dominated by infrastructure spending, relying instead on foreign aid to support sectors such as agriculture, health and education. (The World Bank, 2019)

IMAGE 7
Kampala City view from Uganda National Mosque
Photo by Pettiina Niiranen

Annual GDP for Uganda in 2018 has been estimated at $27.5 Billion US dollars (USD). In 2018, Uganda's value for Human Development Index was 0.528, representing a state of low human development. In 2017, 79% of the population were living below the poverty line with the population growing at around 3% (one of the fastest rates in the world). (The World Bank, 2019)

The United Nations (UN) classifies Uganda as a 'least developed country', with a gross national income (GNI) of $661 USD. This is well below the 'least developed' threshold of $1,229 USD and one of the lowest in the world. (UN, Department of Economic and Social Affairs, 2019)

Culture

Languages

The diverse range of ethnic groups that make up the Ugandan population contribute to the country's rich culture. In the south, the Bantu speaking people are the dominant demographic. The north contains people generally speaking Nilotic languages. Luganda is the most common language, despite English and Swahili's status as official languages. In multicultural areas such as Kampala, English is used as a common language for people from different regions to communicate. (One Hour Translation, 2016)

Religion

Christianity is the most widely professed religion in Uganda, representing over 84% of the population. 14% of the population adhere to Islam - the largest minority religion.

The country observes national holidays for Ramadan, as well as Easter and Christmas. (Uganda Bureau of Statistics, 2016)

Urbanisation

Uganda has a high rate of urbanisation, with approximately 6 million people inhabiting cities (18% of the national population). Urban areas are swelling rapidly. This is attributed to the prevailing challenges related to poverty, sanitation, health and education issues that are magnified in rural communities. Immigrants to urban areas often arrive without the prospect of employment and must initially move into informal settlements. Approximately 60% of the urban population in Uganda is living in informal settlements. (Omulo et al, 2017)

Katanga settlement

Katanga is an informal neighbourhood in Kampala. It is located about two kilometres from the city center, between Mulago Hospital and Makerere University. Katanga has a population of over 20,000 with more than 50% comprising children under 14 years old.

However, access to adequate water supply, sanitation, waste disposal and housing are widespread issues in Katanga
(Van Leeuwen et al, 2017)

FIGURE 3
Satellite Map of Katanga

MAKERERE KIKONI

OLD MULAGO

MAKERERE UNIVERSITY

MULAGO HOSPITAL

KATANGA

KITANTE

WANDEGEYA

NAKASERO

BUKESA

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Healthcare and education issues remain, although access in both are generally higher than expected in informal settlements – likely due to Katanga's central position adjacent to Mulago Hospital.

Housing

Currently the housing situation in Katanga comprises poorly built single-room residences that often house a large number of residents.

The density of Katanga has continued to grow and complex ownership arrangements exist with sub- and sub-sub-leasing common in the informal settlement. The materials that comprise the buildings often do not last EUR) longer than 3 years. (Muwonge, n.d.)

IMAGE 8
Current housing structures in Katanga.

Almost 70% of Katanga's residents are tenants and 60% of the housing structures are temporary structures. (Van Leeuwen et al. 2017). Based on interviewed residents, monthly rent (2 room house) usually varies between 100 000 and 150 000 UGX (24.4-36.6

Education

Parents in Katanga have most often received informal education or some primary schooling, majorly inhibiting their chances for long-term employment.

Education of children is a significant financial strain on families - access to government schools is available, but many families prefer private education which they consider superior. Anecdotal costs have been noted at 200,000 to 300,000 Ugandan shillings (UGX) per term (50-70 EUR). (Muwonge, n.d.) (Nabwami, 2019)

Health

Adjacent to Mulago Hospital, Katanga has previously had quick and easy access to health facilities. However, changes in Mulago's administration have caused it to become less accessible. Patients can be referred to other hospitals, which causes an issue when residents cannot pay for transport. Residents are also referred to private clinics to purchase medicine. The costs of medicines at the clinics has been seen at double that of rural areas. Where residents cannot afford treatment, they may resort to traditional medicine. (Muwonge, n.d.; Nabwami, 2019)

IMAGE 9 (above). Tailor services in Katanga

IMAGE 10 (below). Car wash facilities in Katanga

Security

Crime rates within Katanga are reported as high, with the Wandegeya police station listed as the nearest police station to Katanga. The settlement draws immigrants from all over Uganda, and desperation is high, resulting in increased crime and drug abuse. (Muwonge, n.d.)

Gender equality

The Ugandan government has identified violence, asset ownership and employment status as key issues facing women in Uganda (Uganda Bureau of Statistics, 2019). Due to poverty, it could be expected that these issues are more severe in Katanga.

Internet

In 2018, 18 million Ugandans had access to the internet (46% of the population), growing very rapidly over the decade. The majority of these consist of wireless mobile phone connections. Recently the government instituted a 200 UGX (0.05 EUR) daily tax on access to internet messaging

IMAGE 11
Child fetching water in Katanga

services. A lack of formal banking services in Uganda means that much of the population rely on mobile phone companies to transfer money via messages. (Ratcliffe, 2019).

Water as a resource in Katanga

Usage

Water is a critical resource for Katanga's population with impacts on domestic habits, enterprises, recreation and health. Potable water usage within Katanga is estimated at around 25 L/person/day. Water supplies in Kampala are generally of poor quality and require local disinfection before drinking.

Most households in Katanga boil water to disinfect their potable water by burning charcoal. Purchasing charcoal represents a significant expense to households. Boiling is slow and represents a source of air pollution within residents' homes and in Katanga's streets.

Water is also an important enabler for local businesses. Katanga's largest and most successful business is a car wash, which has a heavy water usage.

Water is also a critical resource for various street food businesses located in the area. Shopkeepers in turn sell boiled and bottled water to residents. Naturally, water is present in almost all other business activities in Katanga as an indirect but very essential resource

Katanga currently faces an impending water supply crisis due to the combination of several important factors.

Supply and access

There are currently two main sources of water in the settlement: private taps and semi-private springs. The paid taps are located on the fringes of Katanga (piped water does not penetrate far into the settlement). These are owned and operated by private individuals who charge for access, usually at a rate of 200 UGX (0.05 EUR) per jerry can of 20L. This price is around 3 times the price per litre of water supplied from the piped network in Kampala. Apart from the economic cost, the time taken to fetch water can be a significant burden on local residents, particularly women and children. There are also noted safety implications associated with vulnerable parties fetching water. (Muwonge, n.d.; Nabwami, 2019)

The other alternative in Katanga is water provided by several freshwater springs and groundwater pumps within the settlement. There were three main springs in Katanga that operated with various payment arrangements. One groundwater source had electronic per-use tokens that users paid for to operate the pump, while with others, residents paid a single monthly fee for unlimited access. Recently, however, two of the three sources have been shut down due to underlying water quality issues. This could be linked to the large number of unsealed pit latrines and open rubbish dumps that leach contaminants to the underlying shallow aquifers. This has resulted in a large proportion of Katanga relying on a single water source. If the remaining source is compromised, a crisis of water access within the settlement could unfold. Some residents harvest rainwater in an ad-hoc way, but this practice is usually discouraged in Katanga due to poor roof conditions and the presence of 'flying toilets' (a local description of open defecation that is thrown away and can land on nearby roofs).

IMAGE 12 Central waterway in Katanga

Water quality

Katanga is impacted by water quality across several scales. Within households, families must disinfect all drinking water before use, regardless of source. This is not unusual in Kampala, with the official recommendations stating to boil water before use. Like mentioned earlier, most households in Katanga opt for water-boiling by burning charcoal. Also, the storage of disinfected water is problematic, with many households lacking sanitary containers to prevent reinfection of boiled water.

On a larger scale, polluted water from Katanga and surrounds is causing wider environmental degradation. The central waterway in Katanga has deteriorated due to a series of factors, including the inflow of poor water quality. Shallow groundwater has reduced in quality to a level that is unsafe for human consumption. Lack of treatment for sewerage, household and business grey water and contaminated runoff from storms are likely the most significant factors behind contamination.

Sanitation

Access to basic sanitation within Katanga is poor for many residents, increasing the risk of diseases and worsening pollution in the central waterway. While some public toilets do exist in Katanga, they require payment before usage and often consist of improperly constructed pit latrines. To save space, landlords have not included toilets in their constructed houses. The toilets that exist are in bad condition and inadequate. Several residents operate public toilets, charging 100-200 UGX (0.024-0.048 EUR) per use (payment is not applicable to children and elderly). Meeting the payment is out of reach for many residents resulting in common open defecation in drainage channels. (Muwonge, n.d.; Nabwami, 2019) Due to Katanga's shallow groundwater and flood-risk, pit latrines may not be safe or adequate for use.

The leaching and overflow from these systems, due to proximity to storm flows or lack of maintenance, represent a major pollution load to the central stream in Katanga.

Unsealed pits latrines and open defecation also pose a direct risk to the groundwater supply by leaching pollutants into one of Katanga's primary water supplies.

Main Actors in Water Resources Management

As was mentioned earlier, water is supplied to Katanga through privately owned taps and open pipe supplies owned by Kampala Capital City Authority (KCCA). Shopkeeper residents sell boiled drinking water.

Tap Supply
There are several taps around the community that are managed by private individuals and NGOs. The tap owners charge a fee of around 200 UGX (0.048 EUR) per jerry can.

Open Pipe Supply
Open pipe supply of water to Katanga is under extreme stress as most supplies have been contaminated and only one remains safe to use. The open supply is owned and managed by KCCA.

Residents get unlimited water supply from the pipe in exchange of a weekly payment. The remaining uncontaminated supply is located on one end of Katanga, resulting in long fetching routes for many residents.

Water Resell
Shopkeeper residents sell boiled and bottled water that is safe to drink. According to a shopkeeper that we interviewed, she has a special deal to get water from the tap for cheaper.
Boiled drinking water is sold in:
One cup plastic bags for 100 UGX (0.024 EUR) (best seller)
Bottled water, between 500 UGX (0.12 EUR) and 1000 UGX (0.24 EUR)

Development Cooperation

There are several Non-governmental organizations (NGOs) active in Katanga, however little indication of activity in the WASH sectors can be found online. As we interviewed the Chairperson in Katanga, he listed the following active NGOs and Community Based Organisations (CBOs): Help Africa, Mbuyu Foundation and Rescue Katanga. These actors engage especially in local skill development and education activities. The CBO, a group of volunteers headed by the chairperson is also active in water and sanitation improvement activities.

Political Context

Relevant Authorities

The public bodies most relevant to our project include Kampala Capital City Authority (KCCA) and the Ministry of Lands, Housing and Urban Development (MLHUD).

KCCA is the local government entity that services the 5 divisions within Kampala, headed by the Lord Mayor. Each division has a sub-leader, an elected Mayor. Katanga falls within the Kawempe division. KCCA provides services including health, waste management, education, WASH services, and community development. KCCA Strategic Plan (2014) sets out the following themes and objectives to be focused on to build a ‘vibrant, attractive and sustainable city’:

- Economic growth and integrated transport infrastructure
- Planned and green urban environment
- Social development, health and education
- Operational excellence and governance

MLHUD enforces national policies and manages development projects in Uganda. Their recent work relevant to Project Amaka includes improvements in the national land administration system and preparation of a framework for the National Physical Development Plan (NPDP). This plan aims to guide strategic infrastructure planning, economic development and urban development. (MLHUD, 2019)

Relevant Policies

Uganda Vision 2040 is the overarching strategy for Uganda to “transform into a modern and prosperous country” by 2040 (Ugandan Government, 2017). It provides goals and guidance for example on economic development, infrastructure and services, which are all relevant topics to Project Amaka. Other strategies by authorities look to the Vision 2040 when setting goals and frameworks. (ibid)

The Uganda National Slum Upgrading Strategy (UNSUS) is an action plan designed by MLHUD (2008) in collaboration with the United Nations Development Program (UNDP). The plan consists of strategies for slum residents’ inclusion and participation as active partners in developing solutions to address their living conditions. The strategy focuses on slowing down the growth of slums through legal and land market reforms, changing zoning regulations and building codes to provide affordable housing. The strategy paper identifies “lack of political will, bad policy and inadequate planning” as one of the reasons for the formation of slums (ibid).

Project Amaka also aligns with Agenda 2063. **Agenda 2063** is an action plan adopted by the Heads of State and Government of the African Union (AU) in 2015. It aims to ensure that the African society works together to build a prosperous and united Africa based on shared values and a common destiny (UN, 2020).

The Agenda 2063 aspirations that Project Amaka aims to address are creating people driven and sustainable solutions, ensuring security and realizing human rights on living conditions.

IMAGE 13
Urban greening in Katanga

IMAGE 14
Walkways of Katanga

Drainage, mobility and service connections

Katanga's main streets and alleys currently act as informal drainage channels that flow with polluted stormwater during rainfall. This is likely deliberate as residents have attempted to avoid constructing homes along natural drainage lines. The heavy Kampala rains have caused significant erosion along the alleys, responsible for the uneven ground that makes mobility limited – especially for elderly or disabled residents. Many of the children in Katanga lack access to footwear, increasing vulnerability to hazards washed onto the pathways and alleys during storms. The unplanned nature of Katanga's streets and housing makes the provision of underground services (such as piped water and sewer connections) difficult to implement.

Urban farming and greening

As a dense and unplanned settlement, Katanga is suffering from a severe lack of vegetation or green space. This is not uncommon within urban settlements in Kampala and around the world. In the face of broader WASH issues (water, sanitation, hygiene), however, this may not register as a

03

PROJECT AMAKA PROCESS

IMAGE 15

Post-its for Team Building exercise

Project Amaka Timeline

Through our early collaboration with the MAK student team, we established our main objectives for our project. Besides designing water solutions to supplement MAK team's housing design, we aimed at providing complementary holistic support to their project. This encompassed gathering and analysing input from the Katanga residents on how they envision their living in the future is like, in terms of housing, water and public services. The findings and insights would support Emu ku'emu's further architectural development and Project Amaka's conceptual design for WASH solutions.

Project Amaka Process, consisting of main three stages, research, research synthesis and concept development, has taken place between January 2020 and May 2020.

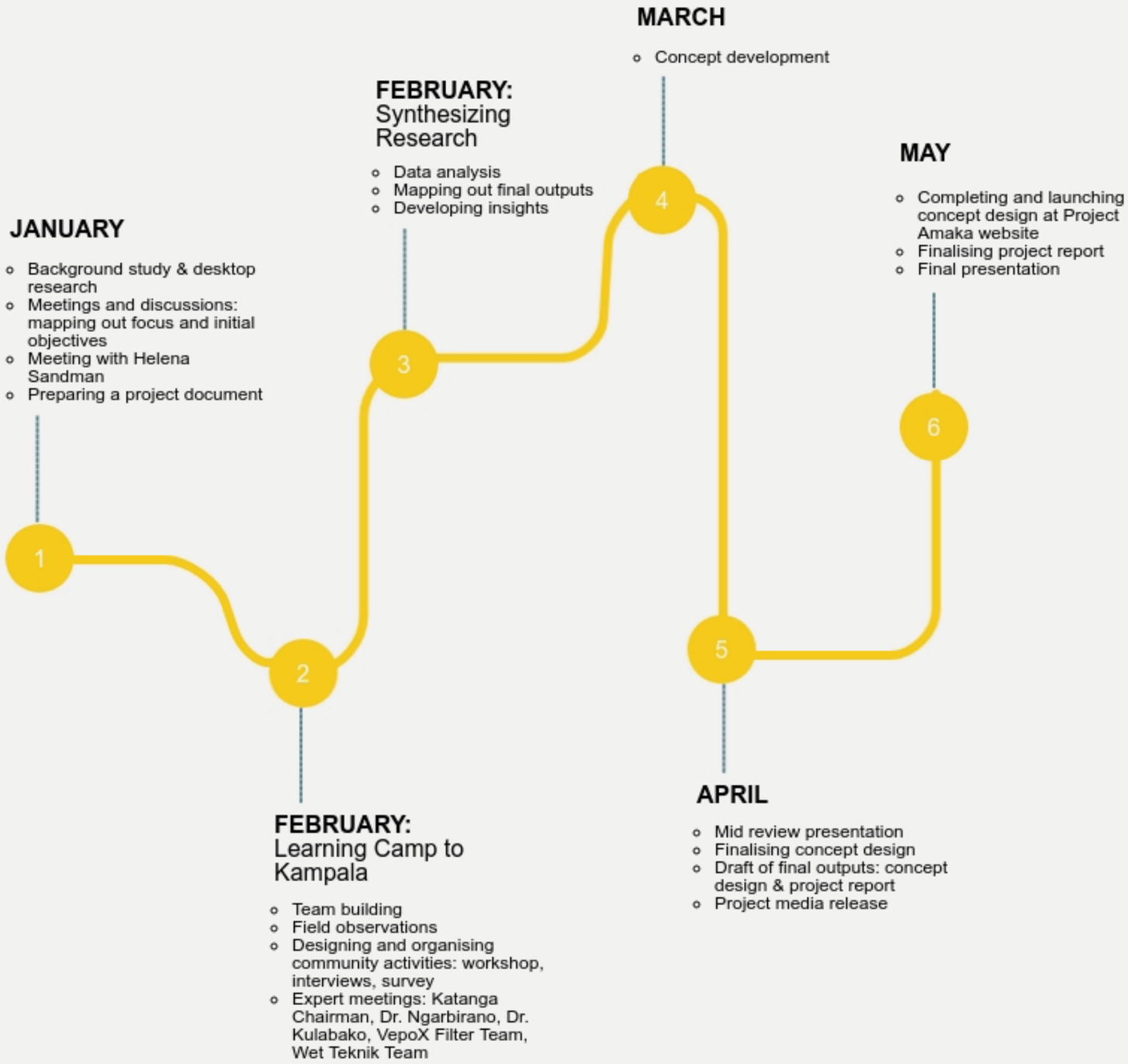


FIGURE 4
Project Amaka journey timeline

Research Methodology

The project included both qualitative and quantitative research methods. The methods used varied between different process steps, however in some steps qualitative and quantitative research elements were naturally crossing over.

Qualitative Research
- Site observations
- Community workshops
- Resident interviews
- Expert meetings and interviews
- Qualitative data gathered from resident survey and desktop research

Quantitative Research
Data gathered from survey & resident interviews on water usage and economics
Quantitative data gathered from desktop research

Background Study and Desktop Research

In order to focus on gathering relevant data from our field investigation during the learning camp to Kampala, we carried out intensive background study on Uganda, Kampala and Katanga.
We researched Uganda's political history, culture, and urbanisation challenges. We looked into Katanga's development: its infrastructure and facilities, water resources, public services utilized by its inhabitants and other stakeholders revolving around the settlement.

In addition, we delved into both local and international NGO programs that have been providing aid to Katanga to understand how the settlement had developed through those. Key findings from the desktop research are presented in section 2, Background.

Meetings and Discussions

During our early project discussions, we worked to refine our thought process on how to fulfil Project Amaka's success criterias. Our mentors and coordinators provided valuable support and guidance throughout this process.

We developed an initial draft of Project Amaka's results chain that addressed WASH outcome improvement and higher housing quality as the main impact of the project (see below or appendix 2). The plan laid out the critical activities, outputs and outcomes that would result in the desired impact. This plan, especially the critical activities presented, acted as a loose guide for us during the learning camp. However, we later refined it to create a more realistic results chain after having analysed our gathered data. We had discussed beforehand to allow flexibility to modify our results chain and plans as we progressed in our project work. Nevertheless, our work would not be limited only to families.

We also identified families in Katanga as our main focus group and developed a stakeholder map of our project based on this focus.

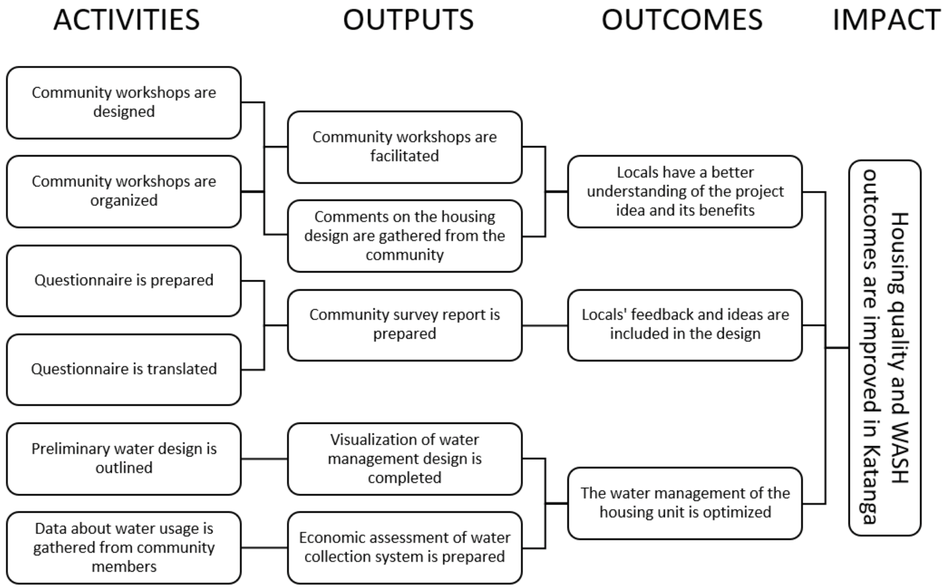


FIGURE 5
First results chain created during early project discussions

We also realized a risk analysis of the project to identify and avoid any (un)expected happenings (see appendix 3). We discussed a preliminary contingency plan to mitigate risks such as team communication issues and lack of availability of interview participants. In addition, the team conferred each other's hopes and fears of the project to establish a better team rapport and manage expectations.

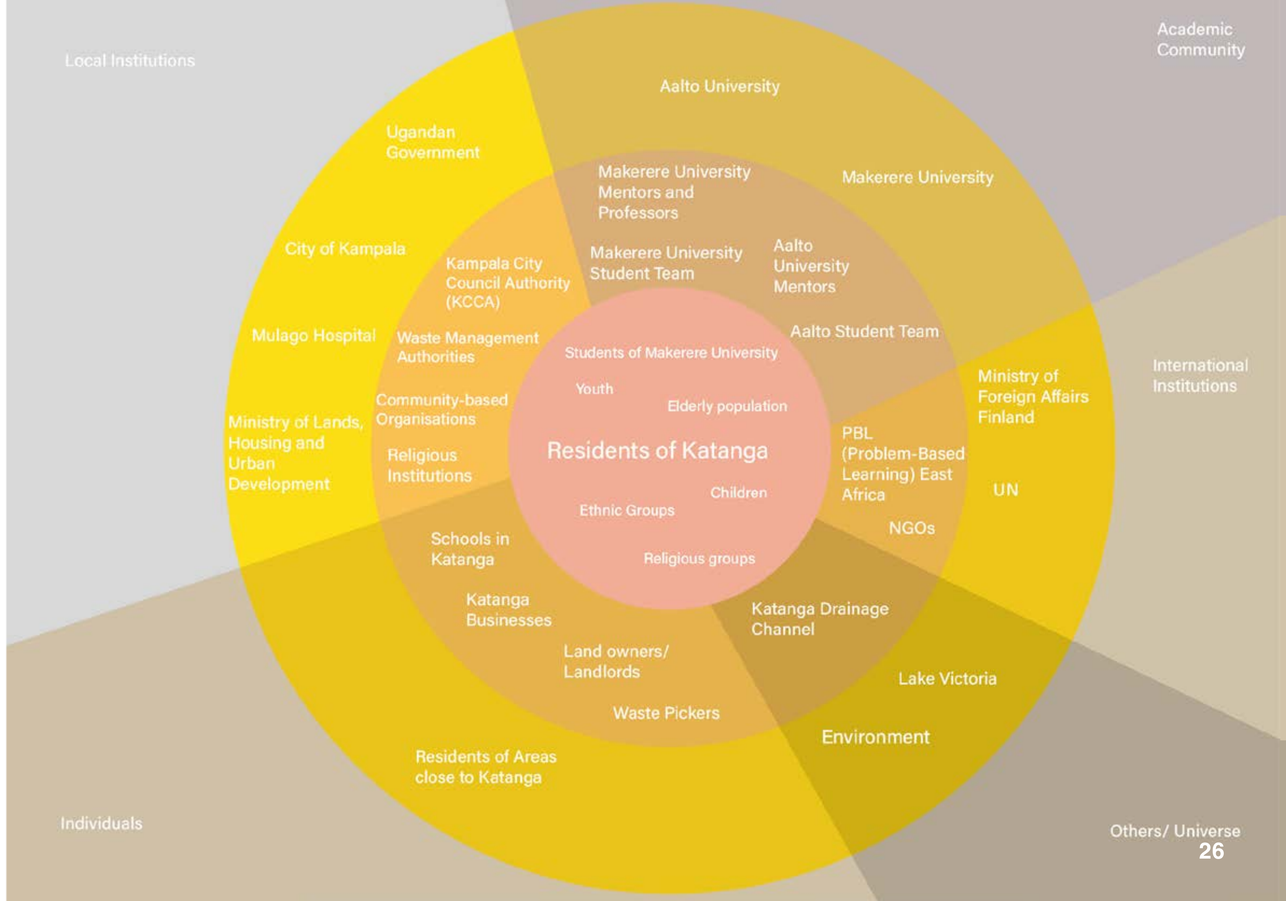


FIGURE 6
Project stakeholder map

Learning Camp to Kampala

Our two-week learning camp in Kampala began February 1st, 2020. We worked at two sites in Kampala: at CEDAT premises at MAK University and in Katanga with the community. We were faced with warm hospitality in both places and we stay appreciative of the working environments our partners had organized.

The first week consisted of team building, refining objectives, field observation, meetings with experts and designing of community activities and engagement. In the second week we organized a community workshop and gathered data from the residents, met with more experts, began preliminary designs for water concepts and presented our learning camp outcomes in a walk-in exhibition.

Team Building

Since Project Amaka and Emu ku'emu design by the MAK student team aimed to supplement each other, it became crucial to build a strong connection between team members to ensure smooth collaborative working, communication and commitment. To facilitate this, we worked to find mutual understanding of each other's projects and expectations and develop a common ground of motivation. Each member from both teams discussed their hopes and fears arising from the future collaboration and listened to others'. It was interesting and positive to find that everyone had similar hopes and fears – it was easy for the teams to start on a similar footing.

We also took the time to get to know each other on a personal level.

Throughout the learning camp, we worked very closely together with the MAK student team and were able to build strong synergies between the projects with the constant help and support from the project mentors..

We shared hobbies and likes, played team building games and spent time together in our free time. This further built trust between team members and made each of us enjoy teamwork even more.

Interview with Katanga Chairman

To understand our operating environment better, we conducted an interview with the chairman of Katanga. We used the opportunity to ask questions on information we previously lacked, such as current housing situation, sources of main water supply, volunteer work, active NGOs, how the people spent their time, local businesses, local schools and health care. We also learned about his inspiring work as a young leader and his aspirations for the community. Respectfully, we asked the Chairman for his permission to visit Katanga. He agreed and provided us with a volunteer to guide us around the site.

“Water is life - it is our right.”
- Chairman of Katanga

IMAGE 16
Meeting with Katanga’s Chairman

Field Observations

During our site visit to Katanga, each member in both student teams observed the surroundings from a specific point of view. We assigned specific “roles” for us, such as a child, an elderly, a mother, a father, a business owner etc. This was to develop an understanding of the surrounding from a broader and more inclusive perspective. We observed how the residents’ daily life is led, how they interacted with the surroundings and dealt with shortcomings. Through this process we were able to discover good practises, culture and habits, and development needs.

We visited all the sources of water supply in Katanga and observed how jerry cans are utilised by various profiles of people. We gained valuable information from our guide on the development and background of different aspects within the settlement, especially water. The MAK team helped us to tackle the language barrier since the predominant language spoken by the dwellers and volunteers is Luganda. We recorded our experience via notes, discussions and capturing photos.

IMAGE 17

Residents fetching water with their jerry cans from open pipe supply

IMAGE 18
Team visiting Katanga

Community Activities

Workshop

We wanted to understand what the community wanted as their homes, what they wanted to change in the way they live and how they envision their future and Katanga. Hence, we decided to organize a visioning workshop in the community. To attract participants, we created colorful posters welcoming people to participate, both in Luganda and English.

The posters were hung at the workshop zone entrance. The Chairman helped us spread the word among residents and provided us with a shaded space to hold the workshops in. In addition, the community volunteers helped us set up the workshop. Our workshop attracted around 50 participants, both children and adults. To ensure better participation opportunities for everyone, we decided to hold two workshops: one aimed at adults and another at children below the age of 15.

For the adults' workshop, we organized a clay storming session. Clay storming is a participatory design method developed by sustainable architect Anna Heringer, where participants can mold a dream space or outcome out of clay, resulting in highly effective, freeform 3D designs (Guernieri, 2019). We encouraged the participants to create their dream homes and its surroundings with clay, using imagination and outside the box thinking.

We avoided creating a rigidly structured workshop activity and aimed at freedom of creativity to ensure the participants' ideas would flow unrestricted.

After the participants were done molding their creation with clay, we asked them to explain what they had built and further scrutinized their creations through these one on one conversations. The adult participants were also later encouraged to draw out their vision of Katanga's future in the sense of public services and infrastructure.

We collected various and extremely intuitive results from this workshop.

We found that the participants wished to have stronger security, reliable lighting and broader coverage of trees and plants.

The children's workshop was held in parallel with the adults' workshop. The children were provided with paper and markers to draw out their future homes and its surroundings. To avoid distractions, we held this workshop in a separate area from the adults workshop and allowed the parents to have some peace while they concentrated on their own workshop. We avoided using clay storming for the children to avoid physical mess. The children's drawing had similar wants as the adults: reliable lighting in all areas of a multi storey house, and robust security with guards and fences. Interestingly, some drew schools as their dream home.

IMAGE 19 (bottom-right). Drawing activities in community workshop.
IMAGE 20 (top-right). Children showing their drawings of their dream houses.
IMAGE 21 (Left). Group picture of workshop participants and volunteers.

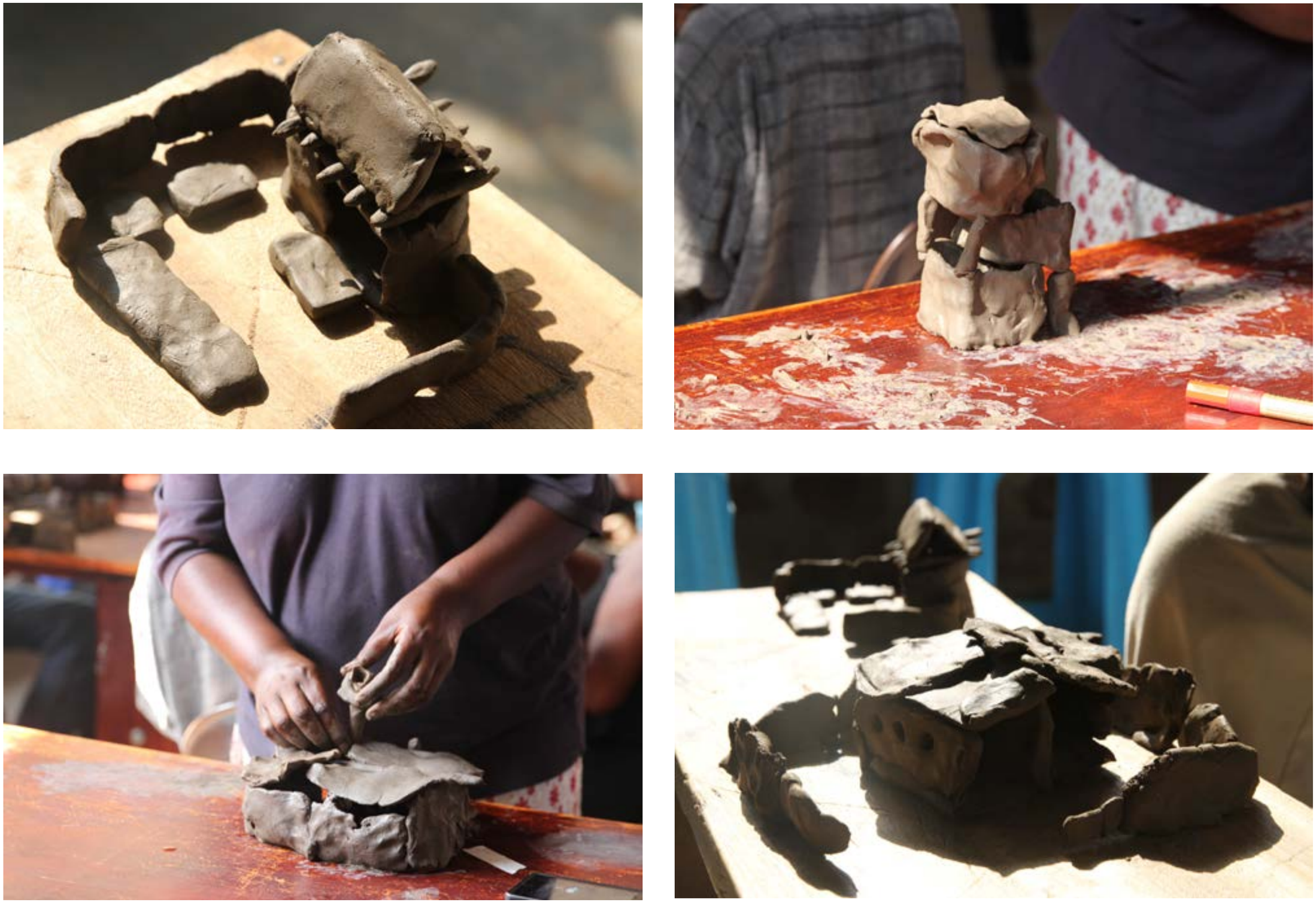


IMAGE 22 Collage demonstrating clay storming results from the workshop.

Interviews

We wanted to find meaningful insights on the community's day-to-day life, their hopes and wishes for the future and develop resilient resident profiles. We also wanted to collect data on residents' water usage to support our technical concept development. Thus, we designed and conducted interviews with residents representing different demographic groups of the community.

We wanted to interview mothers, fathers, business owners, school teachers, young adults, elderly, volunteers, land owners, tenants, urban gardeners, and employees at the car wash. The Chairman arranged volunteers to search residents representing these profiles who were willing to be interviewed. During the interviews, we asked questions (see appendix 4) about their

daily activities
economic situation
employment and source of income
water usage and sanitation habits
family
housing situation
background and journey to Katanga

IMAGE 23 (top). Interviewing a mother in her home
IMAGE 24 (bottom). Interviewing a car washer/young adult

To allow our interviews to flow more like a conversation and put the interviewees at ease, we decided to ask questions in the order that felt natural to ask and be flexible in formulating questions that seemed relevant. We also asked the interviewees to map out their budget plans on paper to see where they prioritized spending their money the most.

Some of the crucial findings gathered from the interview were that

Power outages and heavy rainfall hinder businesses and income generation due to lack of security and outdoor business setups.

Many of the residents are creative and talented in arts and crafts but they have little leisure time for recreation, since most of their time is spent on fetching water, doing chores and working.

Survey

In order to gather quantitative data to support our technical concept development and reiterations of Emu ku'emu design, we designed a survey mainly covering aspects of residents' water usage (see appendix 5). The survey also aimed to gain further insights on residents' wishes about Katanga's development. However, due to time management challenges, we were able to design, translate and distribute the survey only towards the end of the learning camp.

This resulted in us not being able to receive the surveys back from the community in time before our team's departure back to Finland. As coordination of work between the teams became more challenging due to the special circumstances resulting from COVID-19 outbreak after our trip, survey results became difficult to capture. In the end, the survey answers seemed to not communicate relevant data for our concept development, so we found little use for them. Had we planned and distributed the survey earlier during our trip, we probably would have been able to capture the desired outcome.

Expert Meetings

Helena Sandman

Helena Sandman is an architect and currently a doctoral candidate at Aalto University, Department of Design. She is one of Project Amaka's mentors. Her research focuses on integrating empathetic design and user engagement in the design process, and she has 15 years of experience in development projects in Africa.

We had a meeting with Helena in the week preceding the project trip to Uganda. During the meeting, we discussed the information we had gathered on Katanga so far and shared our ideas for holding the community workshop.

Helena gave feedback on workshop activities, brainstormed locations and organisation for the workshop, and provided examples of further observational activities for our team to complete during the trip. She also joined us in Kampala in the latter half of our trip and provided insightful and important feedback on the workshop design.

Dr. Amanda Ngarbirano

Dr. Ngarbirano is an urban planner and lecturer at Makerere University. Her work mainly focuses on urban mobility. She is currently working on projects within Kampala to encourage the accessibility and safety of cyclists and pedestrians.

We were given a presentation by Dr. Ngarbirano at CEDAT. She presented current projects underway in Kampala, including the implementation of a car-free walkway zone connecting transportation hubs in Kampala.We discussed the challenges as well as successful methods of community outreach to encourage public education about the benefits of projects and gather input from the residents.

"Order by shocking the socio-cultural system can create even bigger disorder."
- Dr. Amanda Ngarbirano

Dr. Robinah Kulabako

Dr. Kulabako is a professor of Environmental Engineering at Makerere University. Her research includes the transport of pollutants through groundwater in peri-urban Kampala and the environmental conditions and performance of pit latrines in Kampala settlements.

A few members of our team met with Dr. Kulabako during our learning camp. During the meeting, we discussed concerns about maintaining pit latrines in Katanga and the challenges of other possible sanitation solutions. We also discussed the possibility of connecting existing KCCA water and sanitation utilities within Katanga and confirmed that there is existing capacity to handle loading of Katanga for sanitation.

VepoX Filter team

The VepoX Filter is a household water purification filter developed by a team from Makerere University during PBL East Africa 2019.

We met them at MAK, and the VepoX team shared their presentation materials and project process.

We discussed how the filter seems to be a feasible solution to providing safe drinking water for households like those in Katanga due to the low cost and maintenance needs. However, the product will not be available for wide distribution for some time while the production of the filter is scaled up.

Wet Technik team

Wet Technik is a constructed wetland project developed by a team from Makerere University during PBL East Africa 2019. The project team members gave us a tour and explanation of their pilot project on MAK campus.

The constructed wetland project is still underway and the team is gathering their results. So far, they see promise in the filtration of the water that has passed through the system. We discussed the possibility of implementing a similar installation in other applications, possibly in Katanga, and the benefit of using some materials over others.

04

SYNTHESISING RESEARCH

IMAGE 25
Livestock in Katanga

The steps explained in the process description above are all integral parts of the research done for the project. The background study and desktop research prior to our field trip gave us a context to work with and informed us about interesting and potential focus points. The next step was to synthesize these focus points, ideas and findings into functional solutions and visions by combining different elements of the process: field observations, resident and expert views, and technological knowledge. It is this part of the research process that we will next describe.

This process was kicked off already during the last days of our trip. As the final review of our learning camp, we organized a final exhibition where we presented some of our key findings and our initial understandings of what we could develop based on these findings. We gave a walk-in tour around our exhibition materials to everyone interested in our project and also showed our two-week highlights in a slideshow with recorded sounds from Katanga in the background.

Objectives of Research Synthesis

The main objectives of the research synthesis were:

Analyze observations, discoveries and findings made during the two weeks in Kampala. The goal was to match observations from the field with views of experts, existing knowledge and findings from desktop research.

Develop a holistic view of the water situation in Katanga based on the analysis made on findings and draw critical insights from the analysis. By insights we mean deep understanding of the findings and their implications in our project context. These insights would inform our steps forward, indicating what to focus on and what the project's final outputs should be, thus refining and crystallizing the scope of the project.

The discovery-focused research done in the field, in turn, gave us critical findings that would inform and inspire our concept design.

Impacts

As we analyzed our findings from the field to develop critical insights that would inform our steps forward, we went through a thought process that both expanded and refined our project scope. We discovered that the challenges facing the community are complex and would require input from various angles of urban planning to become fully addressed.
Therefore, our team began expanding our mindset beyond the initial focus points of housing and water.

IMAGE 26 Collage of learning camp final exhibition

Ideas of an urban master plan were developed, however it was soon realised that addressing the challenges on such a grand level would be beyond the scope and capabilities of the project. Hence, we decided to focus our scope back to water, where the core expertise of our team lies. However, we think that understanding the complexity of the problem and the interrelations between the challenges and various aspects of urban planning did help us to develop better informed and more inclusive water solutions in the design phase.

Mapping out final outputs

Informed by the research process, we decided to develop sustainability intervention ideas to the community from the perspective of water. We decided the final output of Project Amaka to be a concept design that includes water solutions that enhance the water sensitivity of the Emu ku'emu house design, and also introduces designs that would improve water supply, accessibility and urban greening within Katanga in general. It includes design sketches, technical descriptions and implementation suggestions. The concept design will be hosted online on Project Amaka website to assure ease of accessibility, interactivity and intuitivity for users. It will also be delivered to the community as a physical booklet where information and design ideas are easily digestible.

The goal of the concept design is to empower and inspire the residents of Katanga to start implementing water improvements where they can, and motivate relevant stakeholders in the public, private and academic sectors to co-create sustainable water solutions in the community. Although designed specifically for Katanga, the concept can inspire other projects in similar environments. Therefore, the concept design can act as a "launch pad" for similar water sustainability projects.

Based on the decision over the project's final output, we revisited and refined our project results chain.

Beneficiaries

Direct beneficiaries

The direct beneficiaries of Project Amaka are the residents of Katanga, especially families living in Katanga, since they were chosen as the target group of our project. The proposed water solutions are meant to empower families, as they aim to turn families' daily struggles related to water into opportunities of sustainable living. However, residents in general will benefit from Project Amaka as a result of community-scale development ideas.

Indirect beneficiaries

Other actors in Katanga are indirect beneficiaries of the project. Community-wide development ideas related to water

and urban greening will benefit for example businesses operating in Katanga, since the solutions are likely to improve economic productivity and even attract customers outside the settlement. Schools will benefit from the improving environment as they could integrate the new surrounding water technologies into their educational projects. The project outcomes also enable KCCA to establish a better presence in the community and care for the WASH needs of the residents. Thus, it helps the city authority to execute their strategic plans related to improved urban environment and social development. As the solutions could be applicable in other similar areas as Katanga, these communities in Uganda (and potentially abroad) could benefit from our concept design. Lastly, the partnering universities benefit in terms of new knowledge and project expertise being created.

FIGURE 7
Project Amaka Updated Results Chain

05

RESULTS AND INSIGHTS

IMAGE 27
A house modelled by a workshop participant

System Map

A critical attribute from the synthesis of our learnings from our interactions with the community and the results from the engagement was a system map of our project context. The system map was created to assimilate our findings and observations from a perspective in which water interacts with a family in Katanga. The map below was used to make visible the layers of complexities within the system and the relations among the actors involved in it. The actors and resources are divided into categories of usability, accessibility and supply of water. The connections between the actors highlight the flows related to knowledge, financial transactions, decision-making, regulations and services.

This map helped us get a bird's eye view of the whole system and locate gaps and links in the system and in our understanding. These gaps and links enabled us to develop critical insights that would guide us into the next stage of concept development.

Results and Insights

Insights

We distilled our findings and observations from the qualitative and quantitative research data into 3 main Insights. These insights touch upon four themes: capacitive, environmental, social and economic impacts on the people of Katanga. These impacts are the conclusion of all fronts on which water as a resource impacts the life in Katanga. Unlike the popular belief, water management is not only affecting the physical environment, physical health and economy of a community but also has a profound effect on the social, capacitive and mental health of the community.

For making Katanga thrive in terms of water, it is necessary to improve the accessibility of safe water supply in the region. Drainage and rainwater should be managed in a sustainable manner, the burden of household water management should be lessened, and management of waste, including sanitation, should become more rigid. This vision combined with the Emu ku'emu concept about sustainable living embarked us on our concept design creation journey.

Katanga Water System Map

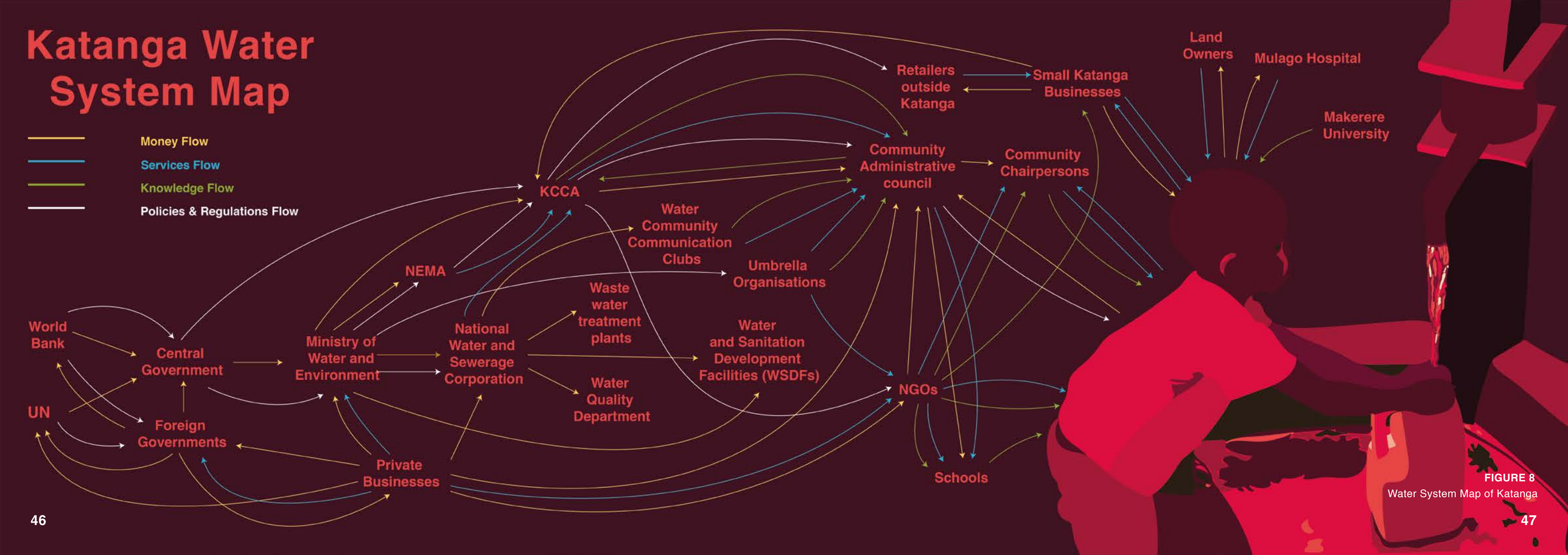


FIGURE 8
Water System Map of Katanga

Insight 1

Management of rainwater is not only about creating an alternative source of potable water. It also affects the accessibility of space for economic and recreational purposes. This insight mainly touches upon the economic impact of management of rainwater and urban runoff, while also looking into its impacts on the social structure and capacitive strengths of Katanga.

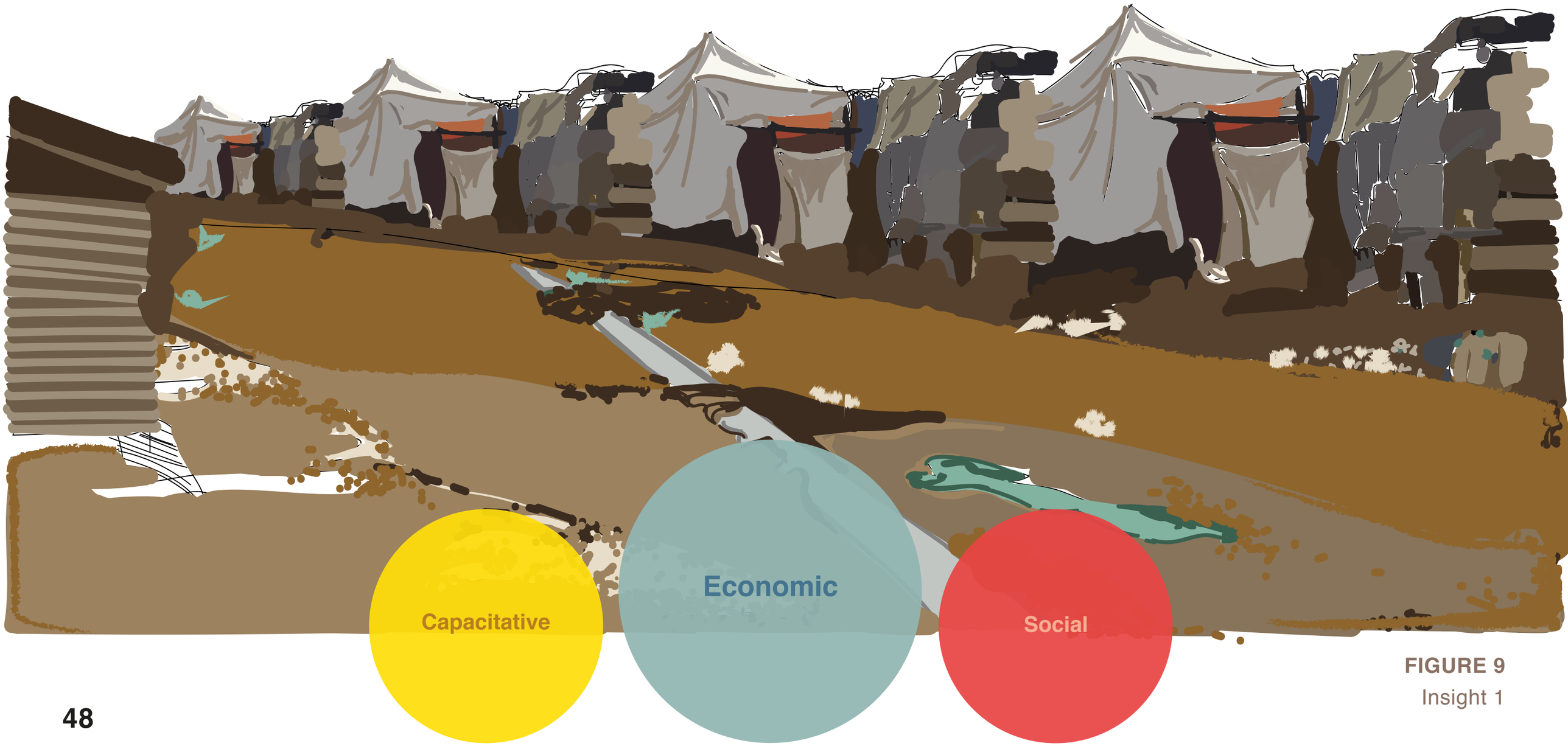


FIGURE 9
Insight 1

Insight 2

Society in Katanga functions in survival mode. Residents – especially adults, but also children – work day and night to meet their daily needs. Time spent in managing a household's needs in terms of water and economy is heavily dependent on accessibility of water resources. This restricts the residents' abilities to engage in recreational activities or hobbies, endangering the holistic growth of individuals and the community as a whole. The insight presented here has clear social impacts on the community: the uncooperative and hostile work environment and the resulting stress accumulated over the years creates an unhealthy atmosphere.

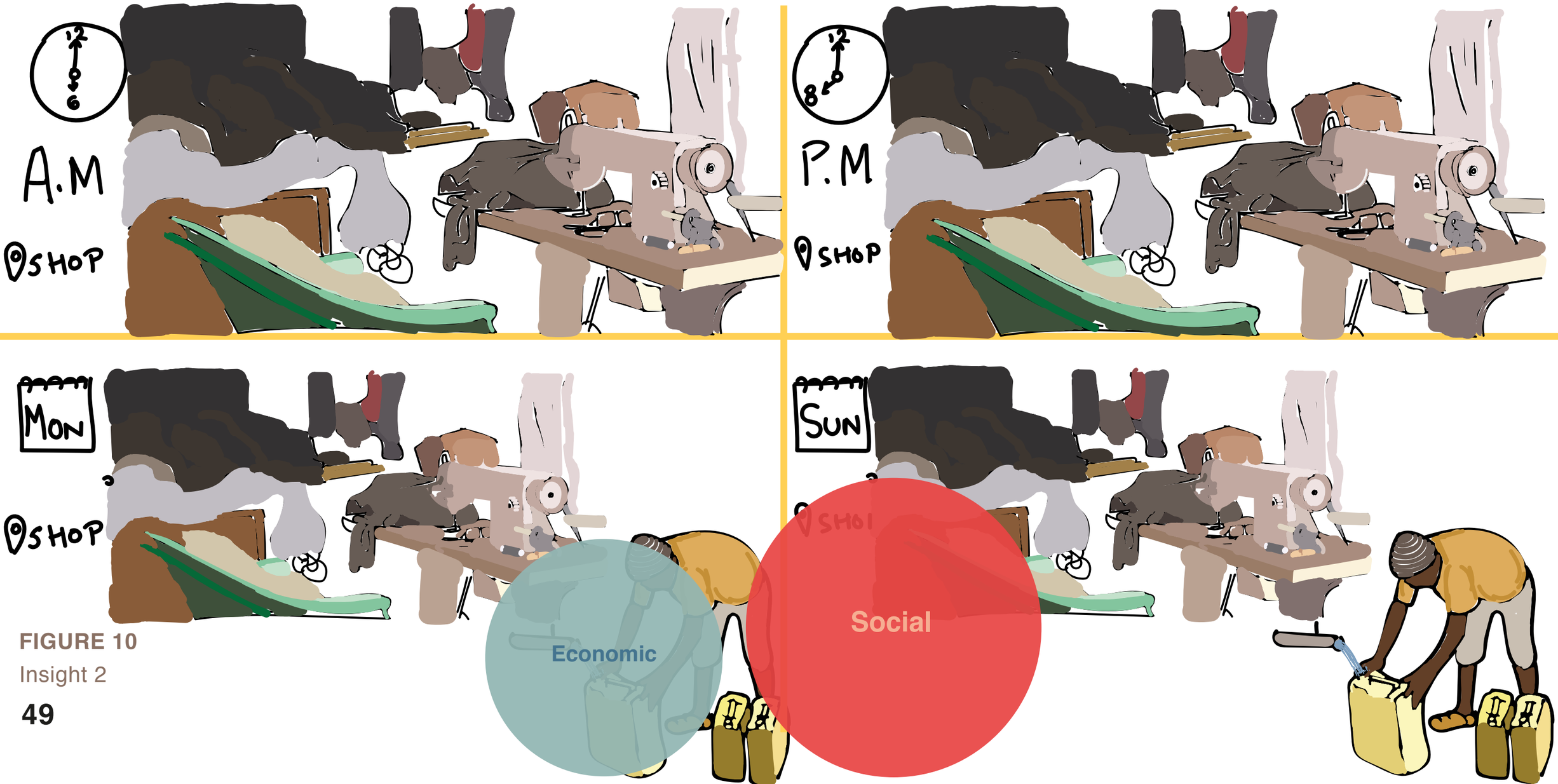


FIGURE 10
Insight 2

Insight 3

Since Katanga is not formally connected with the treated water pipeline running through Kampala, the community is reliant on unreliable groundwater sources. The quality of this groundwater is greatly affected by the drainage system, waste management done in treatment plants, as well as rain water, which opens ways for solid, untreated waste to flow into the ground if left unchecked. This results in groundwater contamination, risking the health of people consuming it. This insight sheds light on how access to water impacts all four fronts of social, economic, capacitive and environmental impacts on life in Katanga.

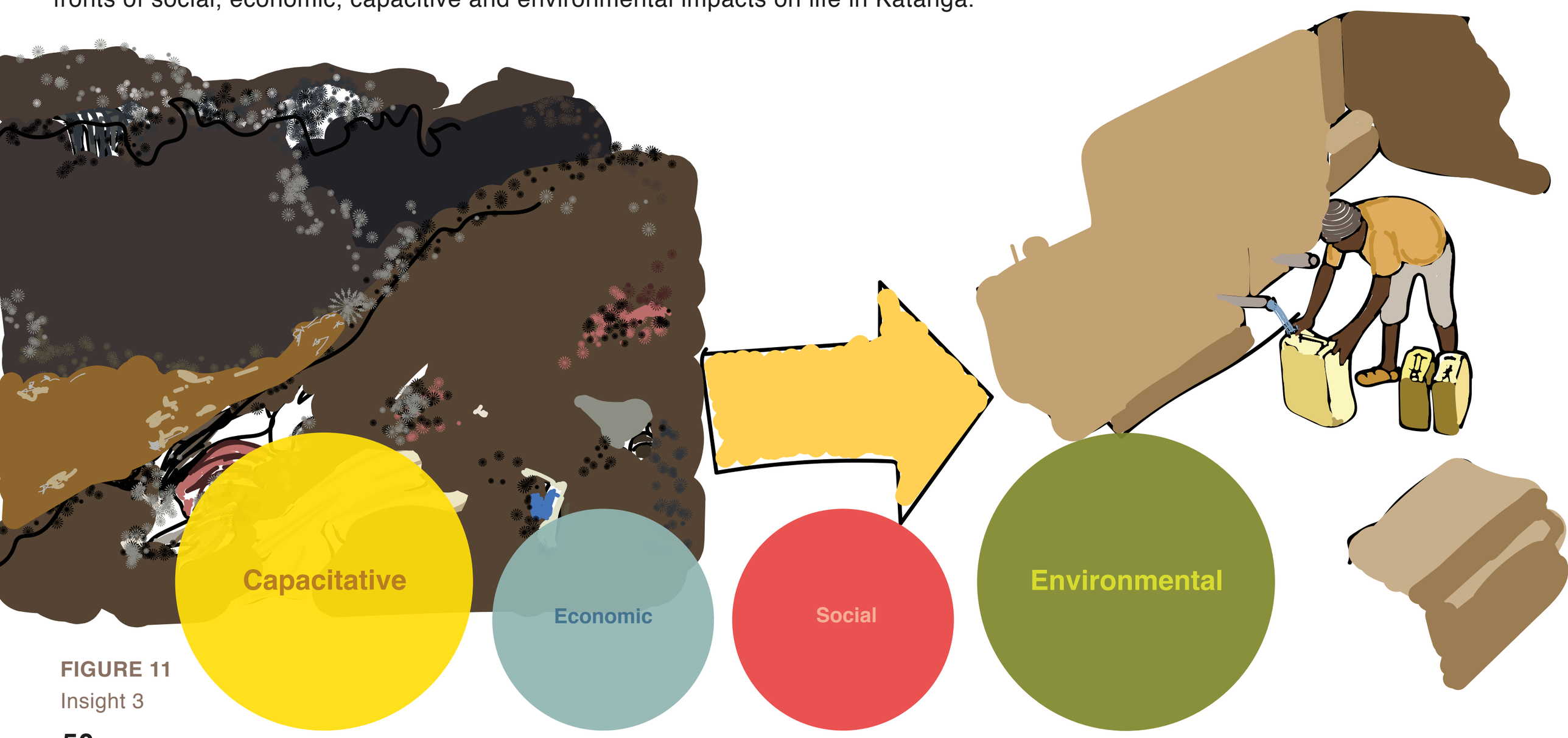


FIGURE 11
Insight 3

06

CONCEPT DESIGN

IMAGE 28
A sewing machine at a shop in Katanga

Concept design

The following section explores the different components of the water solutions that form a concept of a better future for Katanga and its inhabitants. Katanga's specific water-related issues have been detailed in section 4.8. There are design arrangements and technologies available to address these issues within Katanga, with the selection of each bearing an impact on overall affordability. However, in a community such as Katanga, with very low socioeconomic status, it is worth briefly addressing affordability as a distinct issue and looking for design solutions and social opportunities that can improve access to the presented solutions.

Where possible, the proposed solutions also seek to integrate relevant projects and products developed by other local PBL teams including UpPlastic, Wet Technik and VepoX.

While these solutions have been developed with local implementation in mind, they are not solely limited to Katanga and could be used in any combination in similar contexts within Kampala and beyond.

The scope of these issues goes well beyond that of Project Amaka, however the redesign of Katanga's urban form presents an opportunity to introduce social behaviour and funding mechanisms that can increase access to solutions for Katanga's families. The Superblock concept represents an opportunity for neighbours to form housing cooperatives, allowing them to pool their resources to leverage buying power. This can lower costs for many services and products associated with home ownership, including many solutions suggested as part of Project Amaka.

Historically, cooperatives and communal farms were widespread in Uganda, although these were dismantled under the Amin regime (McCool, 2020). Housing cooperatives have been identified in the national housing policy which should allow official recognition. These cooperatives could act a level below the existing form of government in Katanga and have representatives that interact with the Chairperson on larger issues (Uganda Archives - Co-operative Housing, 2020).

Beyond the broader infrastructure issues, Katanga's residents are also facing major issues in the areas of employment, training and financial emancipation that hinder the implementation of the following infrastructure.

To help ensure that the benefits to Katanga are received by its current residents, it is recommended that future infrastructure programs are supported with local labour, along with necessary upskilling and training. Supporting Katanga residents to improve their neighbourhood could help to combat unemployment and the distinct threat of gentrification.

Residential concept: Emu ku'emu modular housing unit

The solutions to water based issues have been based around a housing concept developed by the MAK student team.

Superblock co-housing

The superblock concept revolves around creating residential courtyard spaces with shared facilities that distribute the costs and maintenance responsibilities between several families. This concept of cohousing is implemented in many regions including the Nordic countries and with the Siheyuan found in urban areas of China (Zhang, 2016). The enclosed nature of this block of buildings would create a private area that resembles a communal courtyard. Privacy and safe outdoor space were identified by the community as an urgent social need, something that the superblocks could help to provide.

The superblocks could also serve to centralise water supply and sanitation services, to reduce implementation costs while managing and regulating sustainable usage.

With their common courtyards and shared infrastructure, the superblock concept could allow for the formation of housing cooperatives. This cooperative ownership mechanism could lower the individual cost of access for many services and solutions proposed in Project Amaka.

Piped water could be provided to the courtyard of each superblock allowing 5-6 families easy and secure access to water. This same approach could be applied with several facilities such as sewered toilets, rainwater tanks, urban farming.

Key benefits:

Provide outdoor privacy and security with space to engage in outdoor activities such as urban farming.
Allow a single water connection and sanitation service to be supplied to multiple families at once, reducing implementation costs.

Sharing communal costs between families reduces the total burden on individual households in Katanga.
Potential to improve community cohesion and cooperation between neighbours.

In addition to infrastructure efficiencies, the superblock model is also likely to improve community cohesion, outdoor shading security and cooperation between neighbours.

Drainage, mobility and service connections

It is suggested that drainage and mobility within Katanga are enhanced by using integrated drainage planning techniques. This could be realised by implementing sub-catchment-based drainage centred around natural drainage lines that follow major access paths through Katanga. Drainage culverts are installed along central paths, allowing the stormwater to flow beneath the ground surface and formalising the access for residents. Water enters the culvert systems via grated drains.

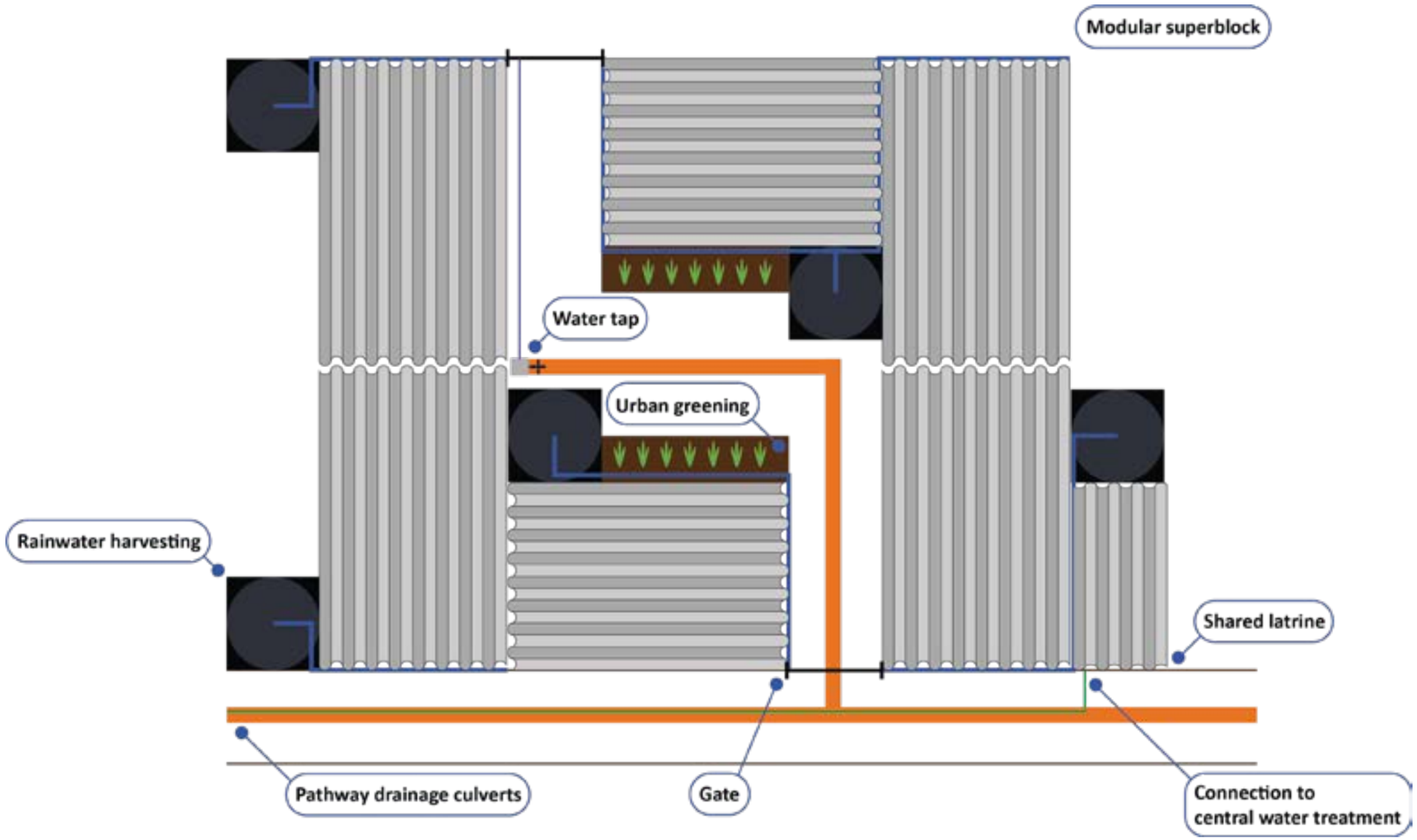


FIGURE 12 Superblock co-housing concept and related water solutions

Overflow runoff from roofs/rainwater tanks are directed towards these pits.

Keeping stormwater in the major drainage channels below the ground reduces the risk of local flooding and pollution hazards from being washed onto the street. During dry weather, the top lid of the culverts provides the street with an even surface that allows residents to move with greater freedom and safety.

Another use of the central drainage culverts could be to house sewer pipes servicing the adjacent properties or superblocks. Attaching sewer pipes to the inside of the drainage culvert could help avoiding significant trenching and installation costs.

Due to their position along natural drainage lines, these central sewer pipes could act as gravity sewer main servicing the adjacent superblocks' toilets and feeding into the existing sewer main running through Katanga creek. Installation in the drainage culvert would also allow for easy maintenance access compared with a traditional trenched sewer pipe.

Key benefits:

- Reduction of stormwater erosion, pollution and flood damage.
- Improving mobility along the main access pathways in Katanga.
- House sewer mains – reducing costs and improving maintenance access.

Water supply

Household rainwater harvesting

To implement this solution, households use their roof area to harvest rainwater. Roofing is designed with a single slope to maximise roof catchment area. Water harvested can be used for washing, gardening and other non-potable uses (potential to pair with effective treatment as a source of safe drinking water). With an established average daily demand between 20-25L/person/day, a case study was undertaken to explore the hydrologic and economic performance of rain tanks for different family sizes.. Installation of new roofing and rainwater harvesting systems need to be paired with an effective education campaign introducing proper maintenance and mitigation of key risk factors (dirty roofs and guttering).

Kampala's climate favours the implementation of rainwater harvesting, with a high annual rainfall spread over two distinct rainy seasons. In Katanga, household rainwater harvesting presents several key benefits:
- Reduced need for households to purchase large quantities of water from paid taps.
- A distributed system for water supply takes pressure off the centralised sources (taps and wells), increasing the resilience of Katanga's water supplies to shocks and stressors.
- Domestic rainwater harvesting has high initial start-up costs (tank, roofing, guttering) but enjoys low maintenance costs for the life-cycle.

Could increase potential for water-intensive activities and business such as urban farming or certain craft-making.

Avoids centralised planning and implementation by KCCA and could be implemented gradually on a household level.

Case study: Rainwater harvesting on Emu ku'emu

The potential for rainwater harvesting in Katanga has been explored using water balance modelling with two years of daily rainfall from the nearby Makerere weather station. This has allowed for rainwater harvesting tanks to be sized for the Emu ku'emu housing concept (average 40m2 roof area) for varying occupants.

A cost benefit analysis was undertaken to understand how long it would take for the rainwater tank to return its initial investment and begin to generate cost-savings for residents. The cost benefit analysis assumes that any water not supplied by the rainwater harvesting system is purchased.

Rainwater harvesting tank analysis

The potential for rainwater harvesting in Katanga has been explored using water balance modelling with two years of daily rainfall from the nearby Makerere weather station. This has allowed for rainwater harvesting tanks to be sized for the Emu ku'emu housing concept (average 40m² roof area) for varying occupants. A cost benefit analysis was undertaken to understand how long it would take for the rainwater tank to return its initial investment and begin to generate cost-savings for residents. The cost benefit analysis assumes that any water not supplied by the rainwater harvesting system is purchased.

The results show:

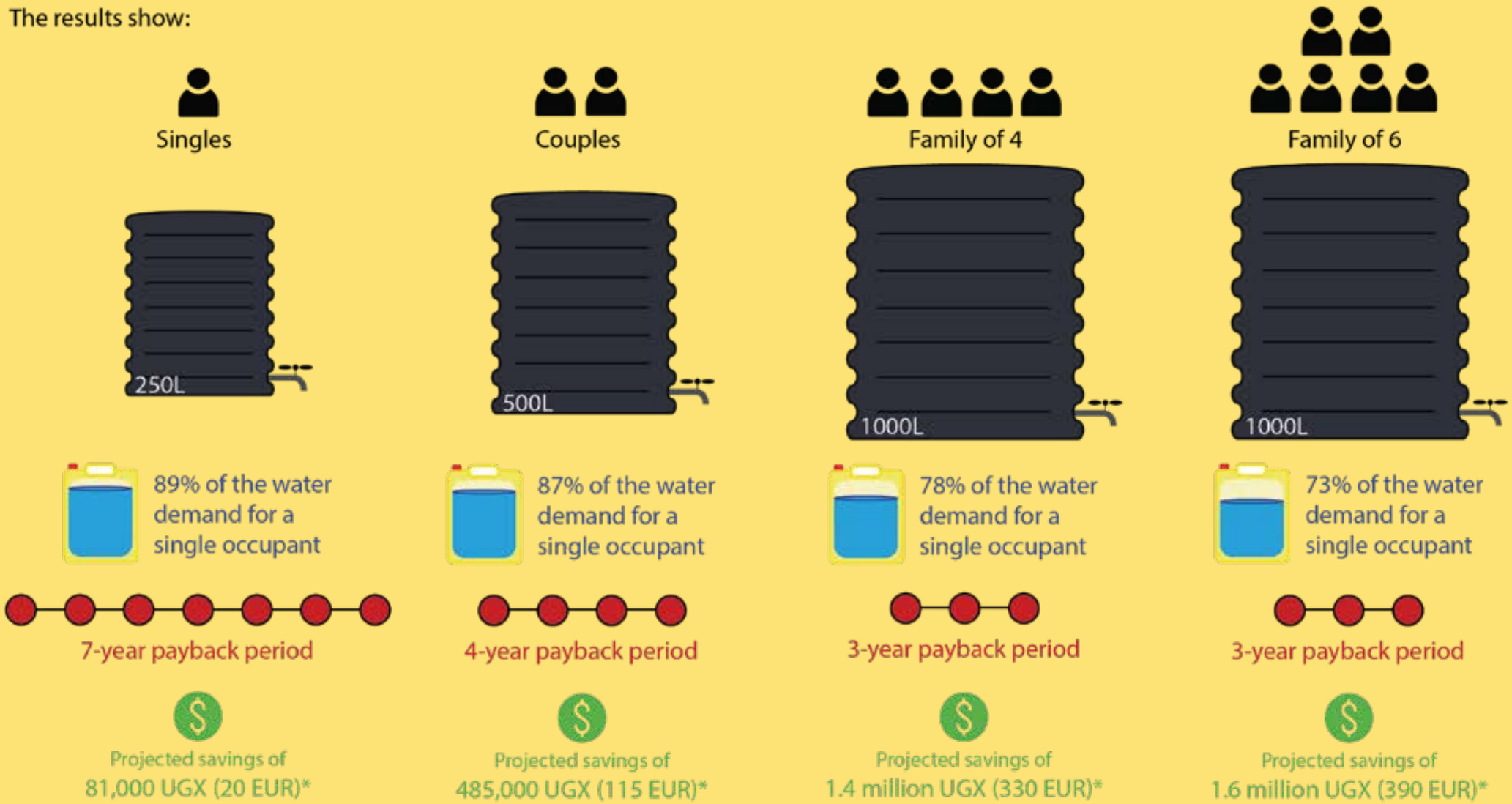


FIGURE 13 Rainwater harvesting tank analysis

From the analysis, rainwater harvesting is an attractive option to reduce expenditure on water for families in Katanga. Smaller households also stand to benefit but not to the same extent as households with larger demands. Other important barriers to rainwater harvesting still exist, such as roof hygiene and maintenance knowledge.

* over a lifetime of 7 years

The modelling shows the following results for different Emu ku'emu inhabitats:

· Family of 6:

A 1000L rainwater tank can provide 73% of the water demand for a single occupant.

After a 7-year period, the family is projected to save a cumulative NPV of 1.6 million UGX (390 EUR) on their water bills.

· Family of 4:

A 1000L rainwater tank can provide 78% of the water demand for a single occupant. The system pays for itself (assumed total cost of 860'000 UGX or 210 EUR) within a period of 3 years. After a 7-year period, the family is projected to save a cumulative NPV of 1.4 million UGX (330 EUR) on their water bill.

· Couples:

A 500L rainwater tank can provide 87% of the water demand for a single occupant. The system pays for itself (assumed total cost of 600'000 UGX or 210 EUR) within a period of 4 years. After a 7-year period, the couple is projected to save a cumulative NPV of 485'000 UGX (115 EUR) on their water bills.

· Singles

A 250L rainwater tank can provide 89% of the water demand for a single occupant. The system pays for itself (assumed total cost of 540'000 UGX or 150 EUR) within a period of 7 years. After a 7-year period, the single occupant is projected to save a cumulative NPV of 81'000 UGX (20 EUR) on their water bills.

From the analysis, rainwater harvesting is an attractive option to reduce expenditure on water for families in Katanga.

Smaller households also stand to benefit but not to the same extent as households with larger demands. Other important barriers to rainwater harvesting still exist, such as roof hygiene and maintenance knowledge.

References and assumptions:

A roof area of 40m2 was to represent the harvestable area of the Emu ku'emu housing concept. The water balance modelling was run over a 2-year period (2018-19) using daily rainfall values from the Makerere weather monitoring station. A water usage rate of 25 L/d/person (reduced to 20 L/d/person for the family of 6) and a price of water in Katanga of 200 UGX per 20L was sourced from surveys and interviews. The SmilePlast LTD website (https://www.smileplast.com/) was used to inform pricing as a local supplier of rainwater tanks in Kampala. Additional costs (such as guttering, installation costs and ongoing maintenance) were less certain, with an initial fee of 400,000 UGX (96 EUR) used to represent these costs. An annual inflation rate of 3.4 % was used to inform the NPV calculations.

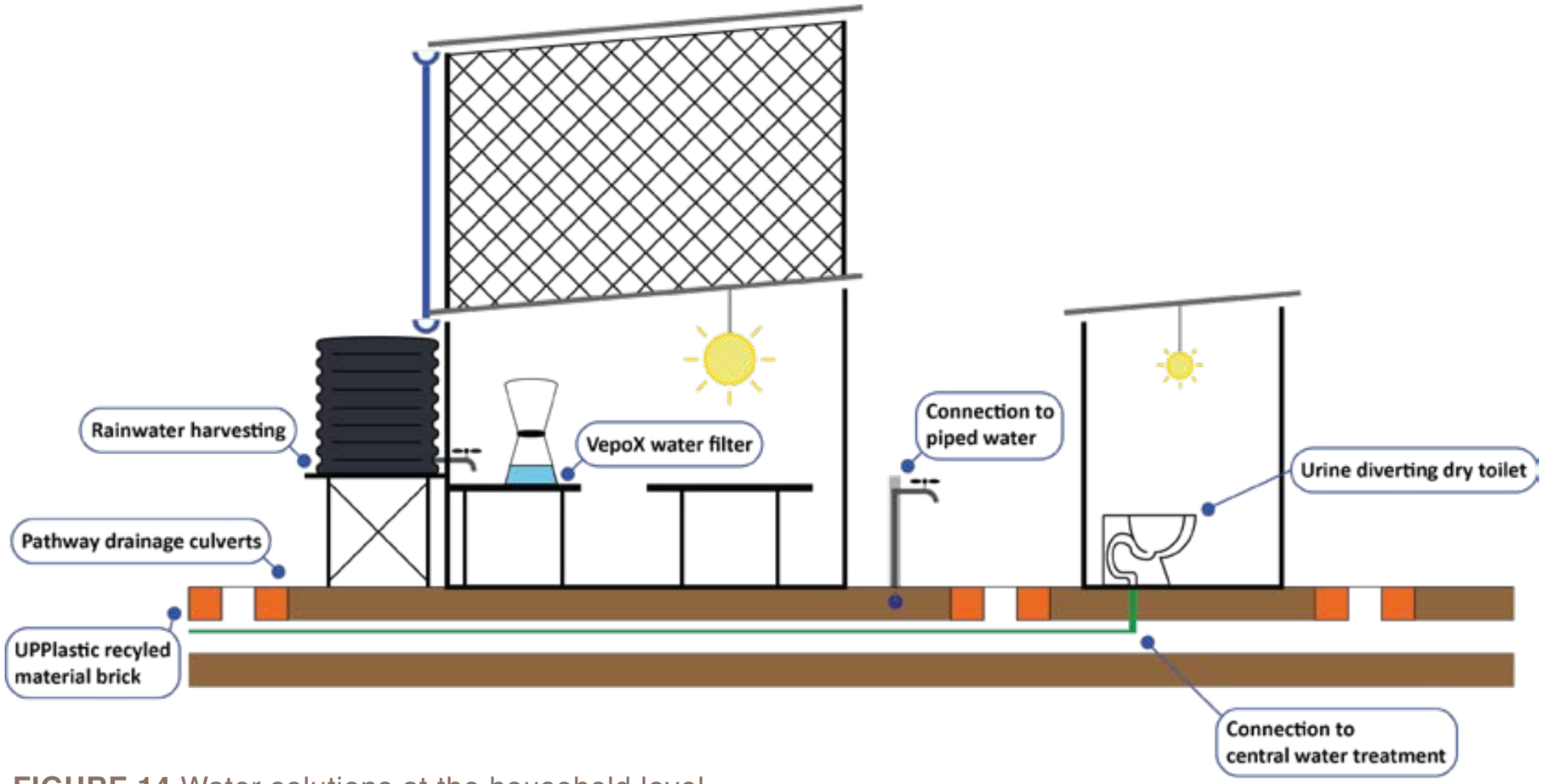


FIGURE 14 Water solutions at the household level

Connection to piped water

Metered taps are introduced to service each 'modular super-block', with the taps located in the common courtyard space between dwellings. The cost of this metered usage is then shared by the coalition of families that own and share each modular super-block. By avoiding delivering water to each household, the number of required connections is reduced by a factor of between 4-6, significantly reducing implementation costs.

The key benefits of increasing the piped water supply within Katanga:

- Improve access to water for families across Katanga.
- Start-up costs are absorbed by the coordinating body, rather than individual households.
- A distributed system for water supply takes pressure off the existing sources, increasing the resilience of Katanga's water supplies to shocks and stressors.
- Likely cheap option per person when compared to rainwater tanks.

Water quality

Household water filters

All available sources of potable water in Katanga require treatment before they can be safely used for drinking. Currently residents disinfect by boiling, however this method is slow, energy-intensive and makes storage of disinfected water difficult. water filter (such as the VepoX system) would allow families to collect water from either a communal water source or their rainwater tank, treat and store a relatively

large volume of clean water securely within their house. The VepoX filter, currently under development by a group of students from Makerere University, is affordable (40,000 UGX or 10 EUR) and able to filter 20L of water in 15 minutes using low-cost filter cartridges. The cartridges have a life span of 4 months, after which they have to be replaced. The system has been specifically designed to address water quality issues in rural and low socioeconomic areas of East Africa.

Key benefits:

- Less time consuming and energy intensive disinfection, reducing local pollution stemming from water boiling.
- Provide a simple and safe method to store a significant volume (20L) of safe drinking water within a household.

PBL collaboration: VepoX

A VepoX filter can serve an entire household for two years and, at USD 10 per unit, is the most affordable durable household filter on the Ugandan market, paying for itself in just six months by eliminating the fuel costs of boiling water. VepoX users also save themselves both the time it takes to boil water and wait for it to cool and the risk of cross-contamination through storage in dirty containers. Women and children no longer have to fetch so much firewood, freeing up time for more productive activities and schoolwork. For households that previously did not treat their water, VepoX Filter is the first source of safe water for their families, with concomitant health benefits.

On a larger environmental level, by eliminating the need to boil water and thus to collect charcoal and firewood from local forests, which act as an essential carbon sink, VepoX filter reduces greenhouse gas emissions. By replacing bottled water, it also reduces plastic consumption.
Text obtained from Climate Launchpad Project summary (n.d.)

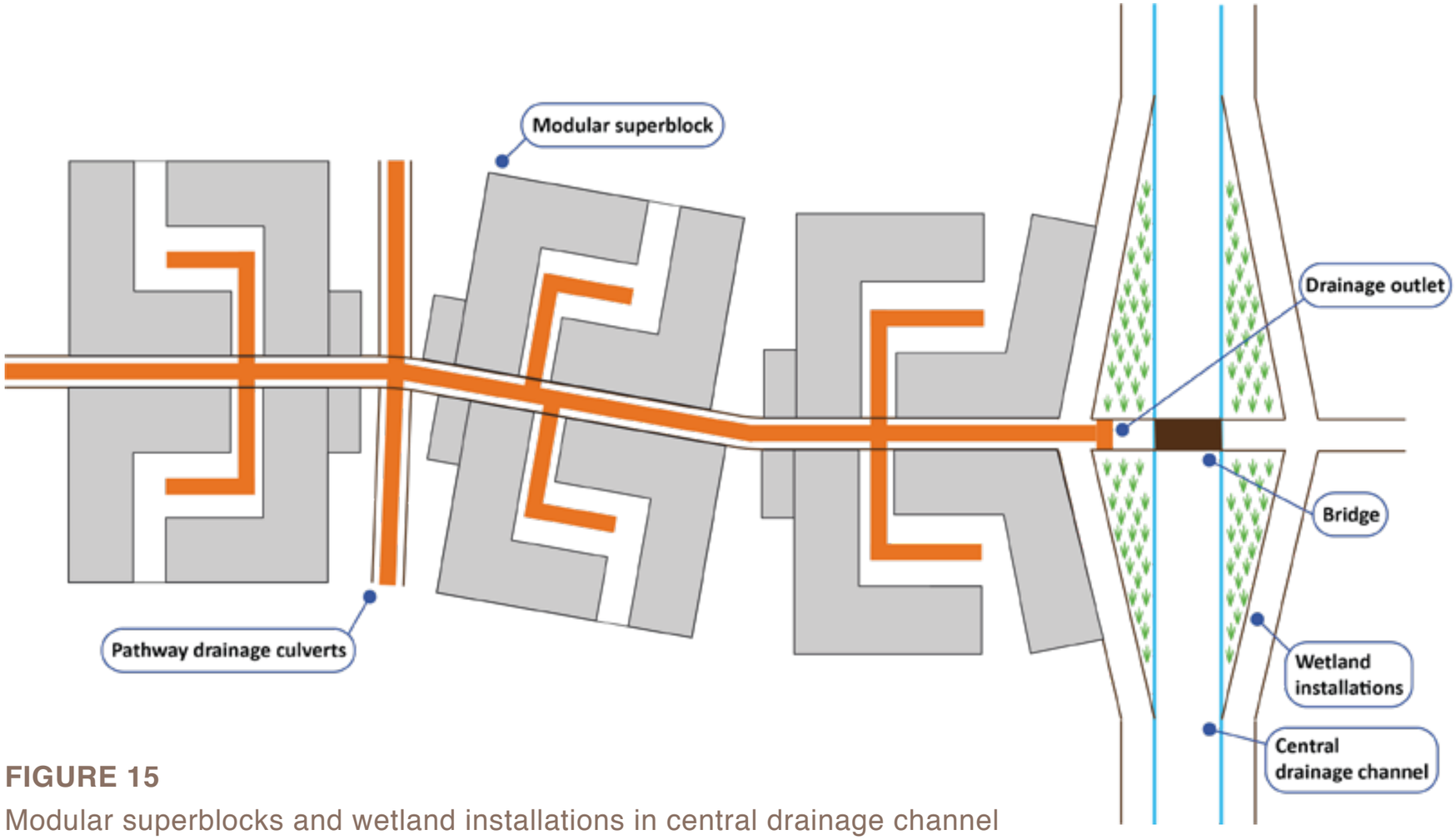


FIGURE 15
Modular superblocks and wetland installations in central drainage channel

Constructed wetlands

The central stream in Katanga has suffered from serious erosion and de-vegetation that result from excessive stormwater flows and pollution levels. Improving stream water quality will improve the health outcomes for the community, reduce pollution to Lake Victoria, improve biodiversity and increase urban greening in Katanga (Venkataramanan et. al. 2019) Nature-based solutions, such as urban wetlands or biofilters, offer a potential solution to improve Katanga's stream in a cost-effective way, while maximising environmental outcomes. In the proposed concept, the main streets of Katanga contain stormwater drains that direct dirty water towards the stream. Small wetlands, established where each drain enters the central stream, could intercept these flows to reduce erosion and pollution. The Wet Technik concept developed by students at Makerere University could be utilised here.

Key benefits:
- Erosion reduction
- Improved water quality
- Reduced community health risks
- Enhanced local biodiversity and urban greening

PBL collaboration: Wet Technik

Wet Technik is a student start-up founded at Makerere University by a multidisciplinary group of students looking at reducing the costs of water usage and environmental pollution by hazardous wastewater through the use of constructed wetlands. Focused on solving the ever-present problem around wastewater handling, we want to bring to light the potential of its recycling to enable optimum water usage. Through using a mixture of modified waste bottle caps and pumice in our constructed wetland, we have proven that it will reduce the area requirements, making this system accessible to the factories, schools and eventually households.

Wet Technik is targeting recycling wastewater from schools and factories as these have knock-on effects on the surrounding communities, as well as the respective schools and factories. Our solution will be more applicable in places with limited land like households in urban settings and factories that have limited land but require a wastewater treatment facility. The product we are presenting gives an opportunity for households and institutions to recycle their greywater generated hence optimum water usage and factories a treatment option for their wastewater to meet the discharge standards of the National Environment Management Authority (NEMA).

Text obtained from Wet Technik Project Summary from Wedge Prize (n.d.)

IMAGE 29 Wet Technik installation at Makerere University

Sanitation

Urine diverting dry toilets

Urine diverting dry toilets (UDDTs) are sanitation systems that separate the collection of urine and faeces, without the need for flushed water. The primary advantage compared to standard pit toilets is that when kept dry, faeces converts into an odourless, lower risk material (Rieck, 2012). In a study comparing sanitation techniques in a nearby settlement in Kampala, UDDTs were the most promising technology scored across social, technical, health, economic and institutional indicators (Katukiza, 2010).

Importantly for Katanga, UDDTs can be constructed and maintained with local materials, have low land requirements and are suitable for flood-prone and high-groundwater areas. There is an established market in Katanga for charcoal (usually used for water boiling) that could provide the UDDTs with the dry carbon source needed for application during use. The dry, odourless excrement can be more safely removed for disposal and has potential to become fertiliser through resource recovery programs (Rieck, 2012).

With adequate uptake, these programs have potential to become a source of local income for residents. Urine from the UDDT systems is generally infiltrated, however with Katanga's shallow groundwater it is recommended that the urine is collected for disposal or treated through water treatment wetlands before discharge to the creek.

Key benefits:
- Can be constructed and repaired with materials available locally.
- No constant water requirement for use.
- Small land requirement.
- Long service life (as it can be safely emptied).
- Suitable for flood-prone and high-groundwater areas.
- Low odour through correct usage.

The discovery-focused research done in the field, in turn, gave us critical findings that would inform and inspire our concept design.

Urban greening

As a dense and unplanned settlement, Katanga is suffering from a severe lack of vegetation or green space. This is not uncommon within urban settlements in Kampala and around the world. In the face of broader WASH issues, urban greening may not register as a local priority among residents. However, research from settlements in India suggests that public greenery acts as common pool resources and can improve social capital, health, nutrition and living conditions (Gopal, 2014).

Environmentally, increased vegetation has significant benefits including habitat for birds and insects, air pollution, water pollution reduction, local flood reduction and erosion control (Du Toit, 2018).
Available space is a significant barrier to increasing trees and vegetation in Katanga. However, the space created using the Emu ku'emu and superblock concepts could be used to improve vegetation in the settlement.

These courtyards could support urban gardening, that currently exists in a space-limited capacity within Katanga.

Urban gardening can help promote food security, nutrition and a source of income for residents. The use of nature-based solutions for issues of higher local priority can help passively increase urban greening,
Key benefits:

- Societal and health improvements associated with increase in urban greening.
- Trees and vegetation help reduce air pollution, water pollution, flooding and erosion.
- Nature-based solutions can help passively increase urban greening.

IMAGE 30
Urban gardening currently established in Katanga

Several other proposed solutions support urban greening initiatives, including water treatment wetlands in the central stream and the creation of semi-private courtyards within each residential superblock.

Achieving the vision

The concept design and the vision it proposes for Katanga defines a transition for the area from surviving to thriving. Each solution represents a resolution to an individual issue, however, it is important to note that only an effective combination of solutions can achieve a thriving Katanga. This is due to the integrated and varied role water plays within Katanga and how solutions interact with each other. For instance, properties that are connected to the piped water system should not be prioritised for rainwater harvesting, and properties with functioning UDDTs should not be prioritised for connection to the sewer network. This highlights the importance of effective, long-term planning before implementation of the suggested solutions can begin.

Water access and sanitation services represent the most urgent needs for the community and should be treated as such, however their long-term success and sustainability depends on the integration with the urban form.

Implementation priorities

The themes that should be explored as priorities include those that affect the redesign of Katanga's urban form. These foundational changes are likely to change the functional layout of Katanga and lay the infrastructure frame for other implementation of other solutions.

Installing water supply infrastructure to an area of Katanga should improve water access for residents, but the existence of underground water pipes could make the implementation of drainage and mobility improvements more difficult in the future. For this reason, it is critical to establish a long-term plan for the development of Katanga that considers the interdependencies of proposed solutions.

Katanga's long-term development plan

The plan for Katanga's development is suggested to contain short, medium and long term outcomes that avoid conflicting solutions.

The short-term outcomes suggested for implementation are:

- establishing an urban plan for the Emu ku'emu and the superblock concepts
- formalising the drainage and mobility of Katanga's streets and pathways to fit this plan

While it may not be financially possible for initial widespread implementation of Emu ku'emu and the superblock, it is critical to plan the streets and urban form to accommodate these in the future.This will allow the gradual uptake of the housing concepts into the future. It is recommended that the development plan for Katanga includes provisions for all of the suggested solutions in the short-term, to ensure that short-term actions do not conflict with later stage activity.

The medium term is suggested to involve actions to implement water supply and sanitation services that secure the long-term well being of residents within Katanga. As the 'future' layout of Katanga's streets has been formalised, this allows the infrastructure to be installed in a 'permanent' manner and take advantage of design synergies (such as the suggested installation of sanitation utilities within drainage culverts). It is during the medium term that decisions for which method of water supply is desired (e.g. rainwater harvesting or connection to piped services) can be formalised.

Long term actions include those that are not classed as critical to providing essential services to residents, but rather deliver more nuanced areas of Katanga's future vision. This includes improving water quality and urban greening outcomes that will passively improve the quality of life in Katanga.

Implementation Recommendations

To fully realise the impacts of the concept proposal and lay the ground to achieve the vision for Katanga to transition from a surviving community to a thriving one, we have developed a recommendation for implementation of our concept proposal in the community of Katanga.

The recommended implementation plan places the community at the heart of all the proposals as the ultimate goal for the project is to establish self-sustenance with respect to water resource management in Katanga. Water resource management involves a full cycle from water supply, access, use and wastewater treatment, drainage, and sewage collection.

Our findings and observations from the trip have highlighted the need for the community to be proactive in decision-making regarding their future. Using our system map, we recognised 4 main categories of actors who are crucial in setting up the building blocks for Katanga's vision of a thriving community : the people of Katanga, public institutions (KCCA, National Water and Sewerage Corporation etc.), and Private Individuals and Institutions (local and International NGOs etc.)(WaterandSD_Vision_to_Action-2.Pdf, n.d.)

The roles are constructed within layers of the timeframes as suggested in the visions and the different concepts and they are recognised as follows:

Collaborative Decision-making

With the proposed concepts, our aim is not only to engage the community in implementing the solutions but also proactively participate and initiate in decision making regarding the implementation of the concepts. This role enables the people of Katanga to attain ownership of the concepts and thus making it their own. This will raise the motivation to achieve the visions as well as the sustainability of the solutions in the future.

The decision making processes will involve working on financing models, management of resources as well as developing governance and policy to guide the future actions.

However, taking note of the scope of the project, going into the details of the role of the community in governance and policy making is left out of the scope of further discussion. However, according to OECD, 'Water crises is primarily a governance issue.' (OECD, 2015); and scratching the surface of the complexities of land ownership issues and the crises regarding water management require the public institutions to acknowledge the need to open governance and policy-making to civil society.

Capacity Building

Our concept proposals do not necessarily introduce new technology but the key is in implementing technologies in an area where it hasn't been implemented before hence the technological gap in the community increases which needs to be addressed. Since we argue that the local community plays a key role in implementing the concept proposals, it becomes crucial to work on building the capacity for the community to engage with the concepts and develop the infrastructure and changing midsets. This shall reduce the dependence of the community on external sources for maintaining the implemented work, thus raising the costs of resulting in failure of achieving the vision. However, capacity building not only targets bridging the technology gap within the community but also enhancing the community's knowledge about the need and value of sustainable living to achieve future visions of self-sustenance.

Kat'anga is a community just like any other, full of potential and talent which has not been able to be utilised due to rising adversities it has had to face which has resulted in reduced feeling of entitlement and belonging. Capacity building deals with emotional capacity along with technological and physical capacities.

Collaborating with the Community and set common goals which align the economic interests of all along with a balance with sustainability

PRIVATE SECTOR

Planning the execution of the proposed design solutions for prototype phase

ACADEMIC INSTITUTIONS

Vision and Design proposal to the community and setting up follow-up feedback meetings with the community and other actors who play a crucial role in achieving the vision

Constructing a knowledge database for creating frameworks assessing risks and future trends in sustainable ecosystems, and evidence-based decision making

Planning the execution of the proposed design solutions for prototype phase

IMPLEMENTATION RECOMMENDATIONS FOR SHORT-TERM VISION

COMMUNITY

Understanding the roles of all the members of the community including women and children in building indigenous knowledge

Creating Action Committees for water access solutions, Emu'ku'emu housing solution, sanitation and waste management solutions.

Initiating a common space for all the actors involved, to come together, work towards collaborative, coordinated and planned next steps towards achieving the vision

PUBLIC SECTOR

Building internal capacity for evidence-based decision making practices and open and collaborative way of working

Planning the execution of the proposed design solutions for prototype phase

FIGURE 16
Implementation Recommendations for Short-term vision

Working with the Action Committees and other actors to identify right tools and incentive plans to deliver solutions at scale

Economic and technological resource management to lead effective implementation of the first phase of Emu'ku'emu and water supply solutions

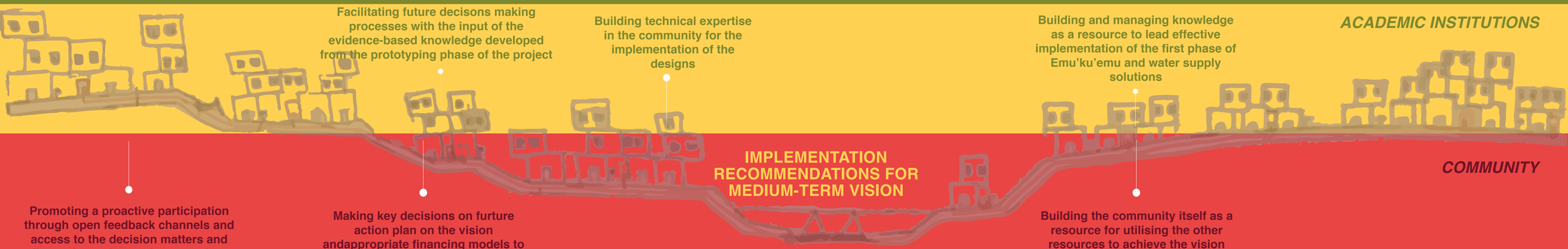
PRIVATE SECTOR

Facilitating future decisons making processes with the input of the evidence-based knowledge developed from the prototyping phase of the project

Building technical expertise in the community for the implementation of the designs

Building and managing knowledge as a resource to lead effective implementation of the first phase of Emu'ku'emu and water supply solutions

ACADEMIC INSTITUTIONS



IMPLEMENTATION RECOMMENDATIONS FOR MEDIUM-TERM VISION

COMMUNITY

Promoting a proactive participation through open feedback channels and access to the decision matters and discussions of committee meetings

Making key decisions on furture action plan on the vision andappropriate financing models to support the course of action

Building the community itself as a resource for utilising the other resources to achieve the vision

PUBLIC SECTOR

Working with the Action Committees and other actors to create models identifying their role, pointing out possibilities and gaps in services and policies

Bridging gaps in governance on water and housing themes as issuesusing fresh knowledge from different actors involved

FIGURE 17
Implementation Recommendations for medium-term vision

Building economic framework for a results-based contract motivating private businesses to participate in the pojects

Working with the community to create new economic opportunities for Katanga

Engaging in development of investment plans to establish adequately equipped healthcare and educational facilities

PRIVATE SECTOR

Building opportunities for the youth to engage in vocational knowledge training and enhancing their economic opportunities

Setting building blocks of understanding within the community on sustainable living and harmonius living practices

ACADEMIC INSTITUTIONS

COMMUNITY

Engaging in Water quality restoration projects and thus leading behavioural change in cultures of community

Fostering and encouraging growth of hobby skills of community to develop self-sustaining practices

IMPLEMENTATION RECOMMENDATIONS FOR LONG-TERM VISION

Assisting the public sector in monitoring the impact and progress of resources, public services and policies

PUBLIC SECTOR

Restructuring policies and strategies that support real needs of the society

Fostering a practice of collaborative methods to community development of various other peri-urban communities in Kampala

FIGURE 18
Implementation Recommendations for long-term vision

07

CHALLENGES

IMAGE 31
A boy throwing wastewater into the drain

Challenges

The main challenges threatening the success of the project are not technical, but rather they are linked to the coordination and implementation of the proposed solutions. The organisation of stakeholders is layered and complex, ranging from residents, subletters, landowners, and governing bodies. Fully understanding this system of connections is difficult and resource-intensive. The combination of private and public water management solutions also poses complications.

Logistics such as inconsistent internet connections already posed issues to regular communication between the project team and the stakeholders. These challenges have been exasperated by the global pandemic measures put in place. The quarantine measures in Uganda have caused less interaction between contacts and stakeholders, and the closing of Makerere University hinders communication and collaboration with the partner student team. These obstacles have slowed the development process and will result in a lack of community feedback in the new designs.

While it would be possible for the community to implement some solutions on their own, other solutions require outside funding and support of the city authorities and utilities.

Aligning the project with the goals of local institutions, generating investment from the community, and finding funding mechanisms represent the three largest future challenges for effective water management in Katanga.

There are also challenges that will affect project development. In order to communicate with the Katanga residents to receive feedback on further design iterations, the project team depends on working through the Makerere University student team and other local contacts.

08

REFLECTIONS

IMAGE 32
A school playground in Katanga

Project Amaka was able to achieve a lot in 5 months. Our group engaged in true multidisciplinary collaboration to find creative and sustainable water solutions for Katanga and its vibrant community. The resulting concept design is functional, comprehensive and extensive and supplements the Emu ku'emu modular housing concept.

The main challenges related to the implementation of water and housing concepts remain, and these challenges go beyond the scope of this project. However, implementation of our concepts might become something that our project team will continue to work on independently from the SGT Programme. The collaboration with the MAK student team is anticipated to continue.

Teamwork during this project was fruitful albeit occasional challenges. One of the key takeaways for all group members were the learnings and new skills developed through multidisciplinary teamwork. We had a chance to learn a lot from each other's expertise and the support from our mentors.

Key strengths of our teamwork were:
- creating a safe space where everyone can learn without fearing mistakes
- establishing clear roles – everyone felt like they were an important part of the team
- inclusivity and trust – everyone's opinions were welcomed and treated equal, everyone trusted each other's judgement and capabilities

Main challenges of our teamwork were:
- management of time and expectations (trying to achieve a lot in a short time)
- consistency in organisation of work

The special current state of the world definitely brought an impactful element to our project. Special circumstances due to the global pandemic proved to hinder collaboration between the student teams. Furthermore, uncertainty and trying to adjust to new routines took a toll on the team mentally and sometimes made focusing on the project difficult. We definitely learned a lot about remote teamwork.

Working with a community and challenges different to what many from our team had worked on before was educational and rewarding. We gained a deeper understanding of global sustainability challenges and the interconnections between various problems. This kind of sustainability knowledge in the global and humanitarian context will be very valuable and useful for us in the future.

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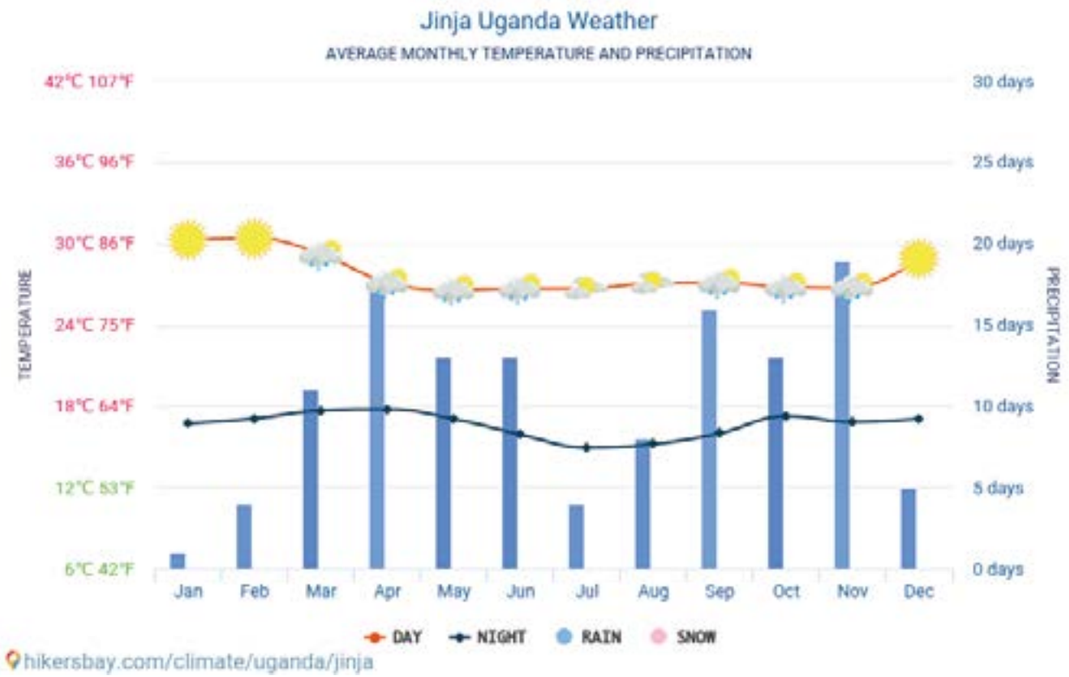
APPENDIX

Appendix 1. Average climate in Kampala. (Source: Hikersbay, 2019)



Appendix 2. Project risk analysis (internal and external risks assessment).

Internal Risk	Likelihood (1-3)	Impact (1-3)	Mitigation
Lack of communication post trip	3	2	Planning and scheduling, using easily accessible communication tools, being active
Lack of participation from the community	2	3	Being flexible with schedules, using translators, planning in advance, easily accessible location, having approachable attitude, marketing
Lack of trust/rejection from the community	2	3	Showing respect, encouraging interaction, meeting with community leaders, having approachable attitude, being transparent and understanding, being prepared to change approach
Poor management of expectations from both student teams	2	2	Having a workshop on expectations for the project, finding common objectives and understanding
Cultural barriers	2	2	Being respectful, transparent and understanding, using translators, actively learning from the culture
Sickness/fatigue during the trip	2	2	Being aware of health risks, food safety and hygiene, taking care of ourselves and each other
Communication issues with local authorities, university staff	2	2	Unambiguous and transparent communication, using translators, meetings
Lack of contact with Makerere student team due to full schedules or communication issues	1	3	Planning and scheduling in advance, transparent communication
Inappropriate project objectives	1	2	Comprehensive research and planning, flexibility towards changing the objectives

1=very unlikely/low impact, 2=moderately likely/moderate impact, 3=very likely/high impact

External Risk	Likelihood (1-3)	Impact (1-3)	Mitigation
No access to data for water design	3	1	Being prepared to change approach
Issues accessing Katanga (physical barriers (eg. flood) or access denied by authorities)	2	3	Being flexible, staying updated, being prepared to change approach
Logistical delays (flights delayed/cancelled etc.)	2	1	Staying informed, being flexible, communication
Civil unrest, natural hazards (floods, storms, etc.)	1	3	Staying informed, being prepared and flexible

1=very unlikely/low impact, 2=moderately likely/moderate impact, 3=very likely/high impact

Appendix 3. Resident interview questions.

<ask to take portraits of interviewees>
<ask to take photos of their space>
<ask if we can record the audio of the interview>

Everyone:
What is their journey to Katanga? (moved in, born there…?) - interactive drawing
Education levels
How old are you?
If you had access to harvested rainwater, what would you use it for?
What keeps you in Katanga - financial, community, family….?
What rent do you pay - who is your landlord?
Given the opportunity, what would you change/fix first around your home/business?
How does Katanga change during and after heavy rains?
What sort of garbage do you throw away - where do you throw it?
Where do you go the toilet - how much does it cost?
Do you mind us coming here, asking questions and working on this project?
Where do you get information?
Internet/mobile phones? Apps?
Are you happy in Katanga?
What's the best part of your day, if any?
Create a budget plan on how they use their money
Do you feel at home in Katanga?
How often do you travel out of Katanga? Why?
Do you have visitors? How often?

Mothers:
What is the household budget and where is the money spent?
Where does your household earn it's income?
Who lives in your household and what do they do during the day?
What is good and bad regarding your home? <Ask to take photos of these things>
Given the opportunity, what would you change/fix first around your home?
How much water does your household use, where does it come from and who collects it?
What sort of maintenance is required on your house? How much does it cost you?
What does your family do for leisure?
Where do you currently use the toilet?
What does your household use electricity for?
Do you have animals?

What age were you when you had your first child?
How do you spend your income?
What is your husband's daily routine? (if applicable)
Who is the decision maker in the house?
What are your hopes and dreams for a day in your life? (Ask them if they can show around home)
Show around the house and ask to describe the space

Business owners:
What is your business and when did you start?
What extra space would you need to improve your business opportunity?
Where do you sleep - close to your business?
If you had access to rainwater, how would this affect your business?
Why did you start your business - is it successful - aim of profits for a day?
Do you employ others - if not, would you like to?
Who are your customers and suppliers?
How often do you need supplies - do you have enough space to store - how do you get it?
Do you have similar business (competitor) close by - if so, what attracts customers to your business?
How important is water to your business - how much do you use?
Do you like working in your field - do you just do it to survive?
If Katanga was developed, how do you think this would affect your business?
How does the weather (rain, sun) affect your business?
If you had the available space, would you start a new or change your existing business?
What are your hopes and dreams for a day in your life? (Ask them if they can show around home if located close to business)

Person aged 50+:
What do you do during the day?
How easy is it to move around in Katanga?
What is your role in the community - How does the community help you?
What do you get your household water - has the price of water changed over time?
Are you healthy - if not, do you get assistance?
How has the housing situation changed since you arrived in Katanga?

Teacher:
Do the kids drop out - why?
When are the kids in school?
What happens to girls when they have their period?
Who funds the school and teachers?
Is there enough space for the kids?
What year does the schooling go up to?
What sort of skills are taught?
Qualifications - are you paid or volunteering?
Why do you teach in Katanga?
Do the kids like school?
Does the school collect rainwater - what do you use it for - what is the quality like - do you do maintenance?
What kind of bathrooms do the schools have?
Is there school fees?
How much are you paid?

Young adult:
Where do you hang out?
Do you have family in Katanga?
Do you work or study - do you see university as improving their options - do they see vocational or university as accessible - do they know about scholarship options?
What kind of change would you like to see in the housing and streets of Katanga?
Do you often go to other parts of the city - if so, how do you get there?
What are your dreams for the future?

Father:
How does your family generate income?
How do you contribute to household activities?
How do you spend your money?
What is your daily routine?
Who is the decision maker in the house?
What future do you want for your kids?
What education do you have?
What is your occupation?
What do you do for leisure?
Do you have family out of katanga? Do you keep in touch with them?
Problems related to running of the house?
What are your hopes and dreams for a day in your life? (Ask them if they can show around home)

Community volunteer:
What do you volunteer for?
How did you become a volunteer?
What's the best thing about volunteering?
What's the worst thing about volunteering?
What is the most important development that happened in Katanga?
What did you do before volunteering?
Do you get time to generate income on the side?
What are the most common problems people come to them for?
What kind of aspirations do you have? Job? Study?
What does a Katanga need?
Who do you think needs most help?
Who are the most underrepresented in Katanga?
What kind of projects have you volunteered in?
What kind of projects need more attention? why don't they get more attention?
What kind of family do you have?
Problems related to running of the house?
What are your hopes and dreams for a day in your life? (Ask them if they can show around home)

Car wash:
What's the name of your business?
How much do you pay to the workers?
Do you have requirements to employ?
How many of the workers are from Katanga?
How do you contribute to Katanga?
Are you a registered company?
Where do you get your water?
Where does the wastewater go?
How old are the workers?
How long do the workers stay?

Do you want to upgrade the housing on the land that you own?
Do you own land somewhere else?
Do you live in Katanga?
Do you have business owners on your land?
How do you collect the rent?
Is electricity and water included?

Appendix 4. Community survey

Survey for Katanga Residents
This is an anonymous survey for a student project between Makerere University and Aalto University (Finland). We are trying to create a vision for the future of Katanga and we want to know about life in Katanga! The answers from this survey will be used to understand the community and make sure the future vision includes your views. After filling this survey, please return it to the Chairman's office.

Gender:
Age:
Occupation (Job or homemaker):
Religion:

What is your daily routine?
How many people live in your home?
How many are children?
What are their ages?
Do they go to school?
Are there other people you are planning or would like to live with?
How long have you lived in your house?
What size is your house? (how many rooms)
Where did you live before?
Have you made any changes in your home recently? What were they and why?

How do you get water daily?
Who goes to get the water?
Do you get drinking water from a different place?
Is it good water? (Taste, etc.)
Do you boil the water before using it?
If you buy your water, where do you go to buy it?
How far do you have to go to get it?
How much do you buy? (how many 20L jerrycans)
How much do you pay? (for one 20L jerrycan)
How often do you go get water?

What do you use water for?
What would you do with more water if you did not have to pay for it?

Do you gather rainwater?
Why not? (space? materials? cost?)
Does your house flood?

Do you have access to a toilet?
What kind of toilet do you use?
How far is it from the house?
How much do you pay for a public toilet?
How are the conditions?
Do you have any concerns about the current situation of toilets?

Where does your household get food from?
Where do you store your garbage?
How do you dispose of garbage?

What do you like about Katanga?
What are you concerned about in Katanga?
Do you plan on staying in Katanga or do you want to leave Katanga? Why?
If possible, what would you change first in Katanga?

How often do you have visitors to your home in Katanga?
How often do you leave Katanga? Where do you go? Why?

Is there anything else we should know?

PROJECT AMAKA

Final Report

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