Applying Sustainable Urban Drainage Systems to Urban Floods Management in Area 49 Planned Settlement in Lilongwe City, Malawi

A dissertation submitted in partial fulfilment of the requirements for the degree of Master of City and Regional Planning

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Dedication

I dedicate this dissertation to my mother, Meriam Atupele Majamanda.

Acknowledgements

I cannot talk of the success of this dissertation without appreciating the input of others who contributed in various ways through their encouragement, guidance and support. I really appreciate your help and I cannot thank you all enough.

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Abstract

This dissertation presents a research conducted by Edda Mkombezi titled: "Applying Sustainable Urban Drainage Systems to Urban Floods Management in Area 49 Planned Settlement in Lilongwe City, Malawi".

Currently, there is a frequent occurrence of urban floods in Lilongwe City with Area 49 being the most hit neighbourhood which is also the study area for this research. Therefore, this requires management using nature-based solutions such as Sustainable Urban Drainage Systems (SUDS). The main challenge is that SUDS and urban floods management are not adequately addressed in the current key spatial planning frameworks of Lilongwe City. There is a misalignment of the existing key spatial planning frameworks as far as SUDS implementation and integration are concerned. Thus, there is a need to examine what can be done in order to integrate SUDS into the key spatial planning frameworks. This includes addressing sustainable transitions language, promoting participation of residents and re-imagining the role of spatial planning in water governance.

The aim of this dissertation is to examine how SUDS can be integrated into the key spatial planning frameworks as a management mechanism for urban floods. This aim was achieved by collecting data through case study and discourse analysis methods. The collected data was then analysed using discourse analysis and content analysis.

The results of this study show that there is room for the integration of SUDS in the key spatial planning frameworks but not as an urban flood management measure. Rather SUDS are being proposed as one of the climate-resilient infrastructure that the city needs. On the other hand, residents of Area 49 have their own knowledge and ways of managing urban floods which can be incorporated into the spatial planning frameworks. The language of sustainable transitions being used in the key spatial planning frameworks is not comprehensive and misaligned. The knowledge gained from this study can inform policy review and formulation in disaster risk management and how spatial planning can be used in water governance of neighbourhoods in order to have proactive, context and site-specific response to urban floods.

KEY WORDS: Sustainable Urban Drainage System, Urban Floods, Spatial Planning

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CHAPTER ONE: INTRODUCTION

EXPLORING THE ISSUE OF URBAN FLOODS AND CLIMATE CRISIS IN AREA 49

1.1. Background and Overview

From the word go water is life but water can also kill; a vivid example that nature has its way to fight back. My personal experiences with mismanagement of the water cycle, particularly runoff, made me rethink who is responsible. Is it residents or city council? Who can then take a leading role? Everyone is responsible for taking care of nature by virtue of being part. Anthropogenic activities have harmed the water system through theft and pollution despite water being replenishable through its cycle. Therefore, this dissertation is an exploration of what role regulatory frameworks and residents can play in managing urban floods.

As a young child, I kept moving between the city and the rural areas of Malawi due to the nature of our extended family. Both the city and rural areas had a similar problem of flooding during the rainy season. Flooding in the city was due to the failure of drainage systems along roads that were not paved and had no functional conventional drainage systems. On the other hand, flooding in rural areas was caused by flash floods and full rivers.

The people in rural areas seemed to have gotten used to flash floods as they have a saying which says: "***Madzi sayiwala khwawa***" (*water does not forget its course*). This saying means that flash floods will always occur and they will always happen in the same places that experienced it previously. Therefore, people in rural areas would always stay away from flood streams. One thing that was distinct in the city was water scarcity. A week would not pass without having dry taps for a day or two. These two issues of water scarcity and floods due to drainage failure increased as the population grew in the city.

These memories remained in my head as I grew but made no significant sense until when I became an urban and regional planning student in my first degree. My memories started to make sense and I would notice the change in human settlement patterns with a growth in urbanisation. Floods and water scarcity were increasing in the urban areas. Efforts were being made to provide people with water but they were using the same traditional ways of providing water adopted from the colonial systems.

During an interface with an expert from a water supply institution as part of my first degree study in Bachelor of Science in Physical Planning, he narrated to us the efforts that were being made at that time to curb water scarcity. A dam was being constructed to collect water from the source which is mostly from the mountain forest reserves in Malawi and then directed to reservoirs for distribution to users. There was nothing different with the existing sources of water that were diminishing and the same traditional method was used again. This is ironic as to why repeat a same system that is failing.

The issue of disaster risk management was not popular as it was only brought to our attention when it strikes. That is when efforts would be made to distribute relief items to the victims and that was year in, year out. These then inspired my research interest in applying proactive solutions to the problems of flooding and water scarcity in cities.

This dissertation, therefore, aims at exploring the issues of urban floods in a planned settlement of Lilongwe City in Malawi. One of the contributing factors is a failure in existing drainage systems as highlighted above. By looking at the existing spatial planning frameworks and insights from specialists, Sustainable Urban Drainage Systems (SUDS) are explored in this dissertation on how best they can be applied in order to better prepare for and prevent urban floods at the same time help in planning for cities with little or no water which then helps in contributing to more hopeful, healthy and habitable futures in cities.

This research focuses on Area 49 planned settlement in Lilongwe City, Malawi where floods have been happening frequently (UN-Habitat, 2014). Lilongwe is the fastest-growing city in Malawi that is experiencing floods (Lilongwe City Council, 2010). One of its neighbourhoods, Area 49, is a residential area with a lot of new developments since 2012 (Lilongwe City Council , 2015). Area 49 is surrounded by Lilongwe rural to the west, Area 50 to the north, Area 30 and Area 18 to the east, and Area 56 and Area 48 to the South.

LOCATION CONTEXT OF LILONGWE CITY IN MALAWI AND AFRICA

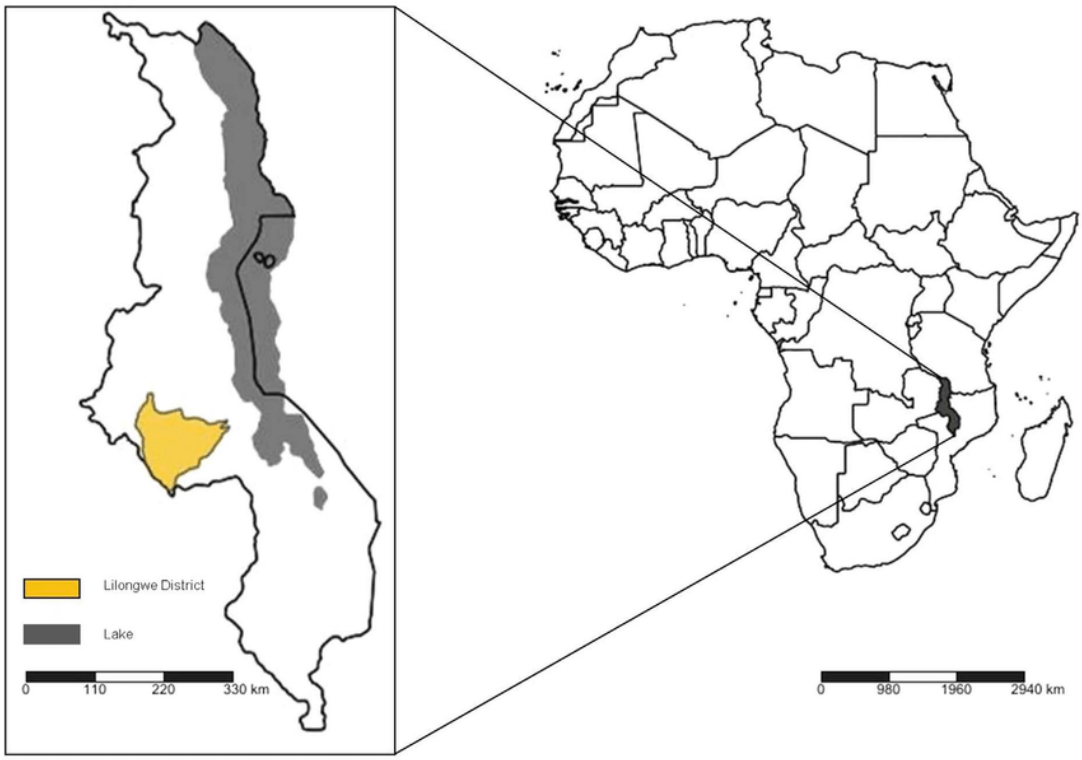

Figure 1: Map showing the Location of Lilongwe City in Malawi and Africa (Source: https://www.researchgate.net/publication/309819292_Future_climate_impacts_on_maize_farming_and_food_security_in_Malawi/figures?lo=1)

The population of Area 49 has increased by 200% from 29, 001 in 2008 (UN-Habitat, 2014) to 58 212 in 2018 (National Statistics Office, 2019). Area 49 is the only planned residential settlement that has been experiencing floods frequently such as in 2015, 2019 and 2023 with the rest being informal settlements and other planned settlements being hit once-off (Government of Malawi, 2020). This, therefore, made it a suitable area for this research to see if residents can take a role in implementing SUDS as one of the ways of managing urban floods.

In many parts of the world, studies have been done on the implementation of WSUD which has been used to manage floods but some failed because they did not pay adequate attention to the social aspects of it for example in Melbourne, Australia, residents were not aware of their role in managing wastewater and stormwater (Radcliffe, 2018). With Area 49 being a residential neighbourhood that is affected, it is necessary to incorporate the experiences and knowledge of the locals. So, this study

takes an approach that sees the social and natural inseparable and explores resident-led SUDS to prevent urban floods in Area 49 in Lilongwe City, Malawi.

The outline of this chapter begins with a background and overview to the issue of urban floods in relation to the prevailing issue of climate crisis. This directly links to the appropriateness of SUDS as a proactive measure in urban flood disaster risk management. This is followed by the problem statement and then significance of the study followed by the aim of the research. The next section looks at the research questions and research methods used. The subsequent section looks at the motivation for conducting the research, ethical considerations, philosophical position and normative values. To conclude the chapter, a description of the structure of the dissertation is laid out.

1.1.1. The Issue of Urban Floods in a Climate Crisis and Era of Extinctions

Transformative change is necessary to address the immense challenges of 21st century which include catastrophic loss of species and habitats whilst experiencing alarming rates of climate change and ongoing socio-ecological injustices. Malawi has been experiencing floods and several other natural and social disasters due to its geographical location along the Great East African Rift Valley (Government of Malawi, 2020). The frequency of flood occurrence has also increased due to climate crisis and urbanisation which has amplified and exacerbated existing threats on people and the environment. Malawi is not the only country that is facing these challenges and it is not a recent phenomenon. Some parts of the world such as Haiti, Bangladesh, India and Guatemala are also prone to disasters and have had frequent occurrences (Atwii, et al., 2022). The impacts of climate crisis and increases urbanisation rates have exposed cities to extreme weather events such as heat, floods, cold waves, drought, wildfire and windstorms (Emilsson & Sang, 2017).

For a number of reasons, it is believed that cities face the greatest challenge in adapting to climate crisis as it amplifies and exacerbates all existing stresses. First off, as of 2022, cities were home to more than 55% of the world's population and this number is expected to rise to 68% by 2050 as urbanization and population growth trends intensify, particularly in Asia and Africa (UN DESA, 2022). As a result, it is thought that cities are particularly susceptible to climate crises (UNEP, 2007). The challenge of

providing and organizing urban infrastructure services is further complicated and uncertain by the concentration of cities' vital infrastructure networks, such as energy, transport, and water systems, which are put under increasing pressure as a result of climate extremes like increased precipitation and droughts (Mguni, 2015).

Similar to other cities worldwide, Malawian cities have also been hit hard by the effects of climate crisis. Floods are one of the main extreme weather events in Lilongwe City alongside fires, epidemics, and environmental degradation (UN-Habitat, 2014). This has caused devastating effects such as loss of lives and property (IFRC, 2020). In 2019 alone, 984 people from 179 households were affected by floods in the city and two died (IFRC, 2020). In 2020, 400 households were also affected by floods that resulted from heavy rains (Chipambali, 2021). This year, 114,637 to 126,215 people were displaced whilst 511 died and 533 went missing the whole of Malawi (DODMA, 2023).

Urban flooding is defined as the inflow of stormwater that is caused when there is a failure of stormwater runoff to infiltrate the soil due to the capacity failure of existing drainage infrastructure (National Academies of Sciences, Engineering, and Medicine, 2019). The causes of heavy stormwater runoff are different according to the types of precipitation that occur in various urban areas. In Lilongwe City, urban floods are caused by heavy rainfall as that is the type of precipitation that occurs in the city (UN-Habitat, 2014). The magnitude of urban floods has increased due to an increase in urban built-up areas (Lilongwe City Council, 2010). In the end, there has been a loss of habitats and decreased permeability of surfaces thereby making the environment more susceptible to floods as any occurrence will be devastating through loss of lives and property (DODMA, 2023).

The actions that have been taken to address the issue of flooding have been reactive. Starting with the Department of Disaster Management Affairs (DODMA), a state-controlled department responsible for planning and overseeing the execution of programs for disaster risk management in Malawi, it mostly focuses much on providing relief aid to affected and vulnerable people during disasters (Government of Malawi, 2020). The Department of Poverty and Disaster Management Affairs (DPDMA) and the Environmental Affairs Department (EAD) are responsible for managing disasters in Lilongwe City (Lilongwe City Council, 2010).

Other stakeholders such as local and international NGOs have also taken the same reactive role of providing relief aid to disaster victims (Habitat for Humanity, 2019). This is not a sustainable way of managing disasters both in rural and urban areas. In order to adapt and make cities more resilient to climate crisis specifically, they have to shift from being reactive to being more proactive. Sustainable Urban Drainage Systems (SUDS) are one of the elements of Water Sensitive Urban Design (WSUD) that can be used to better prevent, prepare for and manage urban floods instead of waiting for them to occur (Armitage, et al., 2014). WSUD is part of recommended green infrastructure tools that are ideal for restoring ecosystem services. The network of ecological systems, green spaces, and other landscape features that are both natural and artificial is referred to as green infrastructure and it includes planted and native trees, wetlands, parks, green areas, woodlands and natural grasslands, as well as potential architectural interventions that include vegetation at the building and street level (Pasquini & Enqvist, 2019).

Ambitions to include ecological relationships more and more into planning procedures have recently become a part of an essentially straight growth path (Metzger, 2018). The discipline initially focused almost completely on human structures, but as comprehensive planning advanced, the focus expanded to encompass social entities and systems with a broader definition. Environmental planning has since broadened its focus to incorporate biological units like biotopes and river basins as functional systems that may be improved or maintained with the aid of deliberate human action (Metzger, 2018).

1.1.2. Problem Statement

As called to attention above, Lilongwe City faces the challenge of increased urban floods, water scarcity and existing policies that do not adequately incorporate proactive disaster risk management mechanisms such as SUDS (DODMA, 2023; Government of Malawi, 2020; Lilongwe City Council, 2015). Urban floods are caused by the failure of existing conventional drainage systems that are not continuous thereby failing to meet their carrying capacity in cases of huge amounts of precipitation (Lilongwe City Council, 2010). These drainage systems also do not align, channel nor drain the water into existing natural catchment areas such as rivers and wetlands. This prompts for the need

to rethink and redress the existing spatial planning frameworks so that they incorporate the SUDS.

The current traditional way of doing things which was adopted from colonial times appears to be falling short of holding the carrying capacity of the drainage systems in an era when climate crises are continuing to hit rampantly (Lilongwe City Council, 2023). Apart from these crises is the increased urbanisation rate which entails that more people will need space to live in urban areas (UN-Habitat, 2014). So, with the failure of existing drainage patterns, a growth in population means the problem will worsen.

Therefore, evaluating the existing spatial planning frameworks is important to ensure that SUDS are integrated and incorporated. The existing frameworks do not engage, consider and integrate adequately on drainage needs and a growth in population will further exacerbate the problem. As the frameworks do not deal with water management and SUDS adequately neighbourhoods such as Area 49 that a lot of development taking place are the ones suffering the most with a higher occurrence of urban floods.

1.1.3. Significance of the Research

It is hoped that the results of this research can be used by both the Lilongwe City Council (LCC) and Malawi Government to inform policies and spatial interventions. LCC can use these results to help develop a policy framework that is more proactive in disaster management instead of the current reactive way. The current city development structure plan (2014)[1] is up for mid-term review as it ends in 2030 therefore the results of this research can also be used to incorporate SUDS when reviewing it. LCC may also use the results to integrate SUDS in its urban disaster management framework and general drainage systems in the city so that all the spatial planning frameworks are aligned. All these have to start at the national level by the government through DODMA and all local government councils can make their plans in line with the national framework. The magnitude of floods has been increasing in

[1] The Lilongwe City Development Structure Plan is synonymously referred to as the Urban Structure Plan in LCC's strategic documents and key spatial planning frameworks.

cities and the nation at large therefore considering the results of this research will help towards achieving Sustainable Development Goal (SDG) number 11 of making human settlements, sustainable, resilient, safe, and inclusive. The results of this research also highlight the role that community-led initiatives play in dealing with planning matters. Disaster management in Malawi is a top-down approach that puts people only on the receiving end. This research aims to show the significance and importance that a bottom-up approach to disaster management is also possible as the social and natural world are completely entangled and interrelated.

1.1.4. The Rationale or Motivation for Undertaking the Study

The main reason for doing this research stems from the researcher's experience in Lilongwe City. Having grown up in the city for part of her childhood, interest was developed in planning issues. After attending the planning school, some of the issues that were seen in the city trickled this interest further. The city has grown substantially with many of the built-up areas taking up space that had natural vegetation and encroachment on wetlands. Urban growth has worsened with the prevalence of climate crisis and global pandemics such as Covid 19. Having studied Natural Systems and Urban Infrastructure modules in the previous degree enriched the researcher's interest and curiosity in how to deal with urban floods. WSUD provided the researcher with an opportunity to further pursue her interests as a dissertation to find ways to solve one of the issues affecting the residents of Lilongwe city in Area 49.

The researcher was also inspired by the concerns about the effects that predicted climate crises will have on communities and the environment which have grown over the past 20 years on a global scale (Mguni, 2015). As climate crises becomes a significant policy concern for cities, more focus is being placed on mitigating and adapting to the challenges ahead at the urban scale (Thodesen, et al., 2022). The issues that urban environments face as a result of climate crisis and densification can be better addressed by climate adaptation methods such as SUDS (Thodesen, et al., 2022). Urban stormwater management infrastructure will experience stress as a result of climate crisis (Mguni, 2015). Conventional drainage systems may not be able to handle the expanding urbanization in a time of climate crisis, natural disasters, and other

problems (García, et al., 2021). Most developing-world cities, like Malawi, now have inadequate infrastructure that is ageing and in need of replacement (Mguni, 2015).

As a result, urban climate crisis responses have started to emphasize infrastructural systems (García, et al., 2021). Urban infrastructure provision and management have, up until recently, the conceptual apparatus that no longer fits engineering and management problems of largely stationary phenomena. Whilst facing a wicked complexity, there is a need to insert deep practices of care, participation and repair in the interests of advancing local-level habitability (National Academies of Sciences, Engineering, and Medicine, 2019). There is a need to pay enough attention to flows, processes and interactions of human and natural systems which should be treated as separate critical infrastructure systems since they are viewed as crucial tools for combating climate crisis; as a result, they shape and will continue to shape urban responses to it. Hopefully, this research, that is taking place in a rapidly developing city, would help in framing response to the concerns posed by climate crisis and rising urbanization.

The primary goal of stormwater management in urban areas has been to collect runoff and direct it to the nearest body of water such as rivers and wetlands (García, et al., 2021). This indicates that stormwater drainage currently places little to no priority on environmental preservation and instead prioritizes quantity management (National Academies of Sciences, Engineering, and Medicine, 2019). This has resulted in flooding, erosion, siltation, and pollution which has had a negative influence on the ecosystem (Armitage, et al., 2013). SUDS consider stormwater as a component of the urban water cycle (Armitage, et al., 2014) and this research will therefore explore how to apply it successfully in Area 49, Lilongwe.

There is a need to change focus from a reactive role to a proactive role in disaster management. For example, after the 2015 floods in Lilongwe city, and many other affected districts, the government proposed to build back better what was destroyed (Chilinde, 2016). The national government did not tackle the issue of how they can prevent disasters if they strike again or have fewer impacts (Hay & Phiri, 2008). This shows how they are only focused on providing solutions only after disasters which is not good. With climate crisis and environmental degradation, cities must become more

resilient to and prepare better for disasters and shocks. And this has to be in all aspects of resilience which are engineering, ecological and social resilience.

Engineering resilience is defined as the ability of a system to return to its single equilibrium state after a brief disturbance by measuring how fast it was restored (Zampieri, 2021). Ecological resilience is the ability of the natural system to absorb shocks and recover itself when a disaster occurs (Adger, 2000) whilst social resilience is defined as how human communities, larger societies, and individuals respond to and recover from shocks (Chilinde, 2016).

The problem statement highlights the failure in some cities that have implemented and worked with WSUD due to the lack of adequate attention to the people and the social realm which is part of social resilience. The prevention of floods in order to protect people and property is a key goal of stormwater management tools such as SUDS (Armitage, et al., 2013). Therefore, applying SUDS to urban flood management does not only help in restoring the ecosystem which is ecological resilience but also contributes to social resilience if people take part. This substantiates why the researcher believes in resident-led SUDS to build social and ecological resilience by getting the deep knowledge, understandings and perceptions of the people residing in the study area (Thodesen, et al., 2022).

1.1.5. The Aim of the Research

This research aims at exploring how resident-led SUDS can be better integrated in the existing key spatial planning frameworks in order to help manage the problem of urban flooding in the planned settlement of Area 49 in Lilongwe City.

1.1.6. Research Questions

Main Research Question

How can the existing spatial planning frameworks (Lilongwe City Development Structure Plan (2014), Lilongwe City Development Guidelines and Standards (2015), and Drainage Master Plan (2023)) be enhanced to incorporate and integrate Sustainable Urban Drainage Systems (SUDS) as a way of managing, preventing and better responding to urban floods in Area 49 in Lilongwe City?

Sub Questions

i. What is the current state of affairs in Area 49 as far as water, floods and social dynamics are concerned?
ii. What role can residents play in applying SUDS in urban flood management by considering their lived experiences and indigenous knowledges?
iii. What are the local ways of shared meaning in disaster management that can be integrated into SUDS and guiding policy frameworks?
iv. Do the existing spatial planning frameworks of Lilongwe City adequately address urban floods management and its mechanisms?
v. How can SUDS be applied in managing the problem of urban flooding to accommodate residents in Area 49?

1.2. Research Design

This research is a qualitative study and the main research question necessitates the need for a qualitative research. A qualitative research design is ideal to address the main question because it is looking at the experiences, perspectives, and meanings. This, therefore, links to the research methods of discourse analysis and case study that have been used in this research.

1.2.1. Research Methods Used

This research uses the case study method and discourse analysis as methods of research. Discourse analysis will also be used as an analytical tool as it is both a research method and an analytical tool. The case study method was used because it involves a deep intensive study (Yin, 2004) of urban flood management in Area 49, Lilongwe City. This helps in finding a better understanding of how the current key spatial planning frameworks inform the management of urban floods in Area 49, and how SUDS is integrated within. Discourse analysis will be used to probe into existing laws, policies and guidelines related to SUDS in Lilongwe City.

Case Study

A case study is an in-depth and intensive study of an individual class or unit that may be a community or city (Flyvbjerg, 2011). Case studies focus on both exploratory and explanatory methods of research to answer the questions of how and why. In this research, the how part will help in finding out how SUDS can best be applied to manage

urban floods. The why part addresses the reason why floods occurrence is prevailing in Area 49. Case studies also require getting knowledge of a particular context which in this case is the area under study (Flyvbjerg, 2011).

This research capitalises on the advantages of a case study which are that it helps in revealing how a number of factors work in unison to come up with specific findings (Winkler, 2022a). A case study also helps in finding deeper meanings and comprehensive details of the unit under study. Lastly, a case study depends on a number of sources of evidence to come up with findings that are verified and triangulated. Triangulation is the application of multiple sources of data in qualitative research to get a thorough understanding of a situation (Neuman, 2014). Therefore, several research techniques were used to get various types of data such as observations, interviews, and mapping.

Despite its advantages, a case study has the following limitations. It is not easy to generalise the results of a case study research and can contain bias when verifying as sometimes the researcher might have preconceived ideas (Flyvbjerg, 2006). To overcome the limitation that it is difficult to generalise the research findings, the study focuses on the whole neighbourhood that has complex residential characteristics in order to have a multitude of perspectives and experiences though it might be incomplete due to lack of time to interview many residents. The neighbourhood also has high-density, medium-density, and low-density residential units which allows for an exploration of a wide range of options for SUDS features that can be used. In general, Area 49 is a heterogeneous neighbourhood that helps in collecting data from various classes which then enable collecting data that can be compared (Yin, 2004). The study also sought input and dialogue from various experts from Lilongwe City Council (LCC)[2]. All these play various roles in disaster management and spatial planning.

To overcome researcher bias, the study takes into consideration all research findings without ignoring any part or undermining the results. Flyvberg, (2006) argues that it is not research bias towards verification but rather falsification that should be prevented

[2] The Lilongwe City Council is the name used to refer to the body responsible for municipal planning within Lilongwe City in this dissertation.

at all cost, therefore considering every detail of the research findings will overcome this limitation. The motivation of this research is to inform policy formation therefore overcoming the limitations of this research helps in making the findings relevant. The other limitation of the case study method is that it is not good for hypothesis testing and theory building. This can be rectified the same way as falsification and generalisation are corrected which is using more methods. In this case discourse analysis will be used as well, and comparing various units so that the research has many techniques not limited to research activities alone (Flyvbjerg, 2006).

Discourse Analysis

Discourse analysis is a research method that involves analysing approaches including written and verbal texts by looking at context-based meanings (Jacobs, 2006). In this case, discourse analysis will be used to find meanings of written texts such as policies and regulations that relate to SUDS and urban flooding in Lilongwe City which in this case are the Lilongwe City Development Structure Plan (2014), Lilongwe City Development Guidelines and Standards (2015), and Drainage Master Plan (2023). This method is so important as it helps to uncover the real meanings of particular texts depending on the context at hand. In this case, the Lilongwe City Development Structure Plan (2014), Lilongwe City Development Guidelines and Standards (2015), and Drainage Master Plan (2023) will be analysed to see if they support SUDS. This will also be done to evaluate existing policy guidelines for urban flood management. A particular approach that will be used is critical discourse analysis as it directly looks at politics and influence of power on planning decisions (Jacobs, 2006).

The advantages of using discourse analysis include its flexibility to be used in any situation and regardless of the context (Jacobs, 2006). Another advantage is that it helps in analysing policies especially in this study where the meanings of language have to be interpreted to see how they deal with the situation at hand (Winkler, 2022). The main disadvantage of discourse analysis is that it is subject to distortion and researcher bias who may choose what to take from the data to suit their results and interpretation. To overcome this, the researcher avoids taking the parts that suit their arguments only. Rather the researcher has to interpret the data how it is by including everything. The

researcher will also be vigilant by avoiding over-generalisations and being careful when selecting evidence (Jacobs, 2006).

1.2.2. Research Techniques

Research techniques are different from the methods in that they provide the actual activity that was taken to collect the data. The first research technique is observation which is necessary as some of the research questions will be answered by just looking at the existing situation. The other method in this research are interviews which are so important in getting the experiences and knowledge of the experts and residents. Mapping will be used to show the study area and other spatial data which is a strength as within it are multiple activities that can be used in collecting data. Lastly, this study involves reading deeply and widely from both theory and reviewing policies and documents.

Observations

Observations are either participant or field also known as non-participant observations (Winkler, 2022). In this research, non-participant field observations will be conducted. In field observations, the researcher does not participate but rather observes the scenario at hand as a spectator. The researcher takes notes of other ways of knowing such as symbols and drawings on pavements (Sandercock, 2003). This may reveal if there are any symbols of how people communicate for example when floods occur. Various communities have various ways of knowing and communicating. Observations are also useful to analyse the drainage systems of the flood hotspots in Area 49. This helps in trying to find out if the conditions of drainage systems relate to flood occurrence. Field observations will be used to analyse the existing site conditions that can support SUDS. A checklist will be used to check off what was observed against the recommended features from secondary literature.

The first advantage of observation is that it reveals more data than what was expected without the need for sophisticated equipment. This is useful in this research as more information will be found about the occurrence of disasters in Area 49. Despite these advantages, observations also have some limitations. Taking note of scenarios using devices might be distracting and will require permission to be done. Observations might change the behaviour of those being observed if they notice. These limitations will be

minimised by focusing only on drainage patterns along the roads which are public spaces and no photographs of people will be taken.

Interviews

Interviews are one of the most widely used data collection techniques that involve either focus groups, individual face-to-face, ethnographic interviews or oral history (Winkler, 2022). This research uses individual face-to-face interviews whose format was open ended. The open-ended questions in this research will be used to interview key from LCC. LCC officials will be interviewed on the existing spatial planning frameworks and disaster management in the city. LCC officials will be also interviewed on how they manage disasters, ageing infrastructure and plans to address failure of drainage infrastructure.

This research capitalises on the advantages of interviews such as getting deeper insights into the subject under study. The main limitation of interviews is that it is time-consuming. This will be minimised by allocating enough time to conduct the interviews per person for both key informants and residents so that adequate data is corrected.

Mapping

The main research question will be addressed using mapping techniques. Mapping is the art of showing part or the whole of the earth's surface using aerial photographs on a piece of paper or computer-aided software (Manda, 2004). Firstly, mapping will be used to show the geographical location and other factors that influence flooding such as rivers, wetlands and catchment areas in Area 49. From there, buffering which is one of the analysis tools used in ArcMap software will be used to map out areas that are located in buffer zones of rivers, wetlands and catchment areas that were found in the first step of mapping. Coordinates of the flood hotspots were picked using a hand-held Global Positioning System (GPS) which was used to identify the flooding hot spots on a satellite image. Lastly, these maps will be compared with the maps that LCC has of the same area to see if there are differences that some lessons can be learnt on development control and drainage systems.

1.2.3. Analytical Tools

Discourse and Content Analysis

This research uses both discourse and content analysis analytical tools. Discourse analysis will be used because interviews will be conducted with various actors involved in disaster management. This helps in analysing the interviewee's responses of experts from LCC. The frequency of who says what and how often revealed the patterns that will be recorded to give an interpretation (Winkler, 2022). Content analysis will be used in this research because of the expert's interviews. For example, the LCC officials play various roles in their departments that have to integrated into one. This also helps to understand the various processes that these actors take when executing their roles in disaster management. From these two methods of analysis, data with similar themes will be grouped using phrases and keywords. This is equally important as it helps to quantify the qualitative data thereby simplifying it for the presentation of the findings to various stakeholders (Yi, 2018). Policy discourse analysis will be used to review LCC's spatial planning frameworks and policies on disasters and infrastructure plans. Discourse analysis is both an analytical tool and research method that is why in this research, it being used as both.

The advantage of content analysis and discourse analysis is that they are useful for ordering findings and can help in finding keywords and how many times words appear using computer technologies. This is significant in this research because there are various respondents and these analytical tools simplifies the work. Both analytical tools have a similar limitation in that the researcher may only select quotes that support their argument and drop the parts that may show where the researcher went wrong. This can be eradicated by making sure that every quote is analysed and coded even if it is saying the opposite as that also reveals something different that is important and worthy of noting thereby deepening the research findings.

1.2.4. Ethical Considerations

In this research, ethics are considered as part of my obligation as a professional responsibility and moral value (Neuman, 2014). An ethical approach where research involves human participants requires that informed consent is provided by all participants. Therefore, all respondents will be informed in advance that their

participation will be voluntary and they should give consent by signing before participating in the research because the interviews will also be recorded. A template of the consent form is attached in Appendix 1.

All respondents will also be protected by keeping their information confidential and no names will be taken. Non-participant field observations involve taking photographs which require consent from property owners where applicable. To protect the information that to be collected, the data will be saved in a folder protected with a password. I also got approval from the Ethics Research Committee of the University of Cape Town for the Faculty of Engineering and Built Environment to conduct this research as attached in Appendix 2.

The interviews to be conducted during the research process are a dialogue about my ideas, thoughts and the experiences. The interviewees will be able to decide and determine what I may or may not disclose should there be any sensitive issues. As already highlighted above, a consent form will be provided to ensure that proof of consent to be interviewed is attained. This consent form also details the permitted use of the information gathered from the interviewees and details on how to treat the identity of the interviewee.

The data collected from the interviews will play a supportive role to my findings from secondary sources. It will also help in identifying gaps in current studies about the area and that will help to get a sense of the everyday experience and reality with the situation described in the literature. These interviews and dialogues will also help in enhancing or adding to information from the literature as there is no scope for representative, meaningful surveys or public consultation to take place in the timeframe of this dissertation. I will not subject anyone to risk or expose any information that was not given consent for. This is a low risk project and all information was treated in a careful and conscientious manner.

1.3. Philosophical Position and Normative Values

With the increasing need for cities to tackle various intersecting challenges, the researcher thinks it is time to reconsider green infrastructure in Malawian cities. A harmonious coexistence with nature is what should be aimed at if building more

hopeful, healthy and habitable futures are to be achieved by considering green infrastructure such as SUDS that are helpful for restoring the damaged landscapes we are living in currently. SUDS provide for areas that function as habitats for biodiversity and are linked to greater ecological corridors including wetlands, parks and rivers. This can help re-envision the human relationship with nature by reclaiming deep practices of care.

The researcher also recognises the essence of regenerative cultures in relation to SUDS. Regenerative cultures enable people to reposition themselves in the present era by accepting change. The climate crisis needs people to change approaches and build capacity to new pathways of managing disasters. There is a need to act and accept nature's inherent value which humans are part of, in order to restore it as a step towards building resilience to both natural and social disasters.

The success of various urban planning concepts depends on participation of local people and learning from their experiences. The researcher therefore highlights the importance of multiplicity in this study by harnessing and honouring local knowledge. Multiplicity appreciates the need to understand people's experiences and the complex components of a system which are always different and what is true for one person may not be the same for someone else. In this research that involves the social aspects and experience of people in SUDS therefore multiplicity is relevant.

This does not mean that this research considers people only, a deep ecologist standpoint considers the need to highlight the significance of human-nature relationship. Deep ecology[3] recognizes the need to bridge the gap between humans and the non-human world, placing an emphasis on the welfare of all species on Earth, and seeing humans as an essential component of nature (Griffith, 2013). Deep ecology is crucial in demonstrating how the link between people and nature should be promoted. Urban flooding is directly related to human activity. Values must be

[3] According to the deep ecology school of thought, people should start appreciating nature for what it is rather than only as a resource. This philosophical viewpoint is opposed to the anthropocentric viewpoint, which sees humans as the centre of the universe and thus as having intrinsic worth. Supporters of this theory contend that nature, not people, is endowed with value. The examination of the interaction between nature and people is made possible by deep ecology. A key starting point is how people see nature with admiration, which fosters an excellent feeling of concern for the environment and an awareness of its inherent value.

considered, but they should not be judged by how useful they are to people. A biocentric perspective, on the other hand, contends that all living things have rights and worth. This point of view is at the centre of a significant ethical and environmental debate: Do all things have inherent value? Of course, in my opinion. Deep Ecological Urbanism holds that growth should not obstruct the ability of other organisms to thrive, given the importance of biodiversity.

1.4. The structure of the dissertation

The problem being studied, the purpose of the research, the primary research questions, the research methodologies and methods employed to address the primary research questions, ethical considerations, and the researcher's philosophical viewpoint have all been described in this introduction. The second chapter presents a review of the literature along with major academic discussions on SUDS and urban floods by defining relevant concepts and understanding sustainable transitions and indigenous knowledge as applied in the field of SUDS. Chapter 3 provides a contextual analysis of Area 49 and an evaluation of the three key spatial planning frameworks. This is followed by the fourth chapter which discusses the proposed policy interventions on how best to incorporate SUDS in the key spatial planning frameworks of Lilongwe City in order to have an Area 49 without urban floods that has rich knowledge incorporated in the key spatial planning frameworks. Chapter 5 presents how the proposed interventions can be implemented. The last chapter, concludes with a summary of the research's significant findings and suggests topics that need further study together with the researcher’s reflection on this work.

CHAPTER TWO: LITERATURE REVIEW

Photo source: https://www.blacktown.nsw.gov.au/Plan-build/Stage-2-plans-and-guidelines/Water-sensitive-urban-design-WSUD/Water-sensitive-urban-design-WSUD-principles

2.1. Introduction

The first chapter established the problem of urban floods and introduced the research aim of how SUDS can be better integrated into the existing spatial planning frameworks of Lilongwe City specifically Area 49. The first chapter also introduced the research design. This chapter, therefore, aims to explore and engage deeply with the academic literature on SUDS and urban floods and the connection and relationship with spatial planning. This will be done by discussing existing planning knowledge on urban floods and SUDS. The chapter begins with a section on defining some terms and concepts that are related to the field of SUDS, spatial planning and urban floods. Further to that, contemporary debates related to SUDS, urban floods and disaster risk management will be analysed in order to learn what can be taken into this research's scope of work. Case studies will also be discussed on what has been done elsewhere as far as SUDS are concerned in residential areas and how the residents participated.

Climate emergency and rapid urbanization are just two of the many formidable obstacles that face our world today. These obstacles along with extremes, severe weather events and intense rainfall resulting from climate change, increase the amount of stormwater in urban areas and the risk of urban floods. As more land is transformed, hardened, lack of porosity becomes a challenge (Kennedy, et al., 2007) and existing metropolitan areas are progressively developed and densified and with a rising global population, all these put pressure on the environment. Stormwater management needs to adapt to new and changing realities in urban areas, which are already under a lot of strain to manage the risks of climate change. As a result, climate change adaptation is important to develop more resilient and sustainable urban regions. The constant transformation of the urban structure, both with newly developed areas and densification of existing areas, is increasing the number of hard, damaged, and impermeable surfaces, making handling stormwater in the urban landscape an important and crucial feature. Exploring stormwater management practices and approaches in an interface with planning is what this chapter aims to engage and discuss to connect with the first chapter.

2.2. Approaches to Key Concepts

2.2.1. Blue, Green and Grey Infrastructure

Blue infrastructure refers to the use of specialized, low-footprint, highly efficient devices that are installed and retrofitted into pre-existing water collection systems. (Elmqvist, et al., 2015). Blue Infrastructure consists of a collection of existing water bodies such as rivers, lakes and wetlands working together with retrofitted systems thereby forming a semi-natural system. In order to preserve the values and functions of ecosystems and offer related advantages to human populations, green infrastructure refers to the strategically used networks of natural lands, working landscapes, and other open places (Ncube & Arthur, 2021). Grey infrastructure, which includes water and wastewater treatment facilities, pipelines, and reservoirs, is constructed by humans (Ncube & Arthur, 2021). The term grey infrastructure often refers to elements of a centralized water management strategy. In difficult redevelopment contexts, such as densely populated urban areas, blue infrastructure can be used to link the advantages of green and grey infrastructure.

2.2.2. Blue-Green Infrastructure and Nature Based Solutions

In a changing environment, the utility offered by urban green (and blue) space is becoming more and more significant specifically to the management of urban floods (Gimenez-Maranges, et al., 2020). In order to lessen the effects of climate change in urban areas, such as increased air temperatures and flooding, blue-green infrastructure comprises natural and semi-natural systems that have to be implemented complimentary to each other. Blue-green infrastructure (BGI) is defined as the use of naturally occurring and artificially created blue and green components to replicate and enhance the natural hydrological cycle processes of evapotranspiration, infiltration and reuse, which is frequently used in the context of flood and water management (García & Santamarta, 2022). BGI is described as a network of interconnected natural and artificial landscape elements, such as intermittent, ephemeral and perennial water bodies, as well as open, green areas that serve a variety of purposes, including water purification, flood control, and water storage (Ncube & Arthur, 2021).

Blue-green infrastructure plays a significant role in improving urban landscapes and inhabitants' quality of life while lowering sensitivity to climate change threats including flooding and heat stress (O'Donnell, et al., 2021). In order to lower the risk of urban flooding, BGI assets such as green roofs, rain gardens, swales, green roofs, stress trees, wetlands, ponds, and re-naturalized and de-culverted rivers are meant to turn "blue" (or "bluer" during rainstorm events). Sustainable Urban Drainage Systems (SUDS) and Nature-Based Solutions (NBS) are notable examples of BGI since they provide a multifaceted strategy that can further reduce sensitivity to additional climate change hazards like heat stress, water scarcity, and air pollution. In other terms, SUDS use blue-green infrastructure in their implementation mechanisms. BGI is frequently praised for its potential for multifunctionality in comparison to grey infrastructure.

2.2.3. Grey Infrastructure

Grey infrastructure tends to be more inflexible in design and unadaptable in an uncertain future, whereas blue-green infrastructure solutions tend to be flexible and adaptable (Ncube & Arthur, 2021). This suggests that blue-green infrastructure initiatives can help increase urban resilience to climate change and act as potential adaptation choices. These "blue-green" infrastructure solutions include natural resources that offer ecosystem services even as they are being used.

Examples of grey infrastructure are storm drains, sewers, combined sewer systems, or systems that deliver wastewater and stormwater runoff to treatment facilities using a single pipeline network (Larsen & Gujer, 1997). Infrastructure costs are reduced when wastewater and stormwater are combined in one pipeline network, but additional issues arise as a result. It may have some drawbacks since more resources are required to handle bigger quantities of water, and the system is susceptible to major storm events, as professionals and local authorities are learning. Stormwater management systems consume energy and chemicals to treat stormwater, and they are susceptible to overflow and floods, which can contaminate rivers, streams, and lakes (O'Donnell, et al., 2021).

Combined stormwater runoff and sewage flows may surpass the conveyance system's capacity during major storm events and overflow into surface water basins without being treated. Water quality in cities is not only at risk from grey infrastructure (O'Donnell, et al., 2021). The issue is being made worse by an increase in impermeable surfaces brought on by urbanization and densification. Cities' shift from porous soils to impermeable surfaces (such as concrete and asphalt) has had a severe impact on both the hydrological cycle inside the cities and in the surrounding countryside (Ramos, et al., 2017). Increased paved areas are a result of rising population density in addition to cities being larger. Flooding risk becomes worse as the rate of impervious surfaces rises.

By lowering peak runoff following precipitation events, minimizing combined sewer systems overflow, and enhancing water quality, green infrastructure is being taken into consideration as a technique to lessen floods (Pataki, et al., 2011). The amount of post-development runoff and pre-development runoff are intended to be equivalent in green infrastructure (Butler, et al., 2017). Conventional drainage systems use grey infrastructure as their implementation elements.

2.2.4. Ecosystem Services

Ecosystem services may be provided by urban blue-green infrastructure, such as sustainable urban drainage systems (García & Santamarta, 2022). Ecosystem services are defined as the direct and indirect benefits that ecosystems deliver to people as a natural by-product of their ability to function (Elmqvist, et al., 2013). Cities are major hubs for the demand for ecosystem services, and with the predicted doubling of the urban population, this demand will only increase (Elmqvist, et al., 2015). Fundamental problems are brought on by the urbanization process, but there are also chances to create more liveable, healthy, and resilient cities by restoring ecological processes.

Ecosystem services are produced in a variety of habitats in urban areas, including green spaces like parks, vacant lots, urban forests, cemeteries, gardens and yards, campus areas and landfills, and blue spaces such as streams, artificial swales, , lakes, ponds and stormwater retention ponds (Elmqvist, et al., 2015). In comparison, for instance, to ecosystem services produced in rural areas far from densely inhabited areas,

ecosystem services in urban settings are typically characterized by a high intensity of demand and use because there are a lot of direct local beneficiaries (Elmqvist, et al., 2015).

Green and blue infrastructure in urban areas such as SUDS, provide various ecosystem services. Firstly, they help with microclimate regulation whereby the urban heat island effect is diminished by urban parks and vegetation, including green walls and roofs (Pataki, et al., 2011). For instance, a 10% increase in tree cover could cause a 3°C to 4 °C drop in ambient temperature, which would reduce the amount of energy needed for air conditioning (Elmqvist, et al., 2013). The cooling effect of trees in cities may greatly lower the demand for fossil fuels for energy and lower carbon emissions (Elmqvist, et al., 2015).

Ecosystem services also help in regulating water in urban environments. The presence of trees and other vegetation in urban settings, along with porous soils that can absorb precipitation, can significantly reduce the likelihood of surface water floods and relieve pressure on the drainage system. (Pataki, et al., 2011). For the same precipitation events, urban landscapes with 50% to 90% impermeable ground cover can lose 40% to 83% of incoming rainfall to surface runoff, compared to 13% for wooded landscapes (Kaye, et al., 2006).

Another significance of ecosystem services is that they help in providing, restoring and revitalisation of habitats. Urban environments include a surprisingly high diversity of plant and animal species, as well as a mosaic of habitat types (Melles, et al., 2003). In addition to the intrinsic or inherent, value of species and biodiversity, ecosystem services offer deeply significant advantages for a wide range of people from a wide range of cultural backgrounds, as well as for national and local governments working to carry out their commitments to reduce biodiversity loss and restore 15% of all degraded ecosystems which includes 10% of the oceans (McKinney, 2008).

Finally, SUDS offer cultural advantages of ecosystem services. Numerous cultural advantages can be derived from urban ecosystems, and there is proof that urban

biodiversity improves people's quality of life. (Fuller, et al., 2007). Research has demonstrated that having a green view from a window improves job satisfaction and lowers stress at work, while the psychological advantages of green space rise with biodiversity (Lee, et al., 2009). Numerous studies have demonstrated that closer access to green space increases a property's value (Lee, et al., 2009). Urban environments with a variety of ecosystems may also be crucial for giving design elements that can be applied to eco-design and biomimicry in urban planning and architecture (Fuller, et al., 2007).

In terms of ecosystem services, SUDS offer a range of advantages to locals while addressing stormwater management challenges. Residents consider the benefits of various ecosystem services, according to research, and they find that enhanced water quality from fewer adverse consequences is the most valuable (Johnson & Geisendorf, 2022). This then directs professionals and policy makers on how to properly prioritize actions and support the implementation of SUDS and expand the supply of ecosystem services with compelling economic considerations.

The approach taken by ecosystem services is based on a worldview that is utterly modernist and is therefore unable to deal with the complex issues posed by ecological interdependencies in planning processes (Metzger, 2018). As a result, a more substantial change that affects the ontological and epistemological presumptions that underlie planning practice would be needed to ecologise the art of planning (Metzger, 2018). A change that, if accepted, sends the planning profession on a mission to create new methodological toolkits in order to be able to implement such a sensibility in practice. This concurs with the researchers position whereby a paradigm shift is needed to incorporate distinct knowledge, practices and experience depending on the subject area if climate crises such as urban floods are to be managed and prevented using nature-based solutions.

2.3. Conventional Drainage Systems

Hard and grey drainage systems, which are typically underground pipes connected to other networks systems, are a part of conventional stormwater management (Casal-Campos, et al., 2015). The goal of conventional drainage systems is to efficiently route stormwater flows to the nearest receiving stream or sewage system (Hellberg, 2020). As this technique of stormwater management is more widely believed to be unsustainable, systems other than the conventional piped drainage systems are being used. Sustainable Urban Drainage Systems (SUDS) are a novel technique for controlling stormwater that mimics a site's natural drainage prior to development in order to address the shortcomings of conventional approaches (Birch, et al., 2008). Contrary to conventional methods, SUDS initiatives aim to manage and control stormwater impacts as close to their source as possible as opposed to exporting issues to other parts of the catchment (Fletcher, et al., 2015).

Conventional engineered solutions which use conveyance systems to collect and move stormwater as quickly as possible out of the watershed are often mono-functional (CIRIA, 2000). The goal of SUDS, on the other hand, is to collect and keep the water within the catchment for as long as feasible by utilizing processes from natural ecosystems (Johnson & Geisendorf, 2022). Conventional water management practices are well-represented in the urban system and focus on quick conveyance and "end of pipe" solutions. The conventional water system includes large-scale treatment facilities that are downstream of the metropolitan region, transporting subsurface basins and drainage systems, and a significant percentage of impermeable surfaces (Stahre, 2008).

Due to the typical urban drainage system's quick conveyance and significant amounts of impervious surfaces, huge run-off volumes and high flow peaks are sequentially brought on by diminished opportunities for stormwater to penetrate and evaporate (Morandín-Ahuerma, et al., 2019). Additionally, it is harming to the water's purity and despite being the most common method of managing water, alarm bells have been ringing for the past 20 years due to this system's inability to handle both current and foreseeable sustainability challenges (Elmqvist, et al., 2013). The dangers of urban floods cannot be handled by conventional drainage systems because they were calculated and developed for a specific number of users and return period (Casal-

Campos, et al., 2015). Grey pipe systems which is the traditional method of managing stormwater, may lead to technical lock-in and a reduced ability to adjust the system to future development and climate change risks.

The major objective of conventional urban drainage system is to control water volume and to prevent urban flooding in populated regions (Casal-Campos, et al., 2015). Since the water is viewed as an annoyance in the landscape, it is shifted in a way that keeps it hidden. (Casal-Campos, et al., 2018). That is to say, problems related to water quality and even its recreational and amenity aspects are rarely given much consideration when conventional drainage systems are being built (Zhou, 2014). Therefore, there is a need for a paradigm shift as a lot has changed in order for drainage systems to respond to prevailing issues such as urban floods which result from failure of conventional drainage systems.

Numerous scholars have voiced concerns about the long-term sustainability of current drainage technologies due to their negative effects on urban settings. (Zhou, 2014). Additionally condemned are the conventional drainage's severe environmental interference and the contamination caused by combined sewage overflows to receiving watercourses (Casal-Campos, et al., 2018). More importantly, the conventional system is made up of multiple structural elements, such as subterranean basins and concrete pipes. A large sum of money and time are needed for the drainage network's installation and restoration. Because of this, the traditional system typically requires piecemeal expansion and is thus unable to react quickly enough to critical events. In reaction to urbanization and climate change, expanding the conventional subterranean pipe network might not follow general sustainability guidelines (Zhou, 2012). Sustainability is a broad concept that is heavily debated and this is further explained in the next section.

2.4. Sustainability Transitions

Transitions towards more sustainable configurations of production and consumption are becoming a more common way to conceptualize the problem of sustainable development (Mguni, 2015). As a result, the concept of sustainability transitions can be used to conceptualize the shift towards WSUD in general as well as the change towards

higher integration of SUDS into urban landscapes. Theories of sustainability transitions have aimed to comprehend how infrastructure systems alter and evolve according to societal and technological innovation (Mguni, 2015).

It is crucial to recognize that the starting points and motivations for prospective changes towards WSUD in developed and developing cities differ. This is because of the problem of sustainability transitions in urban water management. Although developed cities have conventional water service systems that are relatively fully-developed, they are increasingly faced with issues like deteriorating infrastructure, concerns about path dependence, and the need to make decisions about the development of appropriate infrastructure in the face of climatic and socioeconomic uncertainties (Frantzeskaki, et al., 2017).

On the other hand, the majority of cities in the developing world currently have inadequate urban water infrastructure and deteriorating physical landscapes (Mguni, 2015). As a result, they are faced with the challenge of creating infrastructure that can both meet present needs in an effective manner and be resistant to the effects of expected climate change. As a result, these cities must learn from the mistakes of the developed world and move beyond the technological path dependencies that currently confront the water sectors of developed cities and instead develop more sustainable configurations of urban water systems while also addressing the most fundamental access to water supply and drainage (Frantzeskaki, et al., 2017).

Sustainability transitions differ from historical changes because sustainable development is a normative ideal and a matter of the public good that is prone, susceptible and sensitive to enduring norms and values on the one hand, and the problems of free-riding on the other (Mguni, 2015). Second, sustainability transitions often involve choosing from a choice of green options, when formerly there were only one or two alternative technologies to consider (Frantzeskaki, et al., 2017). Important questions are raised, such as who gets to pick the alternatives and transition routes. Last but not least, the ideas of sustainability and resilience seek to address difficult problems like climate change, which are already prevailing. As a result, previous problems like acid rain and water poisoning may not be perceived as being as urgent

as sustainability. The complexity of sustainability as a concept and its continual development present a challenge for transition studies.

In order to develop strategies that are likely to be successful both now and, in the future, it is crucial to understand the characteristics and current links between the operational and strategic qualities of adaptation strategies, namely resilience and sustainability (Casal-Campos, et al., 2018). It is necessary to define resilience and sustainability below because they are wide, complicated, and hotly contested in academic circles.

2.4.1. Sustainable Development

The definition of sustainable development, which has been widely used in urban planning and management, is the development that satisfies present demands without jeopardizing the ability of future generations to satisfy their own needs (Brundtland, 1987). The idea of sustainable development has received criticism despite being widely accepted due to its normative and prescriptive nature as well as the scope of its definition (Waas, et al., 2011). The three Nested Dependencies Model is then advocated for sustainable development in this research (Doppelt, 2010). This ecocentric approach emphasizes the interdependence of the ecological, economic, and social sectors of sustainable development as opposed to the overlapping model (Griffith, 2013).

Understanding the roots of the words: economy, social and ecology is so important in establishing the connection of the dependent circles. The economy that encompasses the household comes from the word Ekos or Oikos and has a root of the word household. The work “Ecology” and “Ecumene” come from the Greek “Oikos” for household, the place of the family and extended kin, including the non-citizens of the Polis: women, slaves and animals. Where the tension between Oikos and Polis is at the heart of Greek tragedy, the struggle of our times is to recognise the linkages of households of citizens and species that is ecologies with Polis. In this task, what is important is to define what constitutes the words ecology, economy and ecumene as an understanding of this sets the relevance of how dependent on one another they are.

While all societies use the economy to support their way of life, the world cannot survive without its environment. An essential component of social relationships and structures that influences economic decisions is the economy. Natural resources that society needs for sustenance, such water and land, are provided by the environment. This approach acknowledges the intrinsic significance of nature, without which the economy cannot run and society would be lifeless (Griffith, 2013). According to literature, the nested circles depict stronger sustainability than the overlapping circles as shown in figure 2 (Morandín-Ahuerma, et al., 2019).

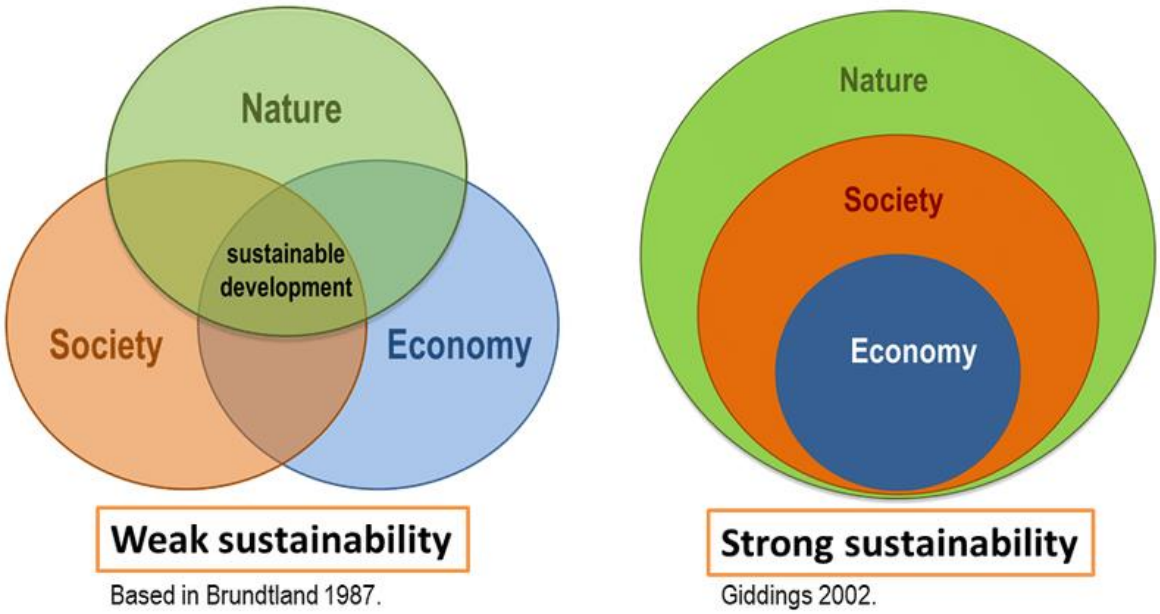

Figure 2: Graphic representations of weak and strong sustainability (Source: (Morandín-Ahuerma, et al., 2019))

In an era of widespread climate change, adaptable systems like SUDS should also aim for sustainability over the long run to fulfill economic, environmental, and social objectives simultaneously (Casal-Campos, et al., 2018). However, adaption tactics with a high level of technological performance might not always be economically viable, environmentally responsible, or socially just which has to change to an ecocentric approach.

Finding solutions that are appropriate now and can accommodate future changes, such as urban development or climate change, is necessary for the goal of sustainability in urban water systems (Casal-Campos, et al., 2015). This is an important factor to

consider in order to guarantee adequate performance and reduce the system's vulnerability both now and in the future. Identification of mitigation and adaptation techniques that consistently provide appropriate levels of service under varying situations is necessary to the uncertain nature of these changes and their effects; in other words, tactics that incur little to no regrets in the face of future uncertainty (Casal-Campos, et al., 2015).

2.4.2. Resilience

The discussion of climate change has increased the importance of adaptation and resilience as means of achieving urban sustainability in light of anticipated climate change impacts (Hellberg, 2020). The main objectives of any sustainable urban drainage system are dependability, resilience, and sustainability (Casal-Campos, et al., 2018). In wake of the existing climate crises, it may be necessary to make adaptive upgrades to urban stormwater infrastructure in order to make it less susceptible to future conditions, whether they are usual or extraordinary (Casal-Campos, et al., 2018). In fact, it is anticipated that the urban water system will be reliable, able to reduce failure frequency and provide a high level of service the majority of the time, as well as acting resiliency to shorten the length and severity of a failure when it ultimately occurs (Butler, et al., 2017).

Although the term resilience has been discussed in the first chapter, there are numerous ways to interpret it as it is a broad concept. For example, there is a difference between resilience "of" cities, which involves broader categories of stakeholders on a larger scale, such as a system of multiple cities, and resilience "in" cities, which consists of individuals or social groupings on a city scale (Ernstson, et al., 2010). The two angles are comparable but not identical and there are frameworks for tackling resilience and the city-scale. Co-management and adaptive governance are concepts that come from the discourse on resilience of rural areas. The scale of the city, which is resilient "in" cities, and the scale of systems of cities, which is resilient "of" cities, are not connected by any theory.

Sustainable Development Goal number 11 calls for cities to be resilient, safe, inclusive and sustainable by 2030 (World Bank, 2019). However, what encompasses resilience is wide and debatable. The outdated methods of using indicators, techno-managerial

fixes, and institutional frameworks of ecological modernization must alter if cities are to address today's problems (Kaika, 2017). Rather, path dependency must be used to create efficient substitutes for traditional ways of gaining access to urban services. This can offer truly clever answers, and dissension practices which serve as living signs of what or where urgently needs to be addressed if resilience is to be attained through social innovation (Kaika, 2017). This aligns with the use of SUDS which mimic nature in preventing floods and also taking experiences, knowledge and opinions into consideration.

The goal of making people more resilient to stressors should no longer be the priority, as this will only make them better able to withstand hardship, deprivation, and environmental destruction in the future (Kaika, 2017). Instead, the emphasis should be on figuring out the players and mechanisms that lead to the first requirement for resilience building. Social processes, such as the intricate roles played by networks, institutions, leadership, social learning, and communities, must be considered when designing future methodology and policy approaches for resilience building (Kaika, 2017). This realization raises more significant concerns regarding the viability of using techno-managerial solutions to achieve socio-environmental justice and completely model the dynamics of global social-ecological change (Amirzadeh, et al., 2022).

In order to meet future difficulties, drainage systems must both run as safely as is practically possible and respond to failure in a safe manner. When a failure occurs, these systems can respond more nimbly and recover more quickly, which minimizes damage and service interruption. Resilience is hereby then defined as the extent to which the system minimizes level of service failure magnitude and duration when subject to exceptional conditions, represented here by a threat or combination of threats (Casal-Campos, et al., 2018). This definition aims to encapsulate the characteristics mentioned above.

2.5. Naming of Sustainable Urban Drainage Systems

While the language varies between areas, sustainable drainage techniques are widely advocated and used worldwide. However, comparable design ideas are used regardless of the terminology used. SUDS are employed in Europe with the major goals of

preserving biological diversity and natural resources for future requirements, protecting priceless water supplies from contamination, and ensuring good public health (Zhou, 2014). Water Sensitive Urban Design (WSUD), a catchment-wide strategy that includes SUDS, was proposed in Australia (Fletcher, et al., 2015). It primarily refers to a planning and engineering strategy to sustainably integrate urban water management into city landscape in order to reduce environmental degradation and achieve harmony between water and the urban environment (Fletcher, et al., 2015).

In the United States of America and Canada, SUDS are referred to as Low-Impact Development (LID), which refers to a strategy that encourages the interaction of natural processes with the urban environment in order to maintain and recreate ecosystems for water management (Fletcher, et al., 2015). In order to lessen the negative effects of urbanization, LID emphasizes the preservation and use of natural elements in conjunction with small-scale hydrological management (Fletcher, et al., 2015). Best Management Practices (BMP) in the United States and LIUDD (Low Impact Urban Design and Development) in New Zealand are two examples of related strategies (Zhou, 2014).

The field of urban drainage has experienced significant change in the last few decades. Its previous focus was mainly on flood mitigation and environmental and human health protection, but it has now expanded to include a range of sanitary, social, economic, and environmental concerns (Fletcher, et al., 2015). In order to define these new approaches, the urban drainage profession has created and embraced new terminology, and it is likely to do so in the future as we move toward a more sustainable and integrated strategy. The term "SUDS" both reflects and directs practice, which is significant because terminology influences and drives policy.

2.6. Sustainable Urban Drainage Systems

Using the advantages of water regulation within the ecosystems to manage and prevent urban flooding, Sustainable Urban Drainage Systems (SUDS), which are site- and nature-based, are one of the trends that are purportedly able to manage the conventional shortcomings of volume control, high conveyance, and secured quality (Gimenez-Maranges, et al., 2020). With the use of nature-based practices including

retention, evapotranspiration, infiltration, filtration, and reuse, SUDS manage water in a way that mimics the site's original hydrological structure. In addition to run-off control, it also brings about co-benefits (Mguni, 2015). They are able to give ecological advantages other than just reducing water runoff, such as biodiversity, habitats, reducing pollutants, and generally enhancing the environment (Kennedy, et al., 2007).

Stormwater is managed by SUDS in a more environmentally friendly manner than by conventional stormwater management because it uses a variety of environmentally friendly methods and technology that strive to have as little of an influence on the hydrological cycles as possible (Butler, et al., 2017). The versatility of SUDS results in a variety of co-benefits, including ecosystem services, which control water flow and may boost biodiversity and create new green spaces (Casal-Campos, et al., 2018).

Pervious surfaces, , infiltration basins, detention basins, green roofs, filter drains and artificial wetlands are a few of the solutions that fall under the umbrella of SUDS (Birch, et al., 2008). These SUDS elements include permeable surfaces, infiltration trenches, shallow drainage channels, swales, green roofs, filter strips, filter drains, purpose-built ponds and wetlands, and detention basins, among other multifunctional features (Birch, et al., 2008). Grey infrastructures are more rigid, but BGI solutions can be more adaptable and typically cost less to implement. They are also renowned for their capacity to provide a variety of additional benefits in addition to flood mitigation (Ncube & Arthur, 2021).

Open or partially open drainage systems, where rainwater is typically visible during runoff, are the norm for a sustainable urban drainage system (La Rosa & Pappalardo, 2019). The facilities that are using and imitating the natural processes that wetlands and ponds use to hold back stormwater, such as infiltration, percolation, and surface runoff inform SUDS. Given that they can be used in multiple locations throughout the drainage system, the facilities can be found in more than one group (Bergman, et al., 2011).

SUDS are a variety of drainage methods and tools that enable the development of amenities, the attenuation and moderation of runoff, and the reduction of pollutants (Hellberg, 2020). Today, permeable surfaces, water storage, filter and infiltration

trenches, swales, wetlands, water harvesting, detention basins and ponds are some of the most widely used SUDS systems (Birch, et al., 2008). By primarily using fixed physical structures like wetlands, ponds, and swales, the devices can be structural. Small-scale, decentralized facilities like vegetation are included in non-structural devices, as are soft measures that use knowledge and experience to change how stakeholders behave and think, such as laws, policies, and programs for training and education (Hellberg, 2020). In order to maximally utilize both of its roles, SUDS frequently combine both sorts of metrics. Additionally, SUDS strategies might be decentralized small-scale solutions to tackle diffuse pollution or centralized measures aimed at focal sources of pollution (Kaye, et al., 2006). To deliver services at various temporal and spatial scales, all of the SUDS devices listed can be utilized singly or in sequence (Birch, et al., 2008).

According to their effects on the water runoff and routing process, SUDS measures can be divided into three classes from a hydrological perspective (Zhou, 2014). The first category includes source management techniques including local infiltration, impermeable pavements, and green roofs that try to contain and reduce excessive water flow upstream (Zhou, 2014). On-site management measures, such as asset protection and topography alteration, are focused on preventing and lowering the effects of flood hazards on recipients' sensitivity (Zhou, 2014). The system's conveyance capacity is measured in the third group of downstream measures (Zhou, 2014).

Being aware of the potential issues with the current and conventional stormwater system is essential to successfully implementing and adapting SUDS or any other sustainable stormwater management technique (Fletcher, et al., 2015). If the innovative and sustainable strategy is applied in the same way as the traditional one, it might not succeed. To ensure successful and effective sustainable stormwater management in the future, implementation must be done differently. Additionally, more than just the technical approach needs to change. Changes must be made to policies, educational systems, society's structures and management, social habitats, and aid initiatives (Ramos, et al., 2017). However, in order for the general public, and particularly the stakeholders, to embrace and comprehend the significance of

implementing sustainable stormwater practices, education is a priority (O'Donnell, et al., 2021).

2.7. Implementation of SUDS

In order to build sustainable urban drainage systems that are incorporated into the urban environment, consideration of more factors than just drainage needs to be considered (Hellberg, 2020). The built environment may express artistic and architectural values, which is very pleasing to the eye (Thodesen, et al., 2022). Additionally, the region may have a distinct personality thanks to the facilities that have been put in place and the overall sustainable urban drainage system, therefore, contributing to the sense of place of an area and this resonates well with the urban water triangle (Kennedy, et al., 2007).

When designing an open drainage system, it is crucial to take the gradient and topography of the area into account in order to be able to manage the runoff volume and how and where the runoff flows (Melles, et al., 2003). To be able to select the ideal mix of facilities that can handle the runoff and overflow both during typical and more extreme rain events, it is also crucial to take the terrain into account. In order to reduce runoff to the rest of the system, drainage systems in all of the case study regions incorporate facilities that control water through local disposal (Hellberg, 2020).

In addition, it is critical to install and include extra areas for overflow and handling temporary flooding in order to be able to lower the risk of flooding in a given location. Gimenez-Maranges, et al. (2020), discusses how SUDS are allegedly able to manage the traditional inadequacies of volume management and high conveyance, and are exploiting the advantages of ecosystem-based water regulation to manage and prevent urban flooding.

La Rosa and Pappalardo (2020) emphasize the need of determining how much water an urban drainage system can manage while mitigating the risk of urban flooding. Water can be transported through various drainage systems or infiltrated and held in the soil, for example. This emphasizes how crucial it is to put local disposal strategies in place since they can reduce expensive conveyance and improve volume management (Gimenez-Maranges, et al., 2020). Adding more areas that can temporarily flood and

handle overflow also helps with volume management because it lowers the likelihood that an area would flood (La Rosa & Pappalardo, 2019).

In order to have a complete picture of where the drainage system should be put in place and which facilities are appropriate, it is crucial to consider the entire catchment, the entire drainage system, and each individual facility at the same time (Gimenez-Maranges, et al., 2020). The local conditions, such as the area's gradient and the ability and content of the soil for infiltration, substantially influence which facilities are appropriate, making it crucial to mix various facilities and solutions (Hellberg, 2020). However, it is vital to put in place facilities that manage stormwater through local disposal since they lessen high conveyance, improve volume control, and cut back on spill over to the rest of the drainage system.

The planning and implementation of areas and facilities within or connected to the area that can control and contain excess runoff in the event of significant rain events is another crucial element (Gimenez-Maranges, et al., 2020). The system must be flexible in order to allow for future re-construction or the implementation of new policies due to the high degree of future uncertainty. Therefore, it is crucial to employ a method that enables the selection of the best possible combination of stormwater facilities for the urban drainage system, one that offers numerous benefits in addition to reducing flood risk (La Rosa & Pappalardo, 2019). This method should also always take multiple benefits into account when determining how much something will cost. This would make it possible to simultaneously plan a long-term and short-term urban drainage infrastructure.

The general attitude toward urban drainage systems needs to change since SUDS should always be seen as the dominant form of drainage system, as opposed to conventional urban drainage systems (Hellberg, 2020). It is crucial to inform stakeholders, communities, and legislators about the potential and value of sustainable urban drainage systems in order to be able to accomplish this change (Thodesen, et al., 2022). Additionally, everyone involved in the planning process must be adaptable and open-minded. Throughout the entire planning process, it is crucial to involve and maintain close communication with stakeholders, residents, citizens, and development corporations (Thodesen, et al., 2022).

According to Alves et al. (2019), there are few resources against available areas in urban areas, therefore many problems must be resolved at once. Implementing BGI and sustainable urban drainage systems, which can give more than just flood management and many benefits, may be a solution to address issue (Ramos, et al., 2017). The most important modification is to the planning process so that new areas can be developed with sustainable urban drainage systems or existing ones can be retrofitted (Hellberg, 2020). Spatial planning frameworks ought to enable the integration of SUDS by setting planning guidelines to be followed. This can start with SUDS complimenting conventional drainage systems in the short run whilst shifting to natural based in the long run. This could make it possible to develop multipurpose, sustainable, and flood-resistant urban regions while also addressing the problems posed by urbanization and climate change (Hellberg, 2020).

2.8. The Urban Drainage Triangle

The overall significance of SUDS can be referred to as the urban drainage triangle. SUDS, which is a relatively new idea in stormwater management, are being recognized more and more as a viable alternative to traditional drainage systems. The urban drainage triangle, which consists of water quantity, water quality, and ecology or amenities as shown in figure 3, demonstrates the range of issues with sustainable drainage choices and how they can contribute significantly to sustainable development (Kennedy, et al., 2007). The ecology or amenity component is the only one of the three functional elements that conventional drainage systems do not even address and has been widely disregarded in drainage system design (Zhou, 2014). The ecology or amenity component, however, is increasingly receiving more attention as its place in the "urban drainage triangle" is fully acknowledged (Armitage, et al., 2013).

Unquestionably, a well-designed SUDS scheme may offer important wildlife and local amenity while still planning for the SUDS' "non-drainage" benefits (CIRIA, 2000). The environmental protection demands have dominated discussion of these "non-drainage" advantages up to this point, and little is yet understood about the social and economic implications of SUDS (Kennedy, et al., 2007). A balance between the three facets of sustainability that are environmental, social, and economic, must be achieved for SUDS to become a long-term viable choice (Kennedy, et al., 2007).

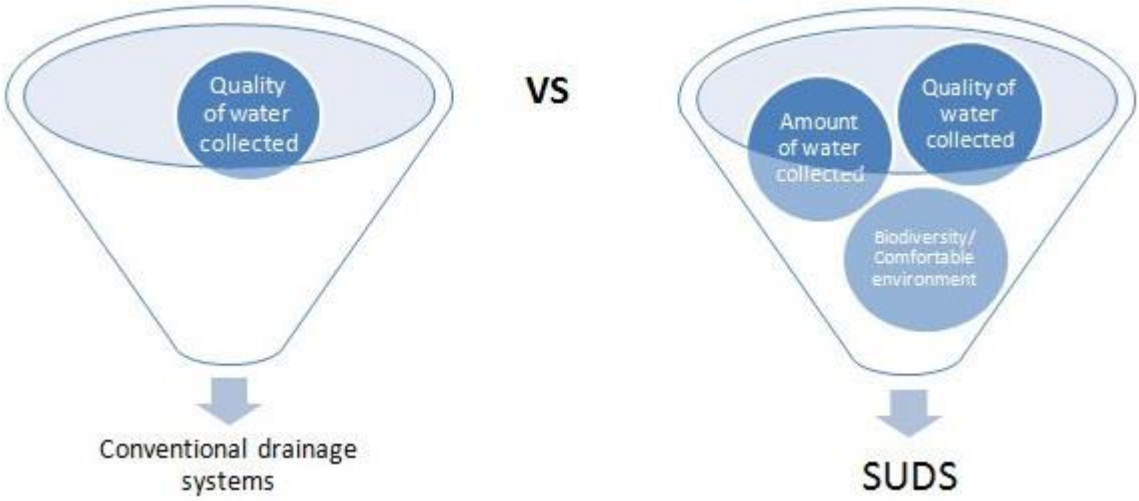

Figure 3: A Comparison of urban drainage benefits between conventional drainage system and SUDS (Source: (Ramos, et al., 2017))

2.9. Elements of SUDS

As mentioned above, SUDS can be implemented as various elements depending on the characteristics of the site. The implementation of these elements depends on soil, topography, gradient and hydrology of the site just to mention a few.

2.9.1. Green roofs

Commonly referred to as "living roofs", green roofs have vegetation growing on them and absorb rainwater by enhancing infiltration and lowering runoff (Birch, et al., 2008). This enables to include green spots on your home even if you have a little amount of land.

2.9.2. Rain Gardens

These are shallow depressions with plants that can endure periodic flooding and absorbent, freely draining soil that help gardens deal with rainfall more successfully (Birch, et al., 2008). They can also be used in conjunction with rainwater gathering techniques. Rain gardens are an infiltration technique that increases the quantity of water that enters the soil, reducing runoff and surface water volumes (Larsen & Gujer, 1997).

2.9.3. Swales

Swales are shallow, wide, vegetated channels that are used to collect and transport water to lessen peak river flows (Larsen & Gujer, 1997). Their bottoms are level, and

their sides have a little incline. They work best when installed in places without significant incline. Swales transport and store storm water runoff while also providing temporary storage and infiltration (Lee, et al., 2009). They eliminate pollution by promoting infiltration.

2.9.4. Permeable Paving

Instead of using porous or permeable materials, permeable paving depends on voids and gaps in the surface to permit penetration (Birch, et al., 2008). Water can infiltrate through porous and permeable surfaces, reducing runoff and peak flows in watercourses and delaying them (Larsen & Gujer, 1997). Paving alternatives include wood chips and recycled aggregates, both of which have the same effect.

2.9.5. Rainwater Harvesting

Rainwater is gathered from a building's roof or paved surface and stored in above- or below-ground tanks for treatment and reuse in irrigation, gardening, and flushing toilets (Thodesen, et al., 2022). The most popular method for implementing SUDS at the property level is the use of water butts, which reduces water consumption while providing a source control for rainfall (Birch, et al., 2008). However, the system's design will determine whether it works or not.

2.10. Spatial Planning and SUDS

Because of the interaction between the constructed, social, and environmental contexts, the urban system has a complex structure (Hellberg, 2020). The complexity of the urban drainage system is also no exception since it entails considerable investments, the combination and integration of numerous systems, and uncertainty over its future status (Hellberg, 2020). Understanding the urban challenges and why they are so complex comes down to the fact that there are only so many resources and areas available in the urban structure, making it necessary to address many problems at once and this where spatial planning comes in. The current urban stormwater systems struggle to meet present and foreseeable issues. New strategies have emerged to handle these difficulties and produce adaptable, sustainable, and natural stormwater management, which are based on climate change and population trends (Hellberg, 2020). These novel methods promise to manage the traditional flaws of

volume control, high conveyance and assured quality while managing and preventing urban flooding by utilizing the advantages of ecosystem-based water regulation (Stahre, 2008).

When minimizing the risk of urban flooding, determining how much water a drainage system can handle is essential (Zhou, 2012). Water can be transported through various drainage systems or infiltrated and held in the soil, for example. Therefore, it is essential that urban ecosystems that manage water be incorporated into planning plans when dealing with the risk of urban flooding (Thodesen, et al., 2022). This will help the crucial shift toward an ecosystem-based approach to urban drainage, which will create and reconstruct a water cycle that is more based on nature and natural systems.

Planning a sustainable urban drainage system is far more difficult and time-consuming than planning a conventional urban drainage system (Hellberg, 2020). Different professionals from various disciplines within the municipal administration are involved in the planning, design, and implementation of sustainable drainage facilities as opposed to conventional facilities. Everyone involved in the spatial planning process must be flexible and open-minded in order to take advantage of all the opportunities presented by the sustainable urban drainage concept (Ramos, et al., 2017). Designing sustainable urban drainage infrastructure that are incorporated into the urban environment requires considering more factors than only drainage's intended use. As highlighted above in the urban water triangle, it brings itself an ecological value, aesthetic value, economic value and technical value just to mention a few (Kennedy, et al., 2007).

SUDS are frequently carried out at the municipal level (Thodesen, et al., 2022). Public opposition to local initiatives has contributed to the implementation of SUDS projects taking longer than anticipated (Thodesen, et al., 2022). Therefore, in order to create consensus and support for these climate adaption measures, a deeper comprehension of public attitudes and priorities is required. Spatial planning should therefore aim to incorporate people' views and knowledge on SUDS to allow for implementation to take place with the consent of the general public.

Consequently, there has been a cautious shift in the urban water sector towards decentralized, alternative approaches to managing urban water in general and urban stormwater in particular (Thodesen, et al., 2022). Such decentralized approaches to water management may assist cities in addressing issues like water availability, flood danger, and public cleanliness as well as offer extra advantages that may improve their overall sustainability and resistance to climate change (Kennedy, et al., 2007). The majority of the current stormwater management systems are made up of traditional urban drainage systems, which are made up of pipes and hard surfaces in grey infrastructure. These systems produce significant amounts of runoff, speed up the removal of stormwater from the area, and reduce stormwater infiltration into the ground. It is commonly recognized that this system cannot handle the rising stormwater levels, which raises the possibility of urban flooding.

The need to address this issue has long been acknowledged, and flood management is a crucial part of sustainable adaptive planning (Kennedy, et al., 2007). Conventional urban drainage systems cannot solve this issue because it has been shown that they are already in danger of exceeding their capacity. Even though it is well known that conventional stormwater management systems have a variety of shortcomings, including volume control, high conveyance, infiltration capacity, and deteriorating water quality, they are still the most popular approach to treating stormwater (Hellberg, 2020).

The move towards establishing sustainable urban drainage systems is significant in order to be able to address the current and future issues of stormwater runoff control within urban areas through spatial planning. These are thought to be a crucial element in developing sustainable and resilient urban settings, which also help to lower the risk of urban flooding (Ramos, et al., 2017). Implementing SUDS will facilitate the transition to an ecosystem-based approach to urban drainage, which will create and re-establish a water cycle that is more based on natural processes (Kennedy, et al., 2007).

To enable them to embrace and comprehend the significance of sustainable stormwater initiatives, the population in general and stakeholders in particular need to be educated (Gimenez-Maranges, et al., 2020). This relates to case studies below wherein involving citizens and residents when putting in place a sustainable urban drainage system has proven to be a successful factor in achieving the intended aims or outcomes of a project (Stahre, 2008). Through participation, they can contribute to the design process and gain knowledge of the system as well as the objectives and meanings of the goals. Participation is crucial in spatial planning and should be considered seriously not casually.

2.11. Indigenous Knowledge in SUDS Implementation and Urban Floods Risk Management

Urban areas could be at risk of pluvial flooding for 3.2 million more people by 2050 than they were in 2015 (Morandín-Ahuerma, et al., 2019). Understanding current coping mechanisms is crucial since they are essential for creating adaption strategies to climate change. Recent research has shown how indigenous knowledge is important for managing climate concerns. Despite being common, particularly in Africa, the application of indigenous knowledge for weather forecasts in urban settings is not well-researched. Early flood risk warnings are aided by indigenous knowledge. People rely on local indicators because they offer a better geographical and temporal match than traditional predictions for predicting climatic disasters (floods and droughts) (Kasei, et al., 2019). As a result, for efficient early warnings and adaptation methods, it is necessary to take into account the validation and integration of pertinent indigenous knowledge into early disaster risk management systems.

As the need for local or indigenous knowledge to generate climate understanding and adaptation techniques is more recognized, there has been a recent increase in awareness that scientific information alone is insufficient to manage climate issues. This research uses the definition by Kasei, et al (2019) which defines indigenous knowledge as a set of knowledge, customs, and beliefs about how living things including humans, relate to one another and their environment that has been passed down through generations through cultural transmission.

Numerous studies have documented how locals have used indigenous knowledge for many years to make well-informed judgements on how to manage climate risks based on their extensive observations of plant indicators, animal behavior, and astronomy (García & Santamarta, 2022). For instance, locals in Swaziland keep an eye on the wind's direction and the crescent moon's form, as well as the heights of emahloko birds' (Ploceus spp) nests on trees, to forecast floods (Kasei, et al., 2019). When nests are high, floods are more likely to happen. Similar to this, villagers in rural Malawi's Mpasu must migrate to higher ground when a black cloud in the west indicates impending floods (Kasei, et al., 2019). Other signs of heavy rains include winds blowing from all directions indicate floods during the rainy season, while a large prevalence of the stalk-boring insect, indicates drought in rural Malawi's Mpasu and Mphampha (Kasei, et al., 2019).

Indigenous wisdom has been found to be helpful in this aspect for forecasting impending weather conditions. There is growing evidence in the literature that indicates convergence between indigenous knowledge and conventional science, despite the different parameters used in observations (Fuller, et al., 2007). Examples include convergence of indigenous knowledge system forecasts with scientific forecasts, climate change and seasonal predictions. There is proof that scientific weather and climate predictions have been incorporated, as well as evidence of policy-related adaptation (Johnson & Geisendorf, 2022). Urban space is understudied, despite the fact that indigenous knowledge has received a lot of attention when it comes to using it to predict the weather or the climate in rural areas, particularly in Africa (Kasei, et al., 2019). Therefore, studies conducted locally on using indigenous knowledge for decision-making in urban settings merit special consideration.

As was already said, traditional societies in Africa have relied significantly on their own indigenous knowledge systems for many decades to conduct systematic observations of their surroundings and deal with natural disasters (Kasei, et al., 2019). These communities, especially those in hazard-prone regions, have produced a significant body of knowledge on catastrophe prevention and mitigation, as well as early warning preparation and responsiveness. This information, which is sometimes referred to as traditional or local knowledge, is acquired via observation and research and frequently

draws on accumulated knowledge that has been passed down from one generation to another (Kasei, et al., 2019). This knowledge adds to climate research by emphasizing factors that climate scientists might not have taken into account and by providing observations and interpretation at a much smaller regional scale with significant temporal depth.

For locals with a low level of education, conventional weather and climate forecasting is often criticized for not delivering concise information on local climatic variation and for its poor communication, such as messages are too scientific and technical (O'Donnell, et al., 2021). The prediction of seasonal rainfall has become more dubious due to increased rainfall variability in many parts of Africa, which is posing a greater challenge to scientists in their efforts to improve forecast accuracy and reliability.

In this regard, studies currently generally concur that using only conventional science to handle climate concerns is insufficient. The importance of indigenous knowledge in guiding solutions for climate adaptation that are accessible, inclusive, and sustainable has been consistently underlined in reports from the International Panel on Climate Change (IPCC) over the past ten years (Kasei, et al., 2019). Indigenous knowledge is regarded as a collaborative idea that, when linked with scientific methods, can be used to create better knowledge systems and context-specific policies.

Therefore, the resilience of these ecosystems may be improved with the aid of indigenous or traditional peoples who are important and active components of many ecosystems. Most indigenous groups who have moved to metropolitan areas still rely more directly on natural resources for their subsistence, and many of these people frequently reside in economically and politically marginal places in a variety of fragile ecosystems. Indigenous knowledge is not well-documented in urban studies, despite its importance and its applicability is frequently site-specific. This is what motivates this research to explore resident-led SUDS so that the experiences and knowledge of residents on urban water management and floods risk management are considered into the existing spatial planning frameworks of Lilongwe City.

An attempt can be made to address the indigenous knowledge system for water conservation and management by taking into account its importance in tackling

important environmental challenges. Indigenous knowledge systems for managing water resources are still widely used and, in some cases, even more advanced than modern knowledge systems (Borthakur & Singh, 2020). The integration of local or indigenous community knowledge into decision- or policy-making processes involving environmental conservation, especially water management, is receiving more and more attention now across the globe. The researcher is of the conviction that major environmental problems facing the world today, particularly those related to managing water and flood disasters, can be addressed and combated with the proper integration of traditional and modern scientific knowledge.

It is necessary to pay attention to and try to integrate aspects and concepts for nature-based solutions in order to support and inform processes for planning and managing nature-based cities (Bush & Doyon, 2023). To develop a framework for nature-based cities, it involves integrating the theoretical facets of urban nature-based solutions and elevating Indigenous voices through knowledge co-production. The epistemological aspect of Indigenous custodianship, knowledge, and cultural practices must be emphasized in the planning for and implementation of nature-based solutions like SUDS. In order to advance the agenda for nature-based cities, it is crucial to acknowledge the relationality, reciprocity, and responsibilities that are inherent in Indigenous knowledge and cultural practice (Bush & Doyon, 2023).

2.12. Case Studies

This section presents the two case studies that this research is drawing from. It begins with a general description of the case studies then lessons learnt than will be taken on board in this research.

2.12.1. Case Study 1: Leidsche Rijn, Utrecht

The greatest current housing development project in the Netherlands is called Leidsche Rijn, and it is situated in the western section of the city of Utrecht (Birch, et al., 2008). When a master plan for the entire area was established in 1995, the project was launched which was completed in 2015 (Birch, et al., 2008). Then, it had about 30,000 dwellings with a capacity for 80,000 people and its surface water makes up about 11% of the area's total land area of 2100 hectares (Birch, et al., 2008). The district was

created as a neighborhood by community, giving each neighborhood a unique identity (Birch, et al., 2008). Leidsche Rijn is split into two hydrologically distinct sections.

With relatively high terrain in the center of the territory and lower-lying portions along the perimeter, the topography varies. The surrounding lower grounds are loamy and not ideal for infiltration, but the higher grounds mostly consist of sandy soils that facilitate stormwater infiltration (Birch, et al., 2008). Stormwater is infiltrated in the center, and spillover is directed to the free-flowing surface canals before being held in the area's sizable lake in the northwest. The lake is in close touch with the groundwater, where it is stored, used for enjoyment, and serves as a habitat for wildlife. To transfer the water to the lake, the canals in the north are deeper, have steeper slopes, and have a higher flow rate. The slopes of the canals are less steep in the southern section, making water infiltration possible (Birch, et al., 2008).

The stormwater management system in this area is one of its distinguishing characteristics. It is designed primarily as an open system that is accessible to the public in order to enhance the quality of life for the locals (Fuller, et al., 2007). A closed loop system is used to control stormwater, keeping as little water from the surrounding region as possible entering the canals and keeping it there all year long to prevent flooding incidents. This is because while rainwater is thought of as a supply of unpolluted water, the water in the nearby Amsterdam-Rhine Canal and the water from the nearby agricultural areas are high in phosphorus concentration, which causes algal growth in the system.

It is crucial to retain the stormwater in the area in order to have enough water in the system during dry spells (García & Santamarta, 2022). This is accomplished through a thorough closed canal system, where water is pushed from lower to higher terrain to keep the canal system flowing. Stormwater that collects on roofs and in small streets is channeled into a lake that is 40 meters deep on the northwest side of Leidsche Rijn via a system of large infiltration trenches and canals (Birch, et al., 2008). The valley in the area's drier regions also aid penetration and replenish the groundwater. Additionally, a lot of yards and low-traffic roads have permeable pavement that allows stormwater runoff to seep into the subsoils.

Leidsche Rijn was an agricultural district in the past, and there were issues that led to the establishment of this stormwater system. Typically, the area's groundwater levels are higher in the winter and lower in the summer. Because agricultural operations need relatively constant groundwater levels, a significant amount of groundwater was removed from the region during the winter, while water had to be imported from the Amsterdam-Rhine Canal in the summer (Birch, et al., 2008). The notion of storing extra water from wet seasons for use during dry seasons developed since the canal's water was comparatively dirty compared to the water in the surrounding area (Bergman, et al., 2011).

By infiltrating stormwater into the ground and using the lake as a buffer between wet and dry seasons, the area's present stormwater management system aids in keeping stormwater local (Bergman, et al., 2011). Normal conditions do not call for additional water supplies, which reduces contamination from outside sources. The groundwater level in the region is controlled and only permitted to vary between seasons by a maximum of 30 cm. However, the lake includes an additional 100 cm of buffer to prevent flooding issues in the event of 100-year rain storms. The water is continuously moved from low to high places, resulting in steady circulation, in order to maintain the open stormwater system's cleanliness and prevent water stagnation. A so-called vertical flow reed bed is included in this closed loop in the northwest part of the area, where phosphates are held back.

In addition to carrying water, the canals give the Leidsche Rijn neighborhood a solid framework (Birch, et al., 2008). Everywhere there is visible water, which gives the place its unique character. To control the accumulated stormwater on site, there is stormwater management and with very few exceptions, the sewer system is not connected to the stormwater (Bergman, et al., 2011). In addition to the technological approaches for water infiltration, transpiration, and storage, stormwater is also utilized in the planning of the neighborhood. Valleys and canals, which are stormwater management components, interact with locals and tourists. Stormwater may not always be visible, but the environment nevertheless creates a unique shape and conjures up images of water. The components give the area its individuality and display the ecological norm.

A growing number of individuals are residing in the new city district due to the area's continual growth (Birch, et al., 2008). Lack of schools, coffee shops, community centers, and many other are some of the area's issues. These institutions are scarce, and as a result, social structures are absent. The locals lament the poor quality of life and the delayed development of the area's identity among the populace. In this case, a local identity was developed using the stormwater management system.

2.12.2. Case Study 2: Augustenborg – Malmö, Sweden

The city of Malmö's Housing Business (MHB), constructed the Augustenborg village in the 1950s; it occupies a space of around 20 hectares (Hellberg, 2020). The area is organized into apartment buildings that range in height from three to six stories, and it was hailed as a model of contemporary Swedish living in the 1950s. In the middle of the 1990s, MHB set out on a mission to repair Augustenborg's reputation as a troublesome region (Hellberg, 2020). The "Eco-city Augustenborg" project was initiated in 1998 in conjunction with other difficulties that also needed to be tackled in the area. The city of Malmö and MHB collaborated on the project, which had as its major objective transforming Augustenborg into a community that is economically, socially, and environmentally sustainable (Stahre, 2008). Sustainable stormwater management, which was implemented in cooperation between MHB, Malmö Water, and Malmö Service Administration, is one of the creative ideas that was implemented as a result of this project.

Prior to the installation of the sustainable drainage system, the area's combined sewage system was used to manage all stormwater (Hellberg, 2020). The system's capacity was low, and the sewers frequently were overflowing. As a result, the basements frequently flooded, especially during prolonged downpours. The project chose to address this issue by managing the stormwater in a more ecological way rather than by resolving it conventionally by upgrading the current system into a duplicate sewer system (Stahre, 2008).

There are many different open stormwater management techniques that were used in the area. These include vegetated and permeable parking lots, vegetated lawns, green roofs, ditches, swales, and canals for reducing runoff (Hellberg, 2020) and infiltrating stormwater at the local source, constructed areas for handling temporary flooding and

ponds that retain runoff (Stahre, 2008). The Lönngatan drainage corridor, the central drainage corridor, and the botanical roof garden of Augustenborg make up the region (Hellberg, 2020).

The objective was to build a sustainable stormwater management system that eliminates the drawbacks of combined sewer systems, manages stormwater in an ecological manner, and lowers the risk of flooded basements (Stahre, 2008). The original concept behind the stormwater management system was to handle excess runoff as close to the source as feasible, employing local disposal, and establishing an open drainage system (Hellberg, 2020).

2.12.3. Lessons from the Case Studies

The following lessons can be noted, learnt and carried forward in the third chapter of this research from the case studies above. Applying sustainability principles in an urban regeneration region successfully is thought to depend on the people' active involvement and interest (Bergman, et al., 2011). Combining the various strategies of a new stormwater system and retrofitting it into the previously existing urban environment can be difficult. An already-exploited area can be successfully retrofitted with a sustainable urban drainage system and put into use (Stahre, 2008). Even though some basement flooding did occur as a result of the implementation and retrofitting of SUDS into the community of Augustenborg, runoff from intense rain events was successfully managed.

When taking measures to lower the risk of flooding, it's crucial to take the local topography into account (Bergman, et al., 2011). It is advised to integrate several types of stormwater control systems in order to handle various sorts of rainstorm events with maximum effectiveness. To determine if stormwater can successfully enter and percolate within the area, it is crucial to assess the soil's capability for infiltration (Stahre, 2008). Investigate whether the system is functioning effectively and add support where necessary to make sure the implementation is achieving the anticipated levels of flood reduction (Hellberg, 2020). Even if the area had not flooded due to traditional drainage, problems downstream would have resulted from runoff from the area. Flooding concerns can be successfully and effectively reduced by implementing SUDS.

2.13. Conclusion

The conventional drainage systems are currently being regarded as unsustainable, centralized and depict the prevalence of colonial planning systems (Kennedy, et al., 2007). Alternatives to conventional stormwater management employing grey infrastructure, such as SUDS using blue-green infrastructure, can significantly minimize the hazards of urban flooding (Alves, et al., 2019). Compared to conventional vegetation and plant installations, maintaining blue-green elements in an open drainage system is more expensive. Therefore, it is crucial to take this into account in the project's costing method to ensure that the facilities will be adequately maintained and functional after deployment. Furthermore, it is crucial to keep in mind that open drainage systems typically have additional costs beyond just trying to manage rainwater as cheaply as possible when comparing implementation costs between SUDS and conventional drainage systems (Hellberg, 2020).

SUDS for managing water quantity and quality have a number of advantages, but their effectiveness and viability have also been questioned (Achleitner, et al., 2007). For instance, the effectiveness of some stormwater infiltration trenches shows that their lifespan is substantially less than anticipated due to the impacts of sand clogging (Bergman, et al., 2011). Achleitner et al. (2007) expressed similar worries regarding the hydraulic permeability of an infiltration and swale system. Their findings demonstrate how the initial background concentrations have a significant impact on the observed chemical conditions of the soil material.

Due to geological and spatial restrictions, issues with urban erosion, water pollution, and the absence of regulating mechanisms, concerns about the practical operation and maintenance of the ponds were also raised (Zhou, 2014). Additionally, the SUDS techniques' limitations in light of the growing hydrological and hydraulic stress are brought on by climate change impacts (Zhou, 2012). It should be emphasized that SUDS approaches have an effect on water flows, but the volume of water is only significantly reduced in extreme situations and depends on local factors including the magnitude and duration of a rainstorm event, the type of soil, and its texture. Therefore, it makes sense to properly combine SUDS and conventional drainage techniques to maximize their complementary effects on drainage design.

Although SUDS methodologies and tools have improved, applying sustainable drainage in practice is still a very difficult endeavor (Zhou, 2012). Although the modeling techniques for SUDS that are currently available having developed over many years, they are still only partially capable of simulating the devices' natural reaction, both in terms of quantity and quality. Due to factors like a lack of SUDS operation and maintenance experience, ignorance of interactions with other water bodies, institutional impediments and barriers towards SUDS practices, and a tendency for many practical SUDS implementations to underestimate their complexity, the resulting performance is frequently unsatisfactory (Thodesen, et al., 2022).

Several distinct disciplines and multidimensional criteria are used in the design of SUDS. However, while making decisions, the majority of specialists and professionals tend to concentrate on and give priority to their particular fields (Achleitner, et al., 2007). As a result, topic-specific strategies and solutions are frequently used without taking into account significant effects from other disciplines. To bring together the various disciplines on a single platform and enable creative and sustainable solutions, an integrated and trans-disciplinary approach will be required. Stakeholders must be aware of the expansive nature of sustainable design and take the urban water cycle into account when making planning decisions.

In the meantime, for SUDS to adapt to future changing conditions, climate change and urbanization changes must be taken into account during the design process (Larsen & Gujer, 1997). Given this situation, a combination of high- and low-tech drainage design solutions will likely be used in the future to strike a compromise between investment cost and performance efficiency. A combination of centralized and decentralized systems will also be needed to bring together the greatest features of the systems and enhance their interoperability for sustainable design. To accomplish these goals, a design framework that incorporates technical, social, environmental, economic, legal, and institutional aspects is necessary (Zhou, 2014).

Being aware of the potential issues with the current and conventional stormwater system is essential to successfully implementing and adapting SUDS or any other sustainable stormwater management technique. If the innovative and sustainable strategy is applied in the same way as the traditional one, it might not succeed. In order

to ensure successful and efficient sustainable stormwater management, implementation must be done differently in the future. The technical approach is not the only thing that has to change and it has to include indigenous knowledge. Changes must be made to policies, educational systems, society's structures and management, social habitats, and aid initiatives. Education is necessary to enable the general public, and particularly stakeholders, to embrace and comprehend the significance of implementing sustainable stormwater management practices (Thodesen, et al., 2022).

SUDS are site specific, tailor made to suit the characteristics of the area. They also promote decentralised implementation of spatial planning frameworks unlike conventional drainage systems. This helps in incorporating the residents which with the beneficial values of SUDS boost the sense of place of the neighbourhood.

CHAPTER THREE: CONTEXTUAL ANALYSIS

3.1. Introduction

Urban flooding is becoming more likely, severe and frequent in Area 49 of Lilongwe City as a result of the climate crisis, increased rapid urbanisation, and rise in impermeable surfaces, as introduced in the previous two chapters. The research aim presented in the introduction is to assess how important spatial planning frameworks currently in use can incorporate SUDS to manage urban floods, which was covered in the first chapter. An overview of the literature on SUDS, urban flooding, and its use in resolving drainage issues in cities was critically examined in the second chapter. As a result, the problems that this dissertation addresses were better framed. So, in this third chapter, the researcher will now move to the case study context and present an analysis of the study area, Area 49. This will include grounding the ideas and challenges in the case study.

This chapter opens with an overview of Area 49. The entirety of Lilongwe City is in other cases included in describing the existing situation because Area 49 lacks a spatial planning framework of its own. The focus of the next part addresses the role that residents play in applying SUDS in urban flood management by considering their lived experiences and indigenous knowledge. This is followed by a section that looks at the local ways of disaster management that the residents use that can be integrated into SUDS and guiding policy frameworks. The next section is on a review of the key spatial planning frameworks which are the Lilongwe City Development Structure Plan (2014), Lilongwe City Development Guidelines and Standards (2015) and the Drainage Master Plan (2023). The chapter ends with a summary of the major findings made throughout the contextual analysis.

3.2. Overview of Area 49 and Lilongwe City

This section aims at situating and locating the study area as shown in figures 4 to 6. This section will include the existing hydrology, demography, climate, geology and spatial analysis of the study area. This research will be conducted in Area 49 which is a neighbourhood located in Lilongwe City. The city of Lilongwe is situated in Malawi's central region (UN-Habitat, 2011). The distances between Lilongwe and Blantyre in the south (330 km) and Mzuzu in the north (360 km) are equal just as Salima in the east

(100 km), and Mchinji in the west (100 km) are equidistant as shown in figure 4 (Strachan, et al., 2021).

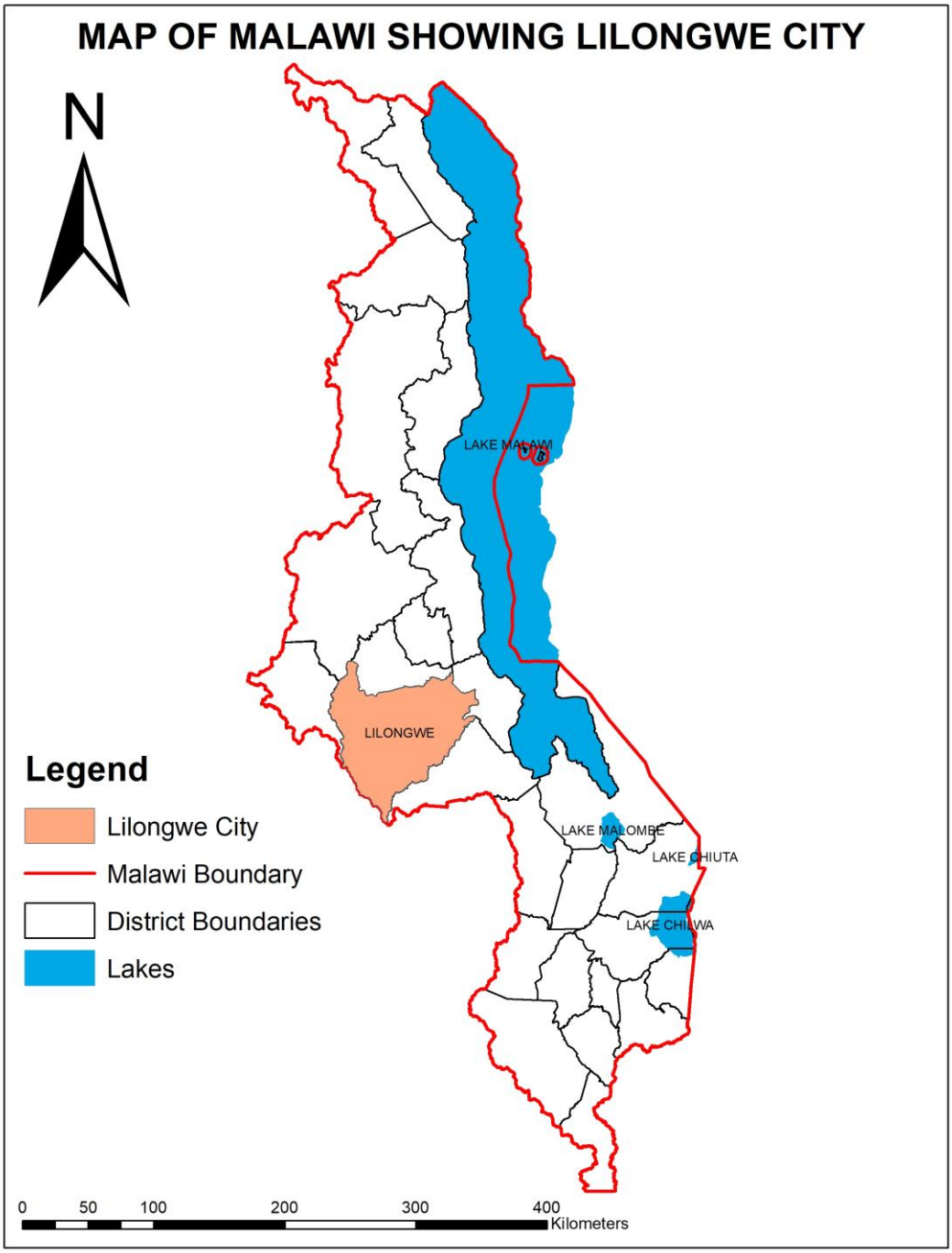

Figure 4: Map of Malawi showing Lilongwe City (Source: Researcher)

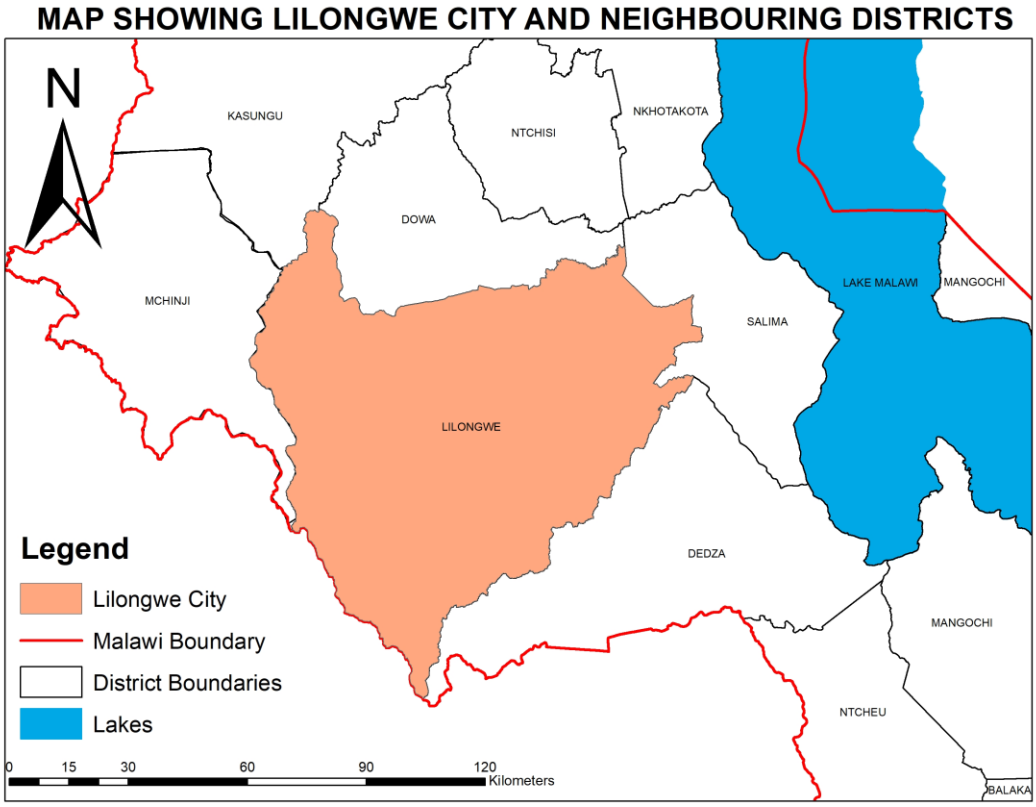

Figure 5: Map showing Lilongwe City and Neighbouring Districts (Source: Researcher)

The biggest city in Malawi, Lilongwe, is situated on the country's inland plains and is named after the river that flows through it (UN-Habitat, 2011). Formerly a colonial town, Lilongwe has served as the country's administrative hub since 1904 (Strachan, et al., 2021). Its significance as a centre of agricultural market expanded in the 1920s due to its location at the intersection of important east-west and north-south thoroughfares and the creation of a significant tobacco industry in its hinterland (Lilongwe City Council, 2020). In 1975, it replaced Zomba as Malawi's capital, which resulted in rapid population expansion in the 1970s and 1980s (UN-Habitat, 2011).

Being the national capital, where practically all of the federal government's headquarters reside currently, has significantly fueled the city's expansion (Lilongwe City Council, 2010). Both the district headquarters for rural Lilongwe and the regional headquarters for the central area are located in Lilongwe (Lilongwe City Council, 2020).

In addition, Lilongwe acts as the main commercial hub for adjacent districts like Dowa as shown in Figure 5, Mponela, Madisi, Mchinji, and Nathenje (Strachan, et al., 2021). These depend on the city's economic resources, among other things. LCC has made some estimates that suggest the city's daytime population might be as high as 1 million (Strachan, et al., 2021).

Lilongwe City experiences annual growth of 3.8% as a result of a high rate of natural increase and rural-to-urban migration (Lilongwe City Council, 2020). As many immigrants struggle to find employment in the city, their housing requirements are also impacted. As a result, Lilongwe City's physical development has been largely unplanned. Because the urban hubs have not developed as anticipated, informal city expansion has not kept pace with the multi-centred, four-sector metropolis that was initially envisaged (Lilongwe City Council, 2020). For instance, it is evident that industries are encroaching on designated green spaces, and there is weak communication between the centers (Lilongwe City Council, 2020). The growth of connections and substitute forms of transportation would open up prospects for luring investment and tourism, among other things (UN-Habitat, 2011).

As of 2005, the government headquarters were moved from Zomba and Blantyre to Lilongwe, it has continued to experience significant rates of urbanisation (Lilongwe City Council, 2010). Since it is Malawi's capital and a significant hub for trade, Lilongwe is essential to the country's prosperity (Chiweza, 2019). The population is rapidly increasing, which demonstrates this. However, because most of this development is unofficial, its services are being put under pressure. This is why the city is under pressure to meet various needs such as infrastructure in an era of climate crises. The increase in population is also evident in Area 49 which a high-density residential area at the expense of the natural environment.

MAP OF AREA 49 AND SURROUNDING NEIGHBOURHOODS

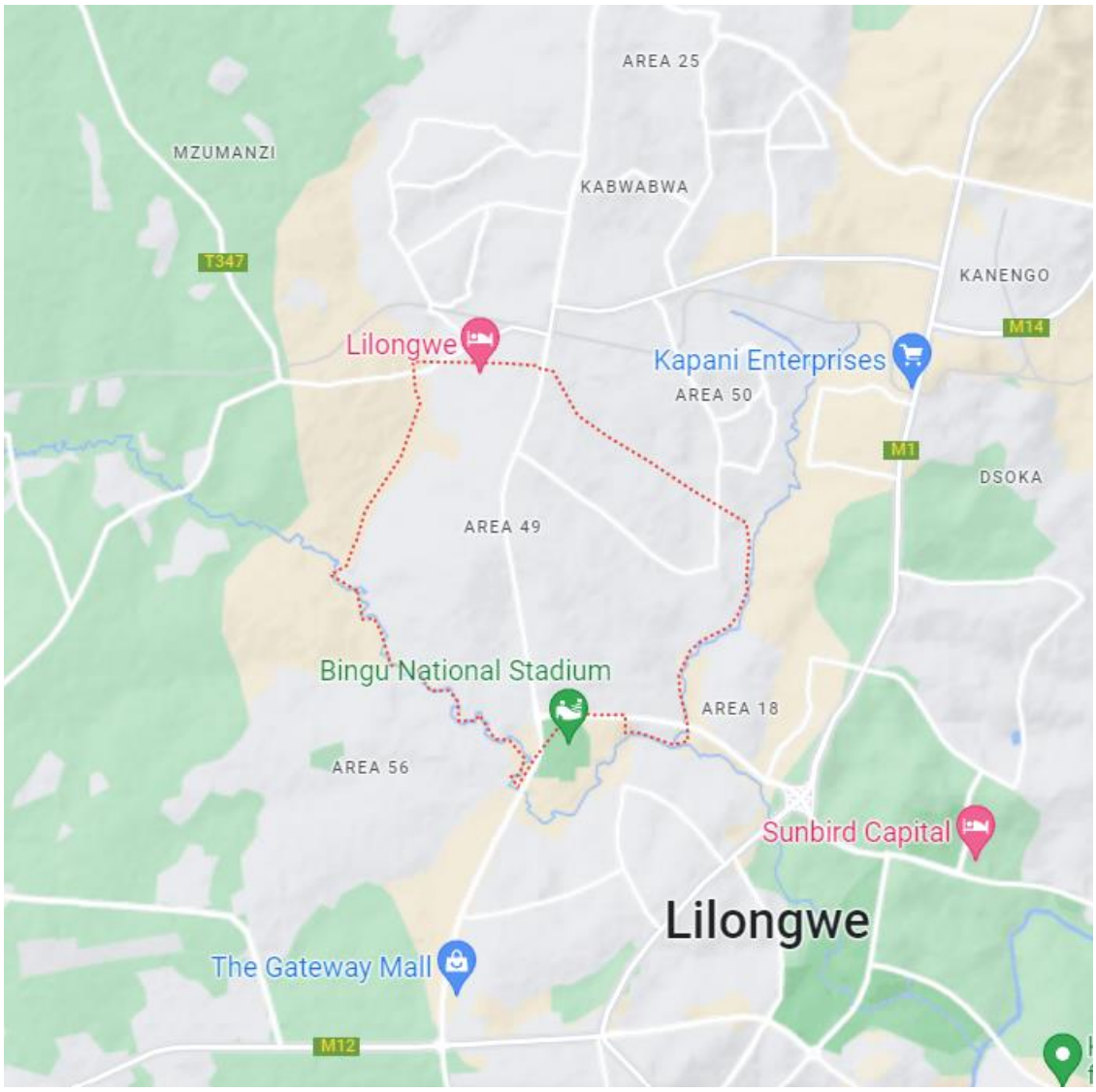

Figure 6: Map of Area 49 and Surrounding Neighbourhoods (Source: Google Maps)

3.2.1. Demography

With a population of about 989, 318 since the 2008 Census, Lilongwe has expanded to become the biggest city in Malawi (UN-Habitat, 2011). 40 years after the city was designated as the nation's capital in 1975, this status has been attained (Lilongwe City Council, 2010). In under 20 years, the city's population increased from 437,090 in 1998 to 989, 318 in 2018 (Strachan, et al., 2021). The population of Area 49 has increased by 200% from 29, 001 in 2008 (UN-Habitat, 2014) to 58 212 in 2018 (National Statistics Office, 2019). This shows that there is a growing demand for land for development to support various human needs including drainage and residential uses.

3.2.2. Environmental Analysis

The services and requirements needed to meet the demands of population expansion, poverty, and urbanization are what drive Lilongwe City's commercial, residential, and infrastructure development (Lilongwe City Council, 2020). This has resulted in the clearance of land and forests to make room for development, the destruction of forests and other natural resources within the City, and the subsequent disruption of the ecosystem's functionality and biodiversity (Lilongwe City Council, 2020). It is regrettable that the land is also highly deforested and intensively farmed to the point of environmental destruction, including the catchments of rivers and streams running through the city (Strachan, et al., 2021). Additionally, during the dry season, some of the nearby gardens, open spaces, woodlands, and plantations are illegally and purposefully set on fire in order to hunt mice for sustenance (Strachan, et al., 2021). These flames frequently get out of control and burn vast expanses of vegetation, aggravating the degradation of the ecosystem and catchment (Lilongwe City Council, 2020).

Water resources have degraded as a result of environmental and catchment degradation (Lilongwe City Council, 2020). Throughout the rainy season, sediment, silt, as well as suspended and dissolved solids, are abundant in the runoff into streams and rivers (UN-Habitat, 2011). Along the waterways, especially the Lingadzi River, which flows on the western edge of Area 49 as shown in Figure 8, settlements, uncollected waste septic tanks, and riverbank farming are common (Strachan, et al., 2021). Additionally, this is close to a section of Area 49 known as New Shire, where flooding is a common occurrence shown in Figure 7. This contributes to the City's overall environmental degradation, including siltation and water pollution. The depletion of the water supplies has caused rivers and streams to dry out more quickly (Lilongwe City Council, 2020). This is in addition to the unattractive landscape caused by the littering of plastics, rags, and other things in the river beds and bank areas of rivers and streams (Lilongwe City Council, 2020).

Only four of the city of Lilongwe's eight sewage treatment facilities are now operational, while the other two have been decommissioned or are being encroached upon (Lilongwe City Council, 2020). This presents a difficulty for the council to maintain

a sufficient number of sewage treatment facilities. Prior to being released into Lilongwe River, the main supply of water for the city, there is a lack of oversight by the City Council and inadequate monitoring of wastewater (Lilongwe City Council, 2010). Due to the restricted number of transportation options provided by the City Council to serve the sewage operations, Lilongwe River is at risk of water pollution (Lilongwe City Council, 2020).

3.2.3. Hydrology and Water Supply Systems

Area 49 and the whole of Lilongwe City have a piped water supply system that is serviced by the Lilongwe Water Board (UN-Habitat, 2011). There has been an inadequate supply of water in recent years due to increased population growth at the expense of existing sources of water (Lilongwe City Council, 2020). Due to this, residents, resort to alternative sources of water such as digging wells in their compounds, collecting water using buckets from rivers and wetlands, and digging boreholes (UN-Habitat, 2011).

In Lilongwe City, flooding is frequent and comprised 48% of catastrophic disasters between 1946 and 2013, and their frequency and severity are rising (Lilongwe City Council, 2010). From November or December to March or April, the city experiences its wet season, which averages 200mm of rain per month (Lilongwe city Council , 2021). The occurrence of rains, which begin in October to November and conclude in April or May the following year, has an impact on Lilongwe City's hydrology (Lilongwe city Council , 2021). In Lilongwe City, yearly precipitation ranges from 900 to 1000 mm with December, January, and February being the heaviest months. Many areas of the city, especially in the Old Town district and informal settlements, are already underwater in January and February due to a lack of infrastructure (Lilongwe city Council , 2021). During this time, diarrhea illnesses like cholera are widespread and frequently made worse by flooding, unprotected water sources and sanitation facilities (Lilongwe City Council, 2020). Five parts of Lilongwe experienced flash flooding over the course of a month in 2020 and some parts of Area 49 were affected (Lilongwe city Council , 2021). The Department of Disaster Management Affairs in Malawi reports that more than 1,500 persons from about 400 houses were impacted (Lilongwe city Council , 2021).

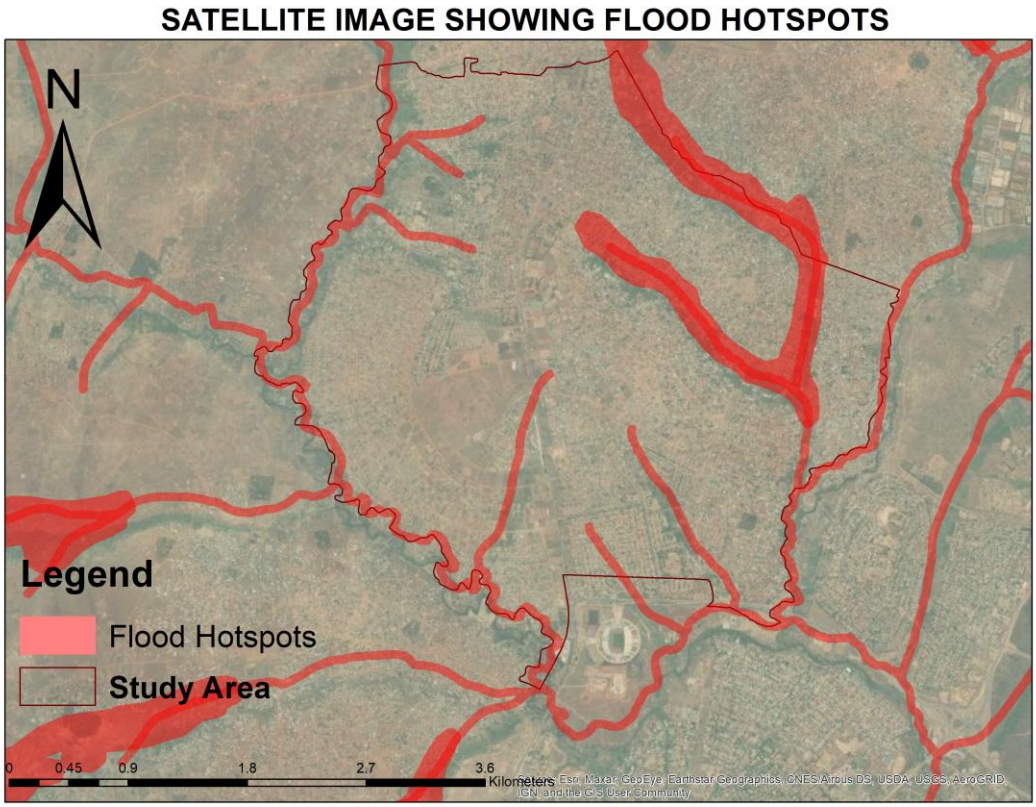

Figure 7: Satellite Image showing flood hotspots in Area 49 (Source: Researcher)

In a scenario of more heavy rainfall brought on by climate change, these weather-related catastrophes, contaminated water and inadequate infrastructure, increase underlying health hazards (Lilongwe City Council, 2020). The city's growing population already finds it difficult to support the piping water supply (UN-Habitat, 2011). The supply is regularly interrupted between May or June and September or October during the dry season (Strachan, et al., 2021). The south of Lilongwe is where issues are most severe because of the population's dense outgrowth (Lilongwe City Council, 2020). The lack of serviced plots within the city is partially to blame for this situation's shortcomings in land planning and allocation (Lilongwe City Council, 2020).

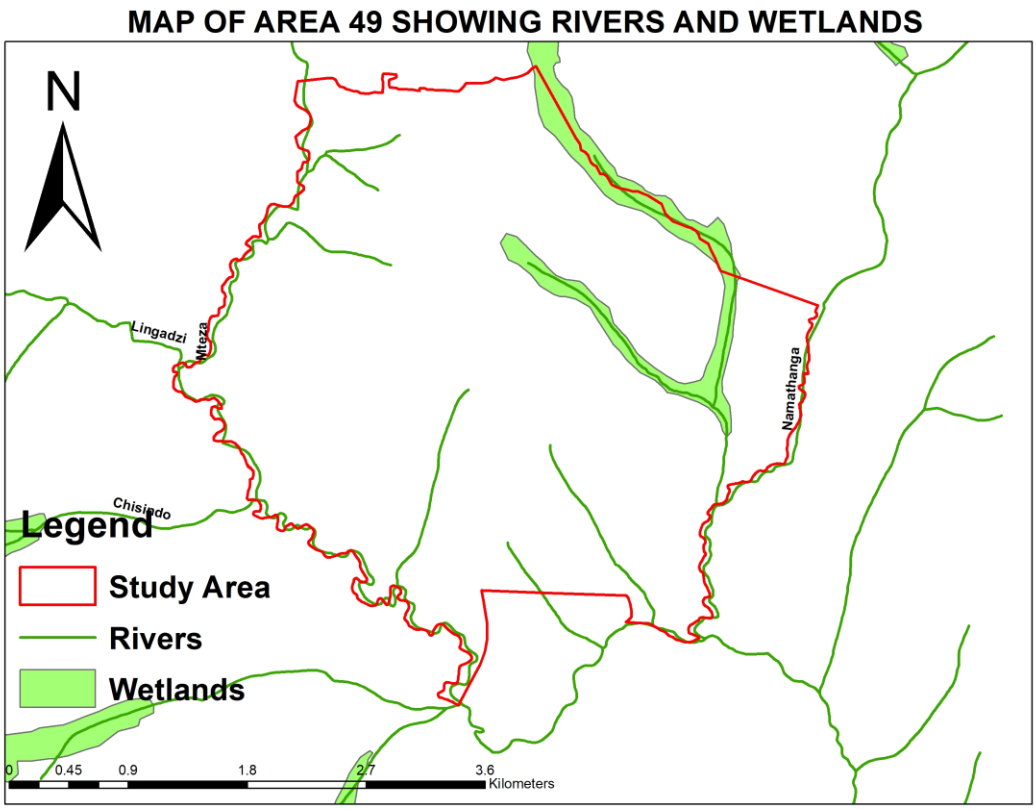

Figure 8: Map of Area 49 showing rivers (Source: Researcher)

After the main tributary Lingadzi River enters the Lilongwe River, the hydrological regime of the river undergoes a considerable change (Lilongwe city Council , 2021). Area 49 is more vulnerable to flooding because the Lingadzi River, which along Area 49 as shown in figure 8 above, carries more water than the Lilongwe River. This is why a flood occurrence on households closer to the river is higher.

3.2.4. Social Dynamics

Local governments in Malawi, including Lilongwe City Council, are relatively new organizations (Chiweza, 2019). Following the restoration of democracy, Malawi adopted a decentralization policy in 1998 with the goal of giving local governments responsibility for the majority of basic service delivery (Strachan, et al., 2021). This has not, however, ever been done completely. Urban services including roads, water, and electricity continue to be tightly regulated by parastatals and ministries of the central government (Lilongwe City Council, 2020). The local government has trouble getting the resources it needs to carry out its duties. In fact, there were no municipal elections

between 2000 and 2014, highlighting a conflict between the national administration and its local counterparts.

An inconsistent legal and policy framework, multiplicity of actors, and competing jurisdictions of power are some of the root reasons of Lilongwe's urban governance difficulties (Lilongwe City Council, 2020). These are made worse by issues with enforcement, politics, the capacity of the government, the level of community involvement, and civic participation in decision-making (Lilongwe City Council, 2020). Area 49, is organized under bock leaders that represent the sectors within the neighbourhood. Block leaders represent traditional leaders that are not recognised in urban systems (Chiweza, 2019). Block leaders are not that efficient as chiefs and that has shown how sometimes participation in Area 49 is not efficient. Block leaders are also not efficient in leading the residents in taking the LCC to task when need be.

Ward development committees are primarily made up of regular citizens or residents in medium- to high-density districts, excluding residents of low-density areas (Chiweza, 2019). Whether intentional or not, the isolation of other people from the city's developing decision-making processes has generated problems. This is why Area 49 does not have effective spaces for citizen participation (Chiweza, 2019). Citizens are mostly not aware of what is going on in the neighbourhood.

3.2.5. Spatial Analysis

Originally, Lilongwe City was planned as a linear, multi-centred, four-sector metropolis, with each sector being intended to be self-contained with specialized services. The region was supposed to be divided into Old Town, Capital Hill, Kanengo, and Lumbadzi per the current zoning plan (Strachan, et al., 2021). Practically every region, unplanned communities and urban sprawl have grown in recent years. Particularly prevalent at the city's southern boundaries is urban sprawl (Lilongwe City Council, 2010). Large plots have been allocated in many central regions, which results in low population density in the centre and exacerbates the congestion issues listed below (Strachan, et al., 2021). Even though just 35% of the city's area is designated as developed, there is significant residential development occurring outside the city's borders. This shows that people with low income and those who may have money but lack political connections face difficulties in obtaining land (Chiweza, 2019). This leads to encroachment even in

planned settlements with natural conservation areas such as wetlands and forest reserves (UN-Habitat, 2011).

AN IMAGE SHOWING AN ENCROACHED WETLAND IN AREA 49

Figure 9: An image showing residential properties built on a wetland (Source: Researcher)

In Area 49, areas along Lingadzi River and wetlands have been encroached with residential developments as shown on the picture above. These are the sites that get affected most when floods hit as the drainage systems are not well connected to the rest of the grey, blue and green networks.

The garden city method was proposed called for a linear, multi-centred urban layout as highlighted above (Lilongwe City Council, 2020). The city's initial plan included the segmentation of the city into 58 planning districts and that is where the name of the study area which is Area 49 came from. This was done to facilitate management and development (Lilongwe City Council, 2020). Area 49 falls under Kanengo which was zoned for high density and quasi residential use. The situation on the ground is a bit different as medium density houses are the dominant land use. The 1986 outline zoning scheme served as the primary impetus for urban development in Lilongwe (Lilongwe City Council, 2010). This plan aimed to encourage controlled urban growth and sensible land use for land uses such as transportation.

The outline zoning scheme was modified in 2010 and is now updated into the current city development structure plan (Lilongwe City Council, 2014). It was in effect until the year 2000. However, there is still a view that insufficient planning is to blame for the rapid expansion of poorly maintained informal settlements and related issues (Lilongwe City Council, 2020). Despite having the potential to grow into a major economic centre, Lilongwe City lacks the financial means to carry out ambitious growth plans or provide essential municipal services and infrastructure (Strachan, et al., 2021). Drainage infrastructure is failing in the city and needs to be revamped into current styles like SUDS. The city council's capacity to make infrastructure investments is constrained by these financial issues with drainage infrastructure not given priority when funds are available (Chiweza, 2019).

The difficulty of providing infrastructure and managing local government should be considered in light of Malawi's overall political system. Following the lengthy one-party rule of Hastings Kamuzu Banda (1966–1994) as the country's leader for independence, Malawi underwent a transition to multi-party democracy in 1994 (Chiweza, 2019). Political and economic interests have long been intimately entwined, with politician-businessmen and politician-businessmen leveraging the state's regulatory power to

produce rents for the goal of furthering their personal and political fortunes (Lilongwe City Council, 2020). Despite the availability of policy documents like the long-term development plan, "Vision 2020," these factors have helped to emphasize populism and short-termism above long-term planning (Chiweza, 2019). During Bakili Muluzi's first term as president of a multi-party system, for instance, planning laws were waived, which caused a boom in the number of informal settlements (Lilongwe City Council, 2020).

Lilongwe, Likuni, and Lingadzi Rivers, as well as the M1's main roads running north-south, Lilongwe-Mchinji, Salima roads, and the railway line running east-west through the center of Lilongwe, all serve as natural dividers of the various city zones thereby informing the city spatial structure (Lilongwe City Council, 2020). This is significant for understanding the setting of Lilongwe and its locations. Along with the characteristics of urbanization in each main area, these are the city's primary geographic features and landmarks (Lilongwe City Council, 2010). The geographical features and marks aid in identifying and proposing major zones that can be used to identify, describe, and analyze the challenges, problems, and opportunities in planning resilient urban development and service delivery throughout Lilongwe City and its satellite urban and semi-urban developments at its periphery (Lilongwe City Council, 2020). Area 49 is defined by rivers to the east, west and south- west as shown in Figure 8.

3.3. What role can residents play in applying SUDS in urban flood management by considering their lived experiences and indigenous knowledge?

Since the dawn of civilization, humans have had to deal with tragedies. In the past, disaster management was dependent on local expertise and conventional wisdom that was passed down from one generation to the next (Carriquiry, et al., 2020). The frequency and severity of disasters have increased in the modern era, necessitating careful preparation and mitigating measures (Kiss, et al., 2022). The modern, technologically advanced disaster management and mitigation solutions are largely universal, fail to consider the specifics of places that may be affected by disasters, and frequently turn out to be insufficient for handling the crisis (Kiss, et al., 2022). In contrast, traditional and primitive disaster management systems are region-specific

and take all relevant factors into account while developing mitigation strategies (Carriquiry, et al., 2020).

Reviving the outdated catastrophe management techniques which are mostly scientific is not appropriate. When dealing with disasters, a combination of contemporary and traditional indigenous disaster management practices and mitigation tactics can be quite helpful (Kasei, et al., 2019). Therefore, the purpose of this research is to examine the value of traditional indigenous knowledge in disaster management specifically SUDS integration. Indigenous disaster management techniques are milieu-specific and built on long-standing observation and knowledge. It indicates that a general disaster management strategy cannot be used everywhere and must be designed with consideration for the physical and social morphology of the area.

To answer this research question, a number of interviews were conducted with residents of Area 49 on their indigenous knowledge on disaster management and SUDS.

> *"Some of us are new here so we do not know much but we know the community is organised. There are people who own their houses and have lived here for their entire lives. Those people can help in inputting knowledge on how to best address floods in our area based on how they know Area 49. Floods are so prevalent here and last year our compound was affected. We could not go to work as we were failing to drive out or walk around. It was bad and if rains come again this year, that may happen again. Unfortunately, we did not see the city council helping us in any way."* Interviewee 1.

One of the interviewed residents said that the city council does not consult them in preparation of spatial planning frameworks such as the recent Drainage Master Plan of 2023. None of the interviewed residents was aware of it despite living in a neighbourhood that is often hit with urban floods.

> *"The policies might be there yes but we are also not aware as to who was consulted or participated in the formulation process. We are often not given notice for public reviews or input on such activities. How then can we work together with them if we are not involved in affairs that involve us?"* Interviewee 3

The issue of ownership also affects the knowledge of indigenous systems of the society. Some residents are tenants whilst some own the houses. Those who own the residential properties have an upper hand when it comes to indigenous knowledge and practices that happen in Area 49.

> *"I am just a tenant and I have not stayed here for a long time. I was affected by the floods last rainy season but there is nothing I can do because I do not own the house. It is also the landlord who knows this neighbourhood better though I am not aware if he has ever stayed here or just constructed the house for rental income generation. I am not really familiar with the traditional knowledge and practices of this neighbourhood. He is the one responsible for fixing the drainage issues here not me. Even if he fixes it that may not help if other houses do not do the same. Individually people are trying to do something but it needs collective effort that can be guided by professionals from the city council."* Interviewee 2

From those interviewed, it can be noted that residents who are tenants are not aware of the indigenous knowledge systems available in Area 49. This does not mean that indigenous knowledge is not available but rather the relationship that tenants have with rented spaces may be the influence as residents keep moving thereby not having enough time to form strong social networks with other residents through which such knowledge can be passed through. This concurs with Kasei, et al., (2019) who highlights that rural areas use and pass indigenous knowledge to other generations more than in urban areas. Rural area inhabitants often live permanently or longer in their villages thereby forming strong social networks and sharing indigenous knowledge.

Despite this lack of indigenous knowledge, it can be noted that the lived experiences of the residents are worthy noting. Some of the interviewed residents confirmed being victims of urban floods. These residents would like to see a change so that they do not experience the floods again. It is such experiences that would influence them in taking part in the implementation SUDS in order to prevent the occurrence of floods.

It should be emphasized that the relationship between LCC and its inhabitants is in a bad state, which indicates a problem on both sides (Chiweza, 2019). The issue with municipal governance in the city is that duty bearers have not changed and still run

councils in a way that ignores the dynamics of democracy, decentralization, and participatory decision-making (Lilongwe City Council, 2020). They have neglected their responsibilities and are more concerned with their own interests than providing services (Chiweza, 2019). The inhabitants, on the other hand, have not yet reached a point where they are demanding participation in civic decision-making from their own city. Despite living in a city, they have no connection to it (Chiweza, 2019).

There is a Development Guideline for Urban Councils that covers citizen engagement and participation nationally (Lilongwe City Council, 2020). It offers a wealth of useful information, such as guidelines for the development of grassroots participation structures at the city, ward, and neighbourhood levels; setup for the creation of urban development plans; inclusion of all actors, including the private sector; key steps in the planning process for urban development; the procedure, timeline, and steps for conducting participatory budgeting; and channels for citizen participation and feedback (Lilongwe City Council, 2020). In contrast to rural councils, citizen participation and engagement is less well understood and utilized by council officers and Civil Society Organisations (CSOs) working with urban councils (Chiweza, 2019). This aligns with the sentiments of the residents who suggest that the council does not put adequate effort into citizen participation. Therefore, the indigenous knowledge that can be consider in integrating SUDS is usually left out.

3.4. What are the local ways of disaster management that the residents use that can be integrated into SUDS and guiding policy frameworks?

This question provides an examination of the existing local ways of shared meaning and practices in disaster management of the residents of Area 49 which can be integrated into the key spatial planning frameworks. Despite having guidelines and standards in the city, different houses have their own arrangements for drainage. The city council does not enforce the guidelines and standards for drainage despite being provided for in the section 4 of LCD G&S (Lilongwe City Council , 2015). This also contributes to the floods as some houses have drainage and some not. The drains are of various width and some with permeable surfaces whilst some not as shown in figure 10 below.

PICTORIAL FOCUS OF CURRENT DRAINAGE CONDITIONS AREA 49

Figure 10: Drainage conditions from various sites in Area 49 (Source: Researcher)

During the rainy season, the households organize themselves along their streets to fix their drains. From the observation and interviews carried out by the researcher, usually residents dig the drainage to clear out silt and solid waste that usually gets the drains filled up. However, this is not very efficient as this is done by people along one street. Therefore, they only fix their drainage systems but do not know what happens beyond the drains after their street. It is also not mandatory as this is only done by households that are willing. Those not interested choose not to take part and this may defeat the whole purpose.

One of the other initiatives taken by the residents is to build the foundations of their houses higher with strong building materials such as stones, sand and cement. This helps in elevating the house so that when flooding occurs, water does not get into the house. This is not regulated by the city councils' guidelines. It is the effort by the citizens themselves to ensure that they protect their houses from flooding events.

> *"After noticing the trend of events during the rainy season, we thought of raising the foundation for our house when we were renovating it. We could not risk building the same old way as floods that affect you may have resulted from a drainage failure from another section of the neighbourhood. So, we just thought of having a better housing structure which we are not sure if it will work as we are not professionals in the built environment."* Interviewee 2

On the issue of using professionals, another resident also echoed on the same:

"The problem is that everyone just sorts out the drainage system of their house. The houses that are affected most are those located on lower side close to rivers and wetlands as that is where all the water goes to. We are affected most during the rainy season because there is no conformity to drainage guidelines. Most of us just build without professional advice which affects the standard of housing infrastructure and this needs to be addressed by the city council." Interviewee 4

The residents also organize themselves in fixing public spaces affected by urban floods especially roads. Roads become inaccessible after urban floods. This is always during the rainy season as that is when runoff increases. The residents among themselves organise labourers to fix the roads to allow them access various services that they need. For example, the residents use sand bags to prevent further soil erosion in earth roads as seen on figure11 below.

AN IMAGE SHOWING SAND BAGS USED TO PREVENT SOIL EROSION ON A ROAD

Figure 11: Use of Sand Bags to prevent soil erosion on roads (Source: Researcher)

From these interviews and observations, it can be noted that residents are aware of the challenge of urban floods that they are facing. It can also be noted that the residents have their own ways of managing urban disasters. Though some of the efforts are temporally and not long standing, LCC can make use of that to work with the residents on how to prevent and better manage urban floods in the neighbourhood.

3.5. How do Lilongwe City's Key Spatial Planning Frameworks address Urban Floods Management and SUDS Integration?

The basis of evaluating the key spatial frameworks under review in this research which are the Lilongwe City Development Structure Plan (2014), Lilongwe City Development Guidelines and Standards (2015) and the Drainage Master Plan (2023), is to see how they incorporate SUDS and urban floods management.

The 1986 Lilongwe Outline Zoning Scheme (Outline Zoning Plan) has been updated and done so with the Lilongwe City Development Structure Plan of 2014 (Lilongwe City Council, 2014) that is also called the Lilongwe City Urban Structure Plan. It was developed with assistance from the Japan International Cooperation Agency (JICA). The plan addresses how the City will develop over the next fifteen years up to 2030 and is meant to be reviewed at least every five years.

Lilongwe City Development Guidelines and Standards (LCD G&S) for LCC were also developed in 2014 with assistance from JICA Project Team for the Project of Urban Plan and Development Management of Lilongwe City (Lilongwe City Council, 2015). The LCD G&S strives to stimulate efficient and proper development, economical and orderly use of land, and a healthy environment. It also offers advice and supports decisions about urban planning and development management in Lilongwe City. Based on the Lilongwe City Development Structure Plan, the LCD G&S governs urban planning and development management.

The Drainage Master Plan (DMP) of 2023 intends to offer recommendations for creating and constructing drainage infrastructure in Lilongwe City that is climate-resilient (Lilongwe City Council, 2023). In doing so, it provides the context, concepts, methodology, and standards for establishing a wide range of solutions, including common design approaches, calculation techniques, indicative sketches, and layout plans, among other pertinent planning and design data (Lilongwe City Council, 2023). This was funded by the World Bank through the Lilongwe Water and Sanitation Project for Malawi.

This section begins with a brief description of when the frameworks were implemented and what the three key spatial planning frameworks aim to achieve. This is followed by

a description of the assessment criteria that will be used to analyse the key spatial planning frameworks. This is followed by an examination of the three key spatial planning frameworks using the assessment criteria. This section ends with a conclusion of what can be noted as the main lessons.

3.5.1. Assessment Criteria for Spatial Planning Frameworks

The assessment criteria have been developed from the main themes that stood out in the literature review as the essential characteristics that a well-integrated spatial planning framework should consider when implementing SUDS. The criteria includes how issues of sustainable development and sustainability transitions are addressed as they help position the relevance of the spatial planning frameworks in current global trends and crises that need to be addressed. Systems of production and consumption must fundamentally change if we are to move toward a sustainable future (Markard, et al., 2012).

Secondly, the criteria also looks at the concept of resilience. Any urban drainage system's main objective should be resilience so that the degree to which a system reduces the level of service failure magnitude and duration when exposed to exceptional conditions should be enhanced (Casal-Campos, et al., 2018). The occurrence of climate disasters, especially in low- and middle-income nations, makes it more important than ever for urban design and decision-making to take a resilience-informed approach. There is increasing focus on more efficient integration of nature-based solutions, including SUDS, with other urban components in order to ensure a successful transition to sustainable, resilient, and cost-effective cities (McClymont, et al., 2020).

The next set of criteria focuses on indigenous knowledge and citizen participation as this research focuses on the natural and social inseparable of SUDS in a residential area. Stormwater is no longer considered a risk but rather a resource under SUDS, which is one of the developing paradigms in urban water management due to the persistence of urban flooding and the inadequacy of ageing drainage infrastructure to handle stormwater (Carriquiry, et al., 2020). Although the majority of global research on SUDS has focused on their technical components, their social implications are occasionally overlooked (Kiss, et al., 2022). In contrast to the previous systems of conventional

drainage system management, which were defined by centralised methods and where communities were often overlooked, SUDS gives a decentralised site-specific approach that gives residents an opportunity to take in the implementation and governance systems (Carriquiry, et al., 2020). The role of humans in space has to be defined as the values of the researcher influence, the role that a human plays in the natural environment is crucial in the management of nature and achieving sustainability. Does the human have a central role, is he or she treated equally as part of nature or the ecology is at the centre in the key spatial planning frameworks?

In addition, assessing the key spatial planning frameworks also requires the need to review coordination efforts. As learned from the successful case studies in chapter 2, coordination is important when implementing SUDS. There is a need for various professionals to work together, existing policies and regulatory frameworks have to be in line just as various departments of a social structure and in this case Lilongwe City Council.

Lastly, there is a need to evaluate how the key spatial planning frameworks recognise the problem of urban floods, drainage failure and climate crises since a problem that is not known cannot be addressed. This will also involve looking at the relationship between SUDS and water management. Therefore, it is essential to review if the three key spatial planning frameworks under review recognise the prevalence of the problem at hand. The factors to consider when implementing SUDS should be set in frameworks to guide implementation. As SUDS are site and context-specific, it is important to evaluate how the issue is handled in key spatial planning frameworks under review. This is in order to find a basis for how SUDS can be implemented on the ground.

3.5.1.1. Sustainable Development and Sustainability Transitions

The Millennium Development Goals (MDGs) were the framework for Lilongwe City's long-term strategic orientation, which highlighted concerns that would speed up growth, alleviate poverty, create sustainable settlements, and strengthen communities (Lilongwe City Council, 2020). Given that the world is now pursuing the SDGs, this is behind as MDGs expired in 2015. The five main issues of governance, housing and land, infrastructure and environment, community development, and economic development made up the long-term strategic direction and goal for all its policies which includes the

three key spatial planning frameworks under review (Lilongwe City Council, 2020). It had a five-year implementation plan, a list of important projects, and rules for monitoring and evaluating progress. This shows that the city council's direction is not in line with international goals. This is already a step backwards from achieving sustainability as this informs the social aspect of it.

How does the Lilongwe City Development Structure Plan (2014) address sustainability?

There is a lack of comprehensive address of the ecological aspect of sustainability in the urban structure plan. The Lilongwe City Development Structure Plan mainly focuses on the social and economic aspects of the city and the ecology aspect is hereby sidelined. There is no dependency of the three circles of sustainability.

> *"Lilongwe has significantly contributed positively towards the socio-economic growth and development of the central and northern parts of the country by providing the necessary high-level services to its rural agricultural hinterland. The urban structure plan provides a spatial framework for the city's annual, medium to long-term economic development plan that will lead to improved livelihood of its residents and the people of Malawi in general. Lilongwe City Council will therefore ensure that this Plan plays its part in poverty reduction in the country by contributing towards job and wealth creation by providing a conducive environment for public and private sector investment".* Expert Interviewee 3.

The Lilongwe City Development Structure Plan mentions the need for the city to be environmentally friendly balanced with social and economic needs but the how part is not addressed.

> *The characteristics of a new type of modern and thriving city are as follow;*
> *(1) Well-planned and environmentally friendly urban development*
> *(2) Well-planned and environment-friendly urban development should be realized by introducing land use control, gradual conversion of unplanned settlement to other land uses, and greenery policy for land use plan. Lilongwe City Council to come up with procedure process for doing this.* Lilongwe City Development Structure Plan (2014). Page 10

How does the Lilongwe City Development Guidelines and Standards (2015) address sustainability?

The LCD G&S just as the urban structure plan focuses on the technical monitoring of planning implementation. It does not address the aspects of sustainability neither is the word sustainable mentioned in the document. However, it highlights on environmental management which provides for the need adhere to buffer strips for streams, rivers, dambos and gullies. It also provides for need for an Environmental Impact Assessment (EIA) for all types of developments listed under the Guidelines for EIA (1997).

How does the Drainage Master Plan (2023) address sustainability?

The drainage master plan focuses on the environmental aspect but does not capitalise on the relationship with economic and social aspects. As such, aspects such as institutional capacity, citizen participation, indigenous knowledge and funding capacity are not well considered thereby rendering the implementation and success of such plan undesirable. The consideration that is there on social and economic aspects is that treating stormwater as a resource is a cutting-edge strategy that can boost local economies, especially in underserved areas, by promoting sustainable local employment, enhancing community resources, and minimizing blight. The term sustainability is mentioned a lot such as sustainable land use and sustainable local jobs but is not defined. Sustainability is broad and debatable as discussed in chapter two thereby there is a need to precisely state what constitutes sustainability in a particular case.

3.5.1.2. Resilience

How does the Lilongwe City Development Structure Plan (2014) tackle the issue of resilience?

The ability to tolerate stress and adversity and to recover from them depends not only on infrastructure but also on institutional capacity and social networks, which can help people come up with coping mechanisms. Unfortunately, the Lilongwe City Development Structure Plan does not address such.

How does the Lilongwe City Development Guidelines and Standards (2015) tackle the issue of resilience?

The LCD G&S is silent on resilience as it just focuses on regulation of planning requirements. So, this depends on what the urban structure plan says. Unfortunately, the urban structure plan does not say anything specific on resilience.

How does the Drainage Master Plan (2023) tackle the issue of resilience?

The DMP focuses on interventions that increase urban resilience to external impacts which should be prioritized from the perspective of human occupation in order to reduce the effects of human activity on natural drainage systems and combine it with acceptable living quality requirements (Lilongwe City Council, 2023). The goal is to implement resilient infrastructure which depicts a focus on engineering resilience unlike social and natural resilience. It does not consider existing social networks that recognise collaboration efforts and composure of how these can bounce back in an event of a flood disaster. The other crucial point a lack of definition as to what constitutes resilience in this case.

3.5.1.3. Public participation and Indigenous Knowledge

Genuine citizen involvement in public policy and decision-making has become increasingly important over the past fifty years, particularly in the area of sustainability (Kiss, et al., 2022). There is growing interest in the depth and types of citizen participation in nature-based solutions, as well as how this participation impacts those solutions' trajectories (Kiss, et al., 2022).

How does the Lilongwe City Development Structure Plan (2014) incorporate public participation and indigenous knowledge?

There is a recognition of local governance structures in situational analysis study pending to the implementation of the urban structure plan. According to the study, this was through the use of block leaders and consultative committees. This does not warrant citizen participation but rather stakeholder participation which is often captured with elite power dynamics and interests. Moving on to the main framework it also does not provide on how citizens can meaningfully take part in spatial planning neither their indigenous knowledge taken on board.

How does the Lilongwe City Development Guidelines and Standards (2015) incorporate public participation and indigenous knowledge?

Since the LCD G&S focuses on guidelines for land use, housing development, transportation planning and urban utilities, participation issues are left out. There are no guidelines on how citizens can participate meaningfully. The LCD G&S does also not provide for what kind of spatial planning developments require participation and who should be involved so that all residents are represented.

How does the Drainage Master Plan (2023) incorporate public participation and indigenous knowledge?

The preparation of DMP involved meetings with consultative committees and block leaders (Lilongwe City Council, 2020). However, in the final document, it does not incorporate role that residents in planned settlements can play in the implementation of climate-resilient infrastructure. Despite residents being the direct beneficiaries, residents in planned settlements also have to put in their views especially experiences, local knowledge and ways of shared meaning. The DMP only provides for need to consult stakeholders in informal settlements before implementing source control solutions.

> *Before their implementation in an informal settlement, the involvement of all stakeholders, particularly the inhabitants, is key for their implementation and maintenance and the existence of an institutional framework with proper funding opportunities and support for community engagement, empowerment, and participation. In addition, proper solid waste and wastewater management accompanied by awareness and educational campaigns are also required to ensure the effectiveness of the solutions in the medium term.* Reads an extract from the Drainage Master Plan (2023), page 72.

3.5.1.4. How do the Key Spatial Planning Frameworks address coordination?

All the key spatial planning efforts at hand show a misalignment. The structure plan is supreme of all and the LCD G&S stems from it. The DMP on the other hand is like a stand-alone document that does not align with any of the other key spatial planning frameworks. Form the interviews with experts, it could also be noted that various departments at the city council do have different prioritises. This affects how

professionals can work together. As echoed in the literature review, successful implementation of SUDS depends on coordinated work amongst professionals such as planners, surveyors, engineers and architects just to mention a few.

This is a different case with LCC as it is evident that professionals do not work together. For instance, planners claim that they were not involved in the development of the Drainage Master Plan. Planning is crucial and had to be involved no matter what. The project that led to the preparation of DMP falls under the engineering department therefore it needed urgent action. That still did not warrant the exclusion of planners in the process, they had to be incorporated. This is evident in how the plan lacks spatial planning direction regardless of tackling important issues such as climate-resilient infrastructure.

This also depicts a lack of consideration for social resilience and ecological resilience. It only highlights engineering resilience which is in contrast with the aim of this research of having a natural and social inseparable in implementing SUDS. Planning professional by its nature aims at bringing the public good which involves participation and care for all nature.

From the plans, it can be noted that more focus is put on informal settlements than planned settlements. The assumption is that all is well in planned settlements and medium to higher-income neighbourhoods (Lilongwe City Council, 2020). This shows a lack of coordination again because the city council should aim at creating a just society. Nearly all of the work is associated with residents of traditional housing or less affluent informal settlements, and their interventions do link less affluent players with private sector actors, middle-class or other affluent or low-density residents (Chiweza, 2019).

The interventions that CSOs have made thus far have also largely focused on strengthening the capacity of already-existing local structures, educating the public about their rights and obligations, fostering communication with duty-bearers, and giving citizens the power to demand better services in informal settlements. This is why Area 49 neighbourhood residents testify that they are not engaged in making of plans and policies let alone interventions. For a neighbourhood that is prone to urban floods,

the citizens equally deserve long lasting interventions just as those in informal settlements.

3.5.1.5. Recognition of the Prevalence of Urban Floods, Water Scarcity and Drainage System Failure

Does the Lilongwe City Development Structure Plan (2014) recognise the prevalence of urban floods, drainage system failure and water management?

The Lilongwe City Development Structure Plan (2014) does not mention anything as far as SUDS are concerned. The situation analysis that was conducted before coming up with the Lilongwe City Development Structure Plan equally does not mention urban floods nor floods as a challenge being faced in Lilongwe City. This may be attributed to the fact it was conducted in 2010 when the issues of urban floods was not prevailing unlike currently. However, it acknowledges the need for new drainage system, though not described precisely, to compliment the current system. The situation analysis also highlighted how drainage along roads are not properly constructed.

The Lilongwe City Development Structure Plan (2014) also recognises the prevailing issues of water supply shortage. Currently, the main source is surface water which needs diversification. It therefore proposes alternatives such as ground water in industrial areas and what it calls isolated villages. Nature-based solutions such as SUDS that provided drainage systems that mimic nature at the same time helping with water quantity are not recognised.

Does the Lilongwe City Development Guidelines and Standards (2015) recognise the prevalence of urban floods, drainage system failure and water management?

The LCD G&S provides for guidelines that should be followed when constructing drainage infrastructure in the city. These are guidelines for constructing conventional drainage systems not nature-based ones such as SUDS. However, it is silent on flooding as it is not mentioned the Lilongwe City Development Structure Plan as well. The LCD G&S framework also provides guidelines for water supply infrastructure which are for the existing conventional and centralised system.

Does the Drainage Master Plan (2023) recognise the prevalence of urban floods, drainage system failure and water management?

Disasters such as floods are recognised in the DMP though not classified urban floods separately as they are dealt with generally as just floods. The study leading the formulation of the DMP recognises floods as one of the main urban challenges that Lilongwe City is facing (Lilongwe City Council, 2020). This does not give guide as to how best to deal with the problem at hand as it is not fully acknowledged as urban floods.

Urban hydrology and drainage are acknowledged by the DMP as being essential to urban development and service provision. The current environmental and watershed degradation and climate change phenomenon are related to the hydrological and drainage status in Lilongwe City and its surrounding. Urban hydrology and drainage are consequently directly impacted by the effects of environmental and watershed degradation as well as associated climate change susceptibility. Urban hydrology and drainage in Lilongwe City have an impact on the city's exposure to increasing flood and drought risks, particularly under the influence of climate change and variability. Infrastructure failure risks and damage are also present in these water-related disasters.

The DMP also recognises the prevalence of flash floods that are caused by the short-duration, heavy rainstorms that happen from November to March can wreck-havoc and produce flooding. Rainfall of a short length and high intensity is particularly interesting because it can generate flash floods, which sometimes result in fatalities and property destruction. This shows that the DMP recognises flash flood occurrence but not urban floods. However, it provides for flood preparedness measures, inundation mapping, emergency management and recovery measures.

As part of climate-resilient infrastructure, the DMP recognises the need to manage stormwater at the source in order to control runoff that turns into wastewater. This is an important aspect of managing water in an era of shortage supply. It also acknowledges the need to transition from conventional drainage systems to sustainable systems such as SUDS. With the help of components like swales and infiltration trenches, SUDS will make the urban drainage system more resilient to flood events and lower the amount of runoff that enters it (Lilongwe City Council, 2023).

3.5.1.6. How do the three key spatial planning frameworks provide the enabling conditions for SUDS implementation?

Of the three key spatial planning frameworks, it is only the DMP that discusses SUDS as a type of climate-resilient infrastructure unlike the USP and LCD G&S. The DMP recognises SUDS as a strategy for stormwater management and floods in general not just urban floods. It also includes considerations such as the extent and type of vegetation that is already present on the land and in the immediate region. It recognises that by intercepting, transpiring, and infiltrating stormwater runoff, vegetation can influence its volume and speed. Additionally, it recognises the significance of nearby or on-site wetlands, surface water bodies, or other ecologically sensitive sites. The DMP also offers decision-making advice for choosing SUDS components and makes an effort to rank each sort of SUDS solution according to how well it fits with the city of Lilongwe's current land usage.

3.5.1.7. Do the three key spatial planning frameworks address the role of a human in space especially natural environment?

The lack of an environmental aspect in the USP shows that human activities are given priority than all nature in the city. The DMP addresses nature-based infrastructure but is not comprehensive enough. The LCD G&S is about planning standards which if not set in the USP, it is obsolete. Although humanity is a natural component of its surroundings, the three main frameworks for spatial planning do not emphasize the interdependence of human and non-human life as well as the value of the ecosystem and natural processes. Interventions like SUDS should be in line with regulations that can support the environmental and green movements and provide a new framework for environmental ethics. The living environment as a whole has the same right to exist and prosper as does humankind. The key frameworks for spatial planning under review here do not provide deeper explanations for the "why" and "how" of how human life affects the environment, as is seen from disasters like urban flooding.

3.5.2. Overall Results from the Evaluation of Key Spatial Planning Frameworks

3.5.2.1. Multiplicity of Actors

The Role of Donors

The city is divided into three management zones as discussed under spatial structure whereas the donors who sponsored the DMP advised to divide Lilongwe City into seven zones which are South East, South West, Central East, Central West, North West, North East, and North Area (Lilongwe City Council, 2020). This shows a conflict of interest and renders other spatial planning frameworks such as The Lilongwe City Development Structure Plan useless. The success of SUDS implementation depends on the coordinated efforts of various stakeholders in a particular setup. This is a different case with Lilongwe City as donors bring in their own pre-requisite conditions if they are to bankroll funds. These plans may not be aligned to the existing plans of the city as seen from the DMP which seems to be an independent framework.

The seven sectors that were proposed in the diagnostic and pre-feasibility studies for climate-resilient urban development and service delivery for Lilongwe are the South East, South West, East Central, West Central, Northeast, Northwest, and North as shown in figure 12 below. The seven sectors were proposed based on characteristics, difficulties, and issues within various areas of Lilongwe.

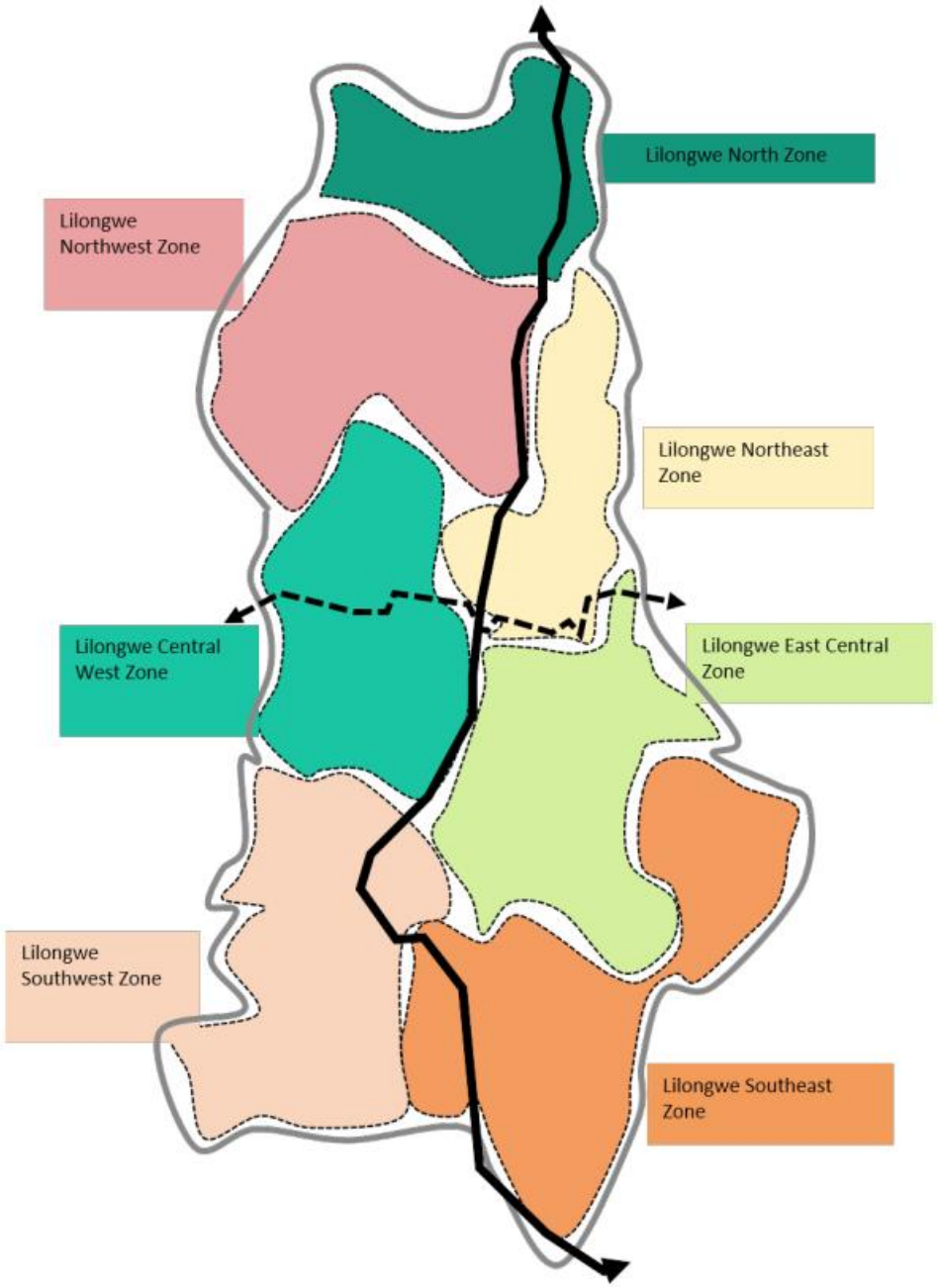

Figure 12: Map of Lilongwe City showing seven zones (Source: (Lilongwe City Council, 2020))

The region west of M1 between the Lingadzi River and the Kanengo-Area 25 - Chitedze road, which is where Area 49 is situated, is part of the central west zone.

Landlords

The legal framework for land governance and land-related regulations determines who has access to land for housing in Area 49 and throughout the entire City of Lilongwe. There is no centralized focal point for buying land instead, there are numerous landlords in both the city and Area 49. The landlords in Area 49 are Ministry of Lands,

Housing and Urban Development, LCC, the Malawi Housing Corporation (MHC), and private people and businesses who all have substantial freehold or leasehold rights to land. It is excellent and appropriate for the LCC to manage all urban land located within the limits of Lilongwe City. This would guarantee adherence to the implementation and modification of urban plans. The Council would be in charge of providing land and enhancing cooperation with service providers in the provision of fundamental urban services such as drainage and water.

Spheres of Government

There is an overlap of roles between various levels of government which also have a mandate of providing various services in Lilongwe City. A notable example is that of the Malawi Roads Authority which is in charge of much of the city's roadways, and it has a reputation for being very politicized and is centrally controlled whilst responsible for the whole Malawi (Strachan, et al., 2021). As a result of excessive political meddling, LCC's ability to govern, manage development, and enhance service delivery is severely hampered. According to the literature, this has been an ongoing issue that has gotten worse since the advent of multiparty politics (Chiweza, 2019). Previous studies have observed that the logic that underlies national politics permeates local governance and has a significant impact on the provision of public goods. This is the same with disaster management which is mainly controlled by DODMA a central government department.

3.5.2.2. Incoherent Legal and Policy Framework

From the review, it can be noted the DMP is a stand-alone spatial planning framework unlike the USP and LCD G&S that are aligned. An assortment of entities engaged in urban planning, administration, and land governance use a number of legal and regulatory tools. A review of these laws and policies reveals numerous inconsistencies, ambiguities, and difficulties with execution. The major frameworks for spatial planning examined above have not yet been unified to offer a single goal and direction. As a result, LCC faces significant difficulties in properly carrying out development planning and control due to the legal pluralism that surrounds the implementation of various interventions, such as SUDS to manage urban floods.

It should be mentioned that due to the diversity of laws and regulations, urban management and governance exhibit a certain type of institutional weakness resulting

from the design of the state. Multiple ministries, local governments, parastatals, chiefs, and political groups all have conflicting jurisdictions and leaderships. Initiatives have ultimately resulted in the emergence of numerous competing, disorganized, and non-collaborative institutions without any conscious effort to do so (Chiweza, 2019). It is extremely challenging to put solutions that address the current climate issues into effect because of these competing authorities. To resolve the misunderstanding in development control and service delivery, extensive coordination is required because no one strategy or institutional framework guides these.

3.5.2.3. Master Planning, Spatial Development Frameworks and Use of Colonial Systems

One notable thing about the DMP and USP is that they are master plans and that definitely has implications on how determination for interventions are made. Master planning is not strategic when solving issues as it focuses on a whole area thereby losing some detailed points of interventions in this case drainage and water.

The City also currently uses a conventional drainage and water supply system that is central and not site-specific thereby missing the need to involve people as the focus is on engineering systems functionality unlike SUDS which deal with what the community has. This also amplifies current problems such as drainage infrastructure failure and shortage of water. Nature-based, blue-green infrastructure solutions such as SUDS are site and context specific that possibly respond to problems from a decentralised way. The use of master plans and conventional systems depict traces of coloniality in LCC's planning system.

Despite being still practiced in Lilongwe City, traditional master planning has come under fire. The Lilongwe Master Plan has an artificiality issue, or, to put it another way, it lacks many of the typical traits of cities that have grown more or less naturally (Mwathunga & Donaldson, 2021). Older ideas as well as the effects of a traditional land use management system are now shaping new approaches to spatial planning, such as spatial development frameworks which offer consistent innovative aspects (Todes, et al., 2010). As a result, it is necessary to consider alternate approaches of spatial planning and whether they are acceptable in specific situations.

3.6. Conclusion

There is a recognition of the prevalence of climate crises specifically floods in the key spatial planning frameworks though not precisely addressing urban floods. This is a step towards finding solutions such as SUDS that are classified as climate-resilient in the DMP. There is a misalignment of the key spatial planning frameworks, lack of coordination, disregard for efforts of residents in disaster management and lack of citizen participation in preparation and implementation of plans just to mention a few results. These therefore point towards a need to revise the plans to be able to address current needs of the city and its residents particularly Area 49. These results will guide the next chapter on interventions.

CHAPTER FOUR: INTERVENTIONS

Photo source: https://www.newcivilengineer.com/latest/benefits-of-sustainable-drainage-systems-go-beyond-making-urban-areas-rain-proof-04-05-2023/

INTEGRATING SUSTAINABLE URBAN DRAINAGE SYSTEMS IN AREA 49, LILONGWE

4.1. Introduction

The third chapter, the contextual analysis, depicted the current situation of urban water management in Area 49 and throughout the entire city of Lilongwe. One of the conclusions of the previous chapter indicates that the City has a number of infrastructure-related shortcomings. The second chapter's emphasis on the significance of SUDS, coupled with feedback from residents, points to the necessity of improving the frameworks currently used for spatial planning. This includes the failure of the existing drainage system, public involvement, the use of local knowledge, and poorly aligned spatial planning frameworks. All of this is taking place in the midst of mounting uncertainty brought on by the climate crisis and a burgeoning population that demands quick action. This is what drives the motive for this chapter which is to intervene by looking at how best the key spatial planning frameworks (Lilongwe City Development Structure Plan (2014) and Lilongwe City Development Guidelines and Standards (2015)), can integrate SUDS.

Urban stormwater management infrastructure will experience stress as a result of climate change (Mguni, 2015) therefore centralized stormwater management systems may not be able to handle projected increases in precipitation adequately, so attention in the urban water management sector is shifting to decentralized strategies based on green infrastructure such as SUDS (Mguni, et al., 2016). It is urgently necessary to abandon the present anthropocentric ideas, such as using conventional drainage systems that are centrally controlled and giving inadequate thought to the local environment. Because the current spatial planning frameworks do not consider the role of people, their experience and knowledge on environmental management, it is crucial to reconsider this, especially in Area 49. It is necessary to make urban surroundings into places where people may live in more harmony with nature and find natural solutions to their issues, like SUDS, which also aid in the regeneration of natural resources.

The third chapter of this dissertation addressed the following sub-questions: What is the current state of affairs in Area 49 as far as water, floods and social dynamics are concerned? What role can residents play in applying SUDS in urban flood management by considering their lived experiences and indigenous knowledge? What are the local ways of disaster management that can be integrated into SUDS and guiding policy

frameworks? Do the existing spatial planning frameworks of Lilongwe City adequately address urban flood management and its mechanisms? This fourth chapter therefore, will respond to the main research question which is "How can the existing spatial planning frameworks (Lilongwe City Urban Structure Plan (2014) Plan and Lilongwe City Development and Guidelines Standards (2015)) be improved to integrate Sustainable Urban Drainage Systems (SUDS) as a way of managing urban floods in Area 49 in Lilongwe City?

4.2. Vision for Area 49

Imagine an Area 49 in the future that encourages people to use their imaginations to the fullest while keeping a positive conclusion in mind. Imagine Area 49 being connected, with permeable pavements and green corridors lining the roadways connecting the major rivers with the wetlands. The residents of Area 49 reconnected with nature, which will lead to a reconnection with the environment and help them realize how much a part of nature they truly are. With their nature-based mechanisms like SUDS in road reserves adopted as the standard, whilst having a rehabilitation and restoration mindset when it comes to water. Imagine residents returning from their daily activities to a charming neighbourhood with safe, clean, and sufficient water, as well as green relief zones that offer shade along the roadways. An Area 49 that understands that water, is a development of creation's influences and wants rather than just a resource for sustenance. A location with living, breathing and dynamic infrastructure serving the people. Imagine watching kids playing in the parks and parents enjoying a relaxing day of fishing in the wetlands.

What would Area 49 with a well-functioning sustainable urban drainage system look like? A flourishing neighbourhood without flash and urban floods whose residents are able to participate in spatial planning matters and interventions with their indigenous knowledge and lived experiences considered. Imagine Area 49 as a community with a strong sense of place that improves how residents comprehend, perceive, and react to social and ecological change. This allows residents to better understand their vulnerability to the climate crisis and how to adapt in a way that will help them recognize and maintain the variety of ways that people define their relationship with their place. SUDS helping enrich ecological value thereby enhancing the local amenity

and creating a beautiful scenery whilst also providing recreational spaces. A community that contributes to the amount and quality of water in a city that takes care of scarce and scared water thereby having a reverential relationship with water.

4.2.1. Spatial Concept for Area 49

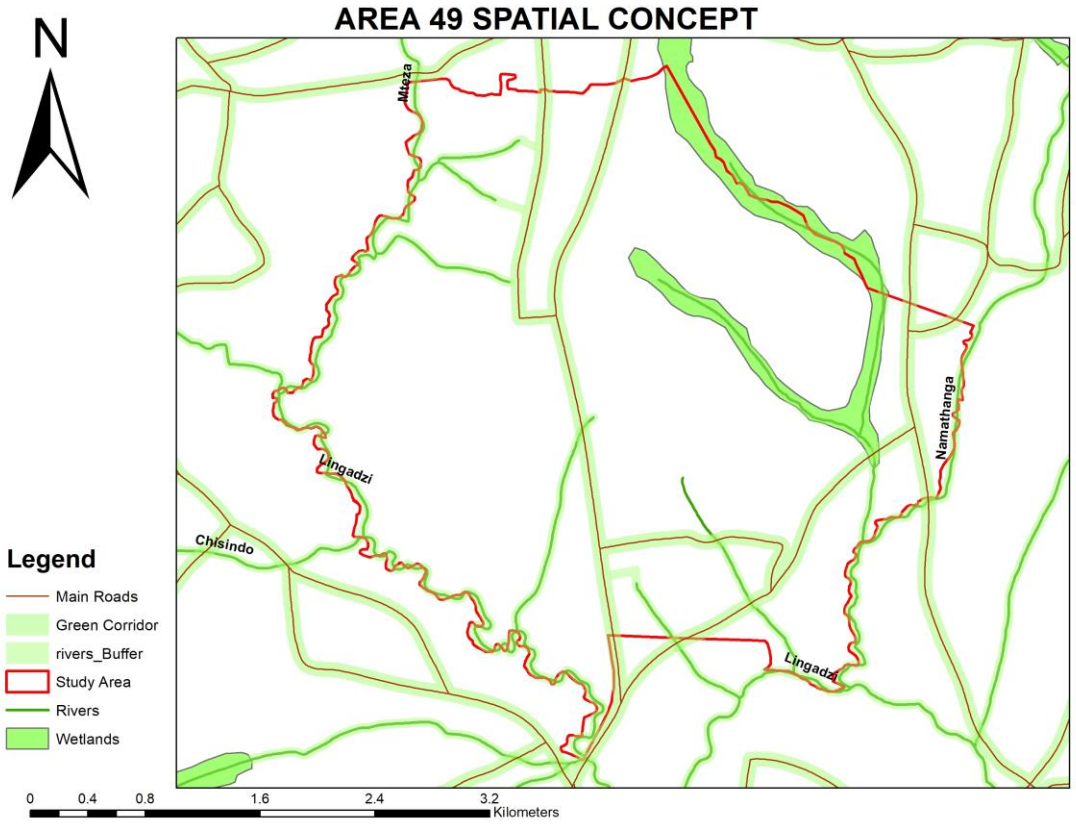

Figure 13: Spatial Concept for Area 49 (Source: Researcher)

As shown in Figure 13, a future Area 49 will have a connected green corridor that will link permeable roadside drainage systems to wetlands through rivers. SUDS in Area 49 can only be enabled by updating the existing key spatial planning frameworks so that they enable this intervention. The 2023 Drainage Master Plan will not be intervened because of the findings discussed in the third chapter. The Drainage Master Plan of 2023 incorporates the need to use SUDS as part of the climate-resilient infrastructure needed in Lilongwe City. However, this framework is not linked to Lilongwe City's Urban Structure Plan (2014) Plan and Lilongwe City Development and Guidelines Standards (2015). The later two do not address SUDS thereby being the two frameworks to be intervened.

4.2.2. Conceptual Framework for Interventions

The conceptual design in figure 14 illustrates the main strategic interventions that would help in realising the vision for Area 49. This directly responds to the main takeaways from the contextual analysis which are language gaps, planning for water governance and participation. These fit in to aid the integration of SUDS into the key spatial planning frameworks of LCC to manage urban floods in Area 49.

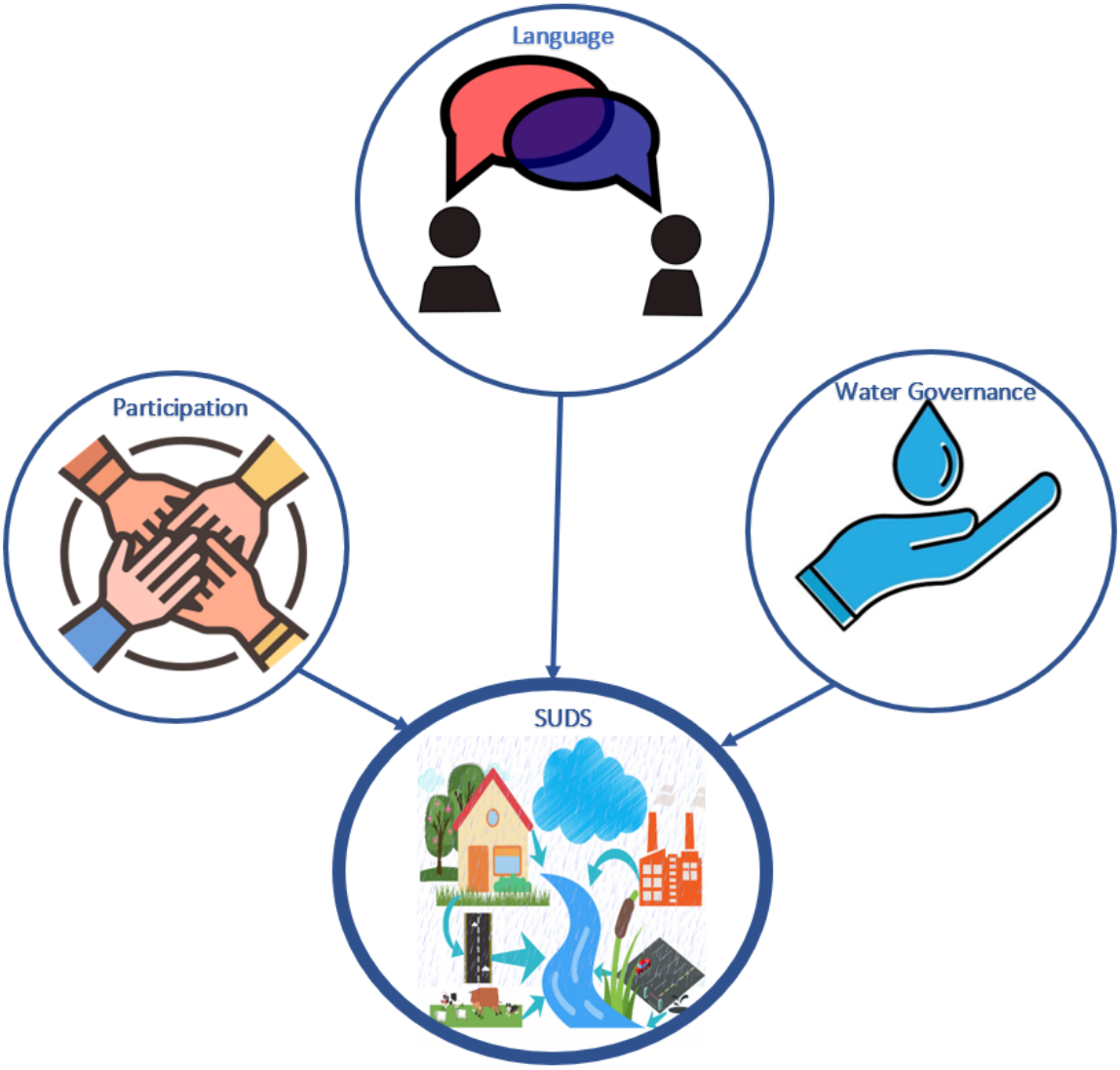

Figure 14: Conceptual Framework for Interventions (Source: Researcher)

4.3. Strategic Interventions to Guide Integration of SUDS in Area 49

This section will look at what can really be done in Area 49 by having a strategic direction to guide intervention. This will also involve highlighting the exact activities that can be carried out depending on the site context and in which section of the key planning frameworks that will be inputted. This section will also provide precedent

studies that support the proposed interventions. It will end with a link to implementation which will be handled in Chapter 5.

4.3.1. Strategic Intervention 1: Addressing the language of Sustainability and Resilience

4.3.1.1. Sustainability

As seen in the third chapter, the Lilongwe City Development Structure Plan does not comprehensively tackle the concept of sustainable development despite being the supreme spatial planning framework in Lilongwe city. Therefore, an analysis and link should be done to the national guiding planning framework which is the National Physical Development Plan (NPDP) of 1987. Malawi currently does not have a guiding framework for sustainable development. Equally, the guiding NPDP is silent on sustainable development and sustainability in general. Lilongwe City was supposed to be the prototype for Malawi's Vision 2020, which has since been abandoned and it was supposed to be an environmentally sound city with a middle-class economy that was powered by technology despite having no interpretation of sustainability in its frameworks.

The intention for SUDS to be a tool for the management of floods in Area 49 identifies and spatially represents a neighbourhood whose environment may coincide with areas of high residential and economic development which poises for the need to state out what sustainability and sustainable development means to avoid the current situation of neglecting the ecological aspect as it is not available in the reviewed key spatial planning frameworks.

Therefore, sustainable development must acknowledge the interdependence of the environment, the economy, and social progress (Waas, et al., 2011). The Lilongwe City Development Structure Plan needs to adopt a sustainability model that is entrenched in its socioeconomic development and its environmental resource base, with the relationships between the various components supported and controlled by a governance framework as this is not available in the current document. The LCD G&S must give guidelines to ensure that all developments in the city are sustainable.

A view of the three dimensions of sustainability that is embedded is illustrated by the nested model in Figure 2 in Chapter 2. The sociocultural layer, which is eventually

nested inside the biosphere of the Earth, is nestled inside the economic layer, or system (Fet, et al., 2023). This conveys the crucial idea that all actions must consider the Earth system. All human activities and developments in Area 49 are required by this model to fit within these layered sustainability dimensions or layers. Then, it becomes clear how the layers relate to one another and how the goals are related. For instance, interactions between human-made systems in the sociological and economic layers and nature result in environmental consequences.

4.3.1.2. Resilience

Since SUDS aim at achieving resilience of the drainage systems to withstand climate crisis events such as urban floods that are prevalent in Area 49, it is important to review the language used in the key spatial planning frameworks to be updated to align with the proposed interventions. A key point of departure is that the Drainage Master Plan of 2023 aims at guiding the implementation of climate-resilient infrastructure such as SUDS. However, it does not define resilience. Both the Lilongwe City Development Structure Plan and LCD&GS do not also discuss resilience. This is a second point of intervention on language is to interpret resilience so that what is in the DMP reflects the main definition in the Lilongwe City Development Structure Plan so that the frameworks are aligned.

According to the particular scope of labour or research, as can be observed in chapter two, the concept of resilience is differentially debated. The main spatial planning frameworks must decide how to interpret the notion because there are many alternative options that could be both helpful and destructive in different ways as done in table 1. The various concepts surrounding urban resilience need to be clarified since varied interpretations may cause confusion among authorities or communities about resilience policies (Amirzadeh, et al., 2022). The notion should be less ambiguous in terms of the scope, aims, and contexts particularly because these policies have an impact on communities and influence how they modify their environment to better deal with future uncertainty (Amirzadeh, et al., 2022).

For neighbourhoods such as Area 49 to cope with the climate crisis, particularly urban floods, resilience is essential. The community's capacity to recover is inversely correlated with its resilience (Mguni, et al., 2016). A strong community will also have

strong ecological systems and strong social connections that ensure people are intellectually, physically, and emotionally able to withstand and recover from a disaster which are aspects of resilience (Fet, et al., 2023). This has to be reflected first in the key spatial planning frameworks by defining what resilience is and what it ought to achieve.

A resilient neighbourhood is better prepared to respond to unfavourable occurrences and provide essential services to all populations in both good and bad times by managing both shocks and pressures (World Bank, 2019). All of these issues surrounded by the climate crisis are intricate on their own, but they are also connected. It takes governance systems with systemic complexity-handling capabilities to effectively address them. Lilongwe city council therefore must be able to learn, adapt, and transform across sectors and levels to build resilience in urban systems.

The characteristics of urban resilience are used to analyse operations and systems (World Bank, 2019). So, for the operations, the first characteristic is robustness, which includes the strength and integrity of urban systems and infrastructure (World Bank, 2019). The other characteristic is inclusion which focuses on ensuring that resilience-building activities benefit everyone, especially the most disadvantaged (World Bank, 2019). Support and coordinated responses to stressors and shocks are part of the coordination element (World Bank, 2019). Systems that learn and develop based on accumulated information and experience are characterised to be reflective (World Bank, 2019). In order to mitigate hazards related to resilience in urban systems, redundancy is also included (World Bank, 2019).

Analysis of resilience using systems is assessed using the awareness, coping, adapting, and transforming (ACAT) model (World Bank, 2019). The ACAT model assumes that urban resilience is attained along a continuum and is made possible by a number of circumstances (Vergara, 2019). The initial stages concern a raised level of awareness and the capacity to handle or tolerate shocks while doing crucial tasks (Amirzadeh, et al., 2022). The infrastructure and institutions of resilient urban systems are then modified to decrease the risks that have been recognized, minimize losses, and recover quickly (World Bank, 2019). With the adoption of policies and investments to endure shocks and strains without serious delays to development, urban system transformation occurs. By releasing economic and social potential through multiuse

infrastructure, risk-sensitive land use planning, and unified social policies, urban systems can further alter themselves (Vergara, 2019). All these have to be described and given direction in the Lilongwe City Development Structure Plan.

Table 1 below, provides the actual strategic interventions that need to be carried out in the Lilongwe City Development Structure Plan (2014) and Lilongwe City Guidelines and Standards (2015) in order to address the language discourse of sustainable transitions.

Table 1: Intervention on Language Discourse of Sustainability and Resilience in Lilongwe City Development Structure Plan

	Guidelines for ensuring applicability	Definition	Framework
Sustainability Discourse	Promotion of land development activities must take place within the available institutional, financial, and administrative frameworks for neighbourhoods to be sustainable. Special attention should be paid to protecting valuable and distinctive natural resources, as well as to ensuring that land use policies are consistent with available tools for environmental management. In addition, all parties involved in land developments activities need to consider that the present and future expenses of providing infrastructure and social services should meet	In this instance, take note that the terms "sustainable" and "development" are frequently used simultaneously. In this instance, both names refer to a single idea called "sustainable development" that should be viewed as a whole and that is based on specific definitions and defining principles. Second, the word "sustainable" can be used without the word "development," as in "sustainable forestry" or "sustainable education." The adjective in this context typically refers to "sustainable	Section 3.1 of the Lilongwe City Development Structure Plan. *This is a new proposed section that should come after the legal status and function. This then replaces the current section 3 on planning history that should be moved to section 4.*

	ecological, social and economic requirements. Given that every human activity uses natural resources and takes place within an ecosystem, ecological sustainability should be a top priority. When planning, infrastructure costs should be taken into consideration. Sustainable cities should be affordable for all, dense and compact.	development" and provides the opportunity to incorporate the basic ideas of the idea into a variety of application domains. Third, "sustainable development" and the word "sustainability" are frequently used interchangeably. Therefore, the definition is: sustainable development is the development that satisfies present demands without jeopardizing the ability of future generations to satisfy their own needs (Brundtland, 1987)	
Resilience Discourse	The flexibility of the spatial planning, policies, and land use management systems needs to be	Resilience in an urban area is defined as the ability of a city and its urban systems, including social,	Section 3.2 of the Lilongwe City Development Structure Plan.

	taken into consideration in order to guarantee sustainable livelihoods in communities most likely to be affected by the effects of economic and environmental shocks. The ability to react and recover after a disaster should enable areas to have sustainable livelihoods that are resilient to shocks. Natural disasters and pandemics have shown how weak and sensitive our cities are, making resilience necessary. Systems should be adaptable so they may evolve with the times and follow trends. Depending on the situation, solutions to various problems and challenges need to be	economic, natural, human, technical, and physical ones, to withstand initial damage, to lessen the effects of disturbances which include tensions, changes, uncertainty or destruction like shocks, natural disasters, changing weather, crises, or disruptive events, and to adapt to change and to structures that restrict present or future adaptive capacity (Ribeiro & Gonçalves, 2019).	*This is a new proposed section that should come after the legal status and function. This then replaces the current section 3 on planning history that can be moved to section 4.*

	site-specific. The issues in Area 49 cannot be resolved in the same way as, say, issues in another neighbourhood. There are differences in the people, opportunities, and natural resources that are available.		

CASE STUDY PRECEDENT: JOHANNESBURG'S SDF ALIGNMENT TO SPLUMA AND NATIONAL DEVELOPMENT PLAN

This precedent study provides a benchmark on how sustainability and resilience discourse can be defined in a spatial planning framework. It was chosen because the city of Johannesburg's Spatial Development Framework (SDF) aligns with the national planning framework and presents how to defined broad concepts such as resilience and sustainability.

The primary spatial policy stance for Johannesburg City is represented by the Spatial Development Framework. It considers the goals and guiding principles of more comprehensive municipal policy, in addition to the spatial policy and legislative initiatives in other spheres of government (City of Johannesburg, 2016). The National Development Plan (NDP) and the Spatial Planning and Land Use Management Act (SPLUMA) of South Africa are two policies and laws that specify what is meant by sustainability and resilience which the City of Johannesburg's SDF applies from (Republic of South Africa, 2013; NSDF, 2018).

The two principles of spatial development, as set out in Section 7 (a) to (e) of SPLUMA in South African are applied as follows in the SDF for Johannesburg; ***Spatial resilience***: securing communities and livelihoods from spatial dimensions of socioeconomic and environmental shocks through mitigation and adaptability that is accommodated by flexibility in spatial plans, policies and land use management systems; and ***Spatial sustainability***: spatial planning and land use management systems must promote the principles of socio-economic and environmental sustainability (City of Johannesburg, 2016).

In terms of applying spatial planning tools to address sustainability and resilience while promoting an economy that promotes social and spatial cohesion, SPLUMA strengthens and unites the NDP's vision and policies in this area (Republic of South Africa, 2013; NSDF, 2018).

4.3.2. Strategic Intervention 2: Enhancing Water Governance through Spatial Planning

This strategy is based on the idea that spatial planning can be used to reduce urban flood risk and help direct future development toward water governance and reduced exposure to urban flood risk in Area 49 by utilizing SUDS. By incorporating natural processes into urban settings, SUDS provide a solution that tries to manage stormwater runoff while minimizing its impact on the environment and maximizing its potential benefits. This encourages water conservation, lowers the risk of flooding, and improves the overall quality of urban living. Area 49 has always relied on traditional drainage techniques that efficiently gather and direct stormwater runoff into subterranean pipes and channels. Numerous problems have resulted from this strategy, including an increase in the risk of urban flooding, water body contamination, and a decrease in groundwater recharge. Conventional drainage techniques also distance urban residents from the natural water cycle.

There is a huge neglect of ecological aspects in key spatial planning frameworks of Lilongwe City as discussed in the previous chapter. Prevailing issues of water quality and supply are therefore not adequately tackled at a time when the city needs proactive response to its water-related problems. There is a need to address water governance and through its underlying discourses of the policy domains, water governance in spatial planning needs to be reimagined (Wiering & Immink, 2006). Instead of the current way of separating water discourse from spatial planning, these two have to be combined. Water is an essential component of SUDS and a key component of resilient cities. Water governance is changing into a more open and communicative, less introverted and expertise-based, policy field as a result of sudden triggering events such as urban flooding, long-term institutional change, manifesting itself in international goals like the SDGs, and discussions about the effects of the climate crisis.

The essence of decentralized systems over conventional, centralized ones in water and climate science are crucial to the agenda that necessitates a reform of water science, policy, and practice that is inclusive, enabling, pluralistic, and transdisciplinary (Hettiarachchi, et al., 2019). Fundamentally, some difficult decisions must be taken,

including promptly facing some pervasive and very real colonial legacies that begin with master planning (Khandekar, et al., 2023).

Decolonized water science acknowledges that neither hegemonic technocentric water science nor conventional knowledge and practices are value-neutral water management, governance, and knowledge systems (Khandekar, et al., 2023). It is crucial to understand the various power structures and agendas that shape how water is viewed, comprehended, and managed. Notwithstanding a wealth of evidence demonstrating the complex, uneven, and path-dependent nature of policy and practice agendas, water scientists are susceptible to persuasive narratives that accept oversimplified worldviews, normative statements, and disciplinary solutions (Khandekar, et al., 2023). This allure comes at the cost of increased social and environmental risks.

A decolonized water agenda would acknowledge that decisions and processes that are purely technological and managerial in nature are problematic, particularly when they are made in elitist, masculine environments or without any obvious ideological underpinnings, such as when markets and individualism are pitted against the welfare state and public institutions (Shrestha, et al., 2019) . Water problems call for a different scientific perspective that considers the diversity of local and contextual knowledge, a wider range of political options, including those outside of the dominant discourses of international institutions, and the ability to reach more critical analysis and inclusive dissension. (Khandekar, et al., 2023)

Much of our modern geographic landscapes are still shaped by colonial remnants, as evidenced by the construction of dams, water supplies, and their sources (Khandekar, et al., 2023), as seen in Area 49, which disregard the political nature of everyday human interactions with water. This is brought on by the politization of the distribution of water resources as a result of partitioning during colonial times and scientifically suspect dataset sources (Shrestha, et al., 2019). Additionally, they continue to spread ideas and ways of producing knowledge that view water as merely an item to be managed, commodified, divided, and exchanged. The involvement of experts with degrees in engineering and economics in planning and policymaking ignores the politics of everyday realities, which are of particular interest to historians and social scientists.

Recognize first that technocratic and capitalist systems serve as the foundation for the dominant knowledge systems, ontologies, and epistemologies of the present (Hettiarachchi, et al., 2019). With obsolete tropes and racist-exploitational imagery and understandings, these hegemonic knowledge forms ultimately drive the agendas of research, policy and planning, multilateral finance organizations, politics, and the media (Hettiarachchi, et al., 2019). The current status quo should oppose the dominance of technical knowledge forms and rhetorical, tokenistic, or unequal kinds of partnerships which are signs that a colonial culture is still in place. Water scientific frameworks, interpretations, and methodologies must develop from, be affected by, and ultimately serve the needs of marginalized groups (Khandekar, et al., 2023).

Second, draw attention to the pervasive colonialism found in current water institutions. The differences between partners from the global north and the global south in terms of who has a place at the table, defining the agenda, taking on leadership roles, receiving compensation are driven by power hierarchies (Khandekar, et al., 2023; Chiweza, 2019). It is found that if the system is not fitted, people will be ignored and probably kicked out.

Lastly, recognizing the necessity for political consensus and being constantly conscious of addressing the prejudices inherent in colonial legacies and not aiming to brush them under the proverbial carpet are essential to resetting the same-old (Khandekar, et al., 2023). There is a need for increased financial support and mentoring assistance platforms operating in water governance that are dedicated to creating such safe places and integrating alternative values into the established order of things (Shrestha, et al., 2019).

So, to align water in spatial planning, there is a need to promote water sensitive designs such as the elements of SUDS described in the second chapter. As outlined below in table 2, various interventions can be implemented in Area 49 according to the context. The Lilongwe City Development Structure Plan should have a section that provides for SUDS under WSUD which is not available currently.

Table 2: Intervention Designing with Water

SUDS ELEMENT	Description	Action	Framework
Protecting Wetlands	Wetlands are a form of swales which is an element of SUDS described in chapter 2. Wetlands are typically described as marshy, shallow-water regions that are either entirely or partially covered in aquatic plants (Armitage, et al., 2013). They are divided into three categories: artificial, modified natural, and natural wetlands (Armitage, et al., 2013). They may serve as a haven for rare and endangered species by providing a vibrant habitat for fish, birds, and other wildlife. Their attractiveness encourages people to use them for leisure. Built wetlands are artificial ecosystems created by humans to resemble natural ecosystems in places where they are not often present. Wetlands also present themselves with stormwater runoff pollutant treatment processes	i. Protecting the existing wetlands and river banks in area 49 that are facing encroachment by enforcing the existing laws on developable land in LCD&GS ii. Designing with water to allow settlements to blend with nature near the wetlands	<u>Lilongwe City Development Structure Plan</u> Section 13 of this framework should be changed to water management. It is also going to be section 14 as there has been an addition of section 3. The new section 24 should encompass all issues to deal with water supply, management and governance and SUDS should be under this section. <u>LCD G&S</u> Land use regulations should be established to restrict access to

	that occur in constructed wetlands such as sedimentation, fine particle filtration and biological nutrient and pathogen removal		places vulnerable to floods and lessen the effects of flooding. These guidelines should be added to section 4 (2 & 3). These should be combined to deal with SUDS in general and provide specifics for implementation instead of treating waste water and storm water separately.
Providing pockets parks for leisure	These should be provided around wetlands, along rivers and conserved green spaces	Pocket parks for leisure around wetlands and conservation of smaller green spaces	LCD G&S Section 4
Harvesting rain water	This involves the temporary storage and repurposing of surface runoff and rooftop runoff. Barrels, rainwater tanks, and other storage structures can be used to retain runoff from roofs	i. Houses should have roof gutters ii. There should be filter shocks to	LCD G&S Section 4

	and other raised impermeable surfaces until the water is needed.	catch debris and leaves iii. Storage facility iv. Debris diverters	
Permeable drainage along roads	The materials used to make permeable paving often have coarse particles, which increase permeability and permit infiltration, filtration, and groundwater replenishment. It contributes to a 70% to 90% reduction in stormwater runoff and a decrease in soil and groundwater contamination.Paving Area 49's public open spaces with permeable paving could improve the quality of the water and make stormwater management easier by regulating surface flow.	All roadside drainage system should have permeable surfaces	LCD G&S Section 4
Ecological corridors	The vegetated strips that are placed next to watercourses and networks are known as ecological corridors.They can be utilized to improve and maintain the quality of water by capturing	Creating a green ecological corridor linking rivers, wetlands and roadside drains	LCD G&S Section 4

	sediments and filtering impurities like phosphorus and nitrogen using biological and physical-chemical processes. The vegetation absorbs surplus water and nutrients during flooding, thereby reducing peak flow and pollutants.		

PRECEDENT STUDY ON WETLANDS: INTAKA ISLAND, CENTURY CITY, CAPE TOWN

This precedent study was identified because it provides a point of reference on how to design residential areas with nature especially wetlands. Area 49 also has wetlands that are being encroached. Planners have to introduce guidelines on how people can develop around those areas by learning from the case of Intaka Island.

Intaka Island in the Century City neighbourhood was constructed to maintain conservation efforts and to produce a beautiful and useful wetland for the surrounding area (Armitage, et al., 2013). The outcome is Intaka Island, which symbolizes a particularly fruitful fusion of real estate development with conservation. Cape Nature granted Intaka Island voluntary conservation status in October 2006, and the building of an environmental education centre was finished in 2010 (Armitage, et al., 2013). Intaka Island and Eco-Centre today welcome a variety of visitors, including senior citizens, school groups, business training events, and birthday celebrations.

The objectives of Intaka Island are to protect a type of rare and endangered vegetation, a type of rare wetland habitat, a habitat for birds, particularly breeding water birds, clean the water in the system of canals at Century City, give Century City a beautiful and healthy "green lung," and provide a recreational and educational amenity (Murray, et al., 2008). The decision was made to reserve 16 hectares as a multi-purpose nature area to protect waterbirds and Sand Plain Fynbos as well as to purify the water for Century City's canal system after significant discussion and expert advice (Murray, et al., 2008). To complement the planned construction, a system of planted wetlands and detention ponds was built, and a new heronry was built on the property, offering a different but comparable bird habitat (Armitage, et al., 2013).

4.3.3. Strategic Intervention 3: Participation in Water Governance and Spatial Planning

Any planning intervention needs participants therefore all substantial development projects that are anticipated to have a significant socioeconomic and environmental impact, such as SUDS, should be required to include a statutory need for public engagement. Local residents must participate in the integration and application of SUDS by drawing on their ancestry and personal experience. Residents in Area 49 have

not yet reached the point where they are pressing their own municipal council for action so that they can participate in the decision-making process. In order to accomplish understanding and learning, as well as cooperative decision-making, participation, which is at the heart of water governance, is predicated on the conversation between the parties involved (Buuren, et al., 2019). It is essential that effective co-creation between public authorities and communities be championed as that is necessary for the development of public value through participation to be successful.

The expanding significance of local initiatives in matters involving water, such as integrating water safety measures with landscape design considers recreational and natural benefits. In order to create public goods and services including water supply and sanitation, irrigation services, blue-green infrastructure, and flood risk controls, several hybrid constellations of public, private, and society actors have arisen. The public, societal, and private actors' roles frequently change and are difficult to clearly define in these situations. The 'public space' surrounding water challenges is being populated by new types of actors and new alliances amongst these actors. However, their interactions are also changing. Their ways of interaction appear to be shifting toward being more horizontal and reciprocal.

This growth can be understood as a reaction to established, institutionalized, technocratic, expert-driven, hierarchical, and monocentric methods to water management. Additionally, it reflects contemporary cultural dynamics in which people are more eager and capable of taking the lead in the creation, development, and provision of services. The classical representative system of democracy is increasingly recognized as needing to be supplemented with more direct modes of engagement and discourse with citizens and other stakeholders to maintain legitimacy. In many fields, there is a gradual transition taking place from governance methods based on new public management concepts to governance methods focused on value creation and co-production.

Urban regions lack a formally stated and approved development planning framework, which has resulted in a leadership impasse locally (Chiweza, 2019). The attempts to eliminate block leaders, who have taken the place of traditional authorities in urban

areas, have made this situation worse. The structures at the Ward and neighbourhood levels of the Council need to be supported. The main issue is proper monitoring, which the city government needs to address. The council needs a participation framework that depends on existing committees in LCD G&S.

Co-production is one method by which citizens can take charge of resolving their planning problems. Urban communities have been able to significantly improve their living conditions through co-production in situations when governments are either incapable or unwilling to provide land and services (Watson, 2014). Co-production examples can show how state-society cooperation can be creative and even beneficial in challenging circumstances. Instead of being a particular organization, it is a prolonged process of mobilization that spans time and geography. It also includes more ambiguous, disorganized, and cyclical forms of collective action, occasionally popular protest, and networks that link organized and dispersed actors in social mobilization processes. It can also include a number of networks and organizations working to alter specific aspects of the political, economic, and social system.

Co-production is defined as a process by which contributions from persons outside of an organization are transformed into commodities and services, primarily the supply of public services like sanitation systems, roads, and schools (Watson, 2014). Through parties' contributions that are varied but complementary, the state's participation with communities can lead to synergy. The state may have resources and technological know-how, whereas communities may have access to local knowledge, time, and skills. Additionally, the capacity for production between the state and society differs, with the states producing the main services while the people producing the ancillary services. Together, the state and its people can improve the outcome thanks to their complementary but separate knowledge bases.

As communities coalesce around the provision and management of services, co-production generates social capital. Co-production can be initiated by the state, institutions, social movements or communities. In each of these situations, the relationship is typically started by the state, and the state retains a dominant position in the power dynamic. Residents in Area 49 must band together to address drainage and water difficulties, which are issues of shared consumption. In order to influence

policy and engage the state more deeply, this must be incorporated to the essential spatial planning policies, sometimes employing co-production techniques.

The following steps have to be put in LCD G&S as the essentials for coproduction. The first step is self-enumeration and mapping, which entails data collection by the citizens themselves and settlement mapping of regions of action in the area, in this case urban floods. Depending on the problems, the LCD G&S must be configured with different levels and types of data collecting. The self-enumeration strategy aids the communities in gaining support for the pressing difficulties they are facing. This is significant in Area 49, since residents do not actively engage in planning decisions. Then, self-enumeration aids in clarifying and reinforcing community demands while also raising their profile with the state.

This is followed by engaging the local government on planning and upgrading. This entails creating a planning process that parallels a social and political process involving savings groups, networks, negotiating with the government, utilizing universities for technical assistance, and creating local committees (Watson, 2014). The planning process would follow a relatively conventional sequence of steps beginning with analysis, moving to visioning, participation around alternatives, and finally moving to intervention and management, all led by the community. Here, the government's functions are primarily those of regulation and the provision of more substantial infrastructure.

Numerous contextual elements influence whether local governments are willing to assist and collaborate with communities during co-production processes. These dynamics reflect past interactions between the state and society, conceptions of the state, of political parties' evolution, and of the formation of people who go on to become leaders and are shaped by the culture that their histories lead them to bring with them. These relationships may be volatile and unexpected since dynamics can also reflect impending events, such as future elections.

The last step is what is referred to as other rituals which involve community-building activities such as learning exchanges, savings schemes and exhibitions. These activities have ideological standing since they serve as a starting point for developing

relationships between people and groups. They demonstrate an organizational commitment to the common good and moral discipline. The fact that none of the co-production methodology's variations adopts a radical approach to social transformation unites them. To nudge state activities in a certain way and secure benefits for certain populations or areas, all adopt an incremental, evolutionary, and social learning strategy.

Traditional spatial planning cannot effectively address the issues that cities are currently experiencing, and co-production may be a valuable framework for creating a more radical strategy for strategic spatial planning (Watson, 2014). This co-productive process, which may be started by non-state actors, would still be led by the public sector but would include a fundamental shift in the balance of power.

Table 3 below presents the proposed interventions that should be incorporated in the Lilongwe City Development Structure Plan and LCD G&S.

Table 3: Participation in Water Governance and Spatial Planning

Intervention	Description	Action	Framework
Meaningful Participation	When participants or residents are able to run a program or an institution, are fully in command of the policy and management components, and are able to negotiate the circumstances under which "outsiders" may change them, meaningful involvement enables citizen control to occur. In cases where citizens are in charge, for instance, public funds would go straight to a local non-profit, which would then have complete authority over how the money is used (Arnstein, 1969).	Formulation of participation guidelines in the LCD G&S. The guidelines should enable access of all eligible participants, safety, etiquette and resources.	Lilongwe City Development Structure Plan This should form part of Section 10 which looks at implementation as that is the step that needs participation
Promoting the existing fora of citizen participation	Community development committees need to be used to strengthen public participation processes through capacity building and information sharing. It may be feasible for residents to become more involved in the development process, via design and construction, and thereby	The community development committees must be reactivated and empowered	Section 10 of Lilongwe City Development Structure Plan

	assume collective ownership of the project once it is finished, if the process of public involvement is given more power over the project's conclusion.		
Promote coproduction	Acknowledging that the greatest persons to provide advice on what supports and services will improve a person's life are frequently those who have personally experienced a particular ailment. It facilitates keeping conversations grounded in reality and person-centred.	i. Self-enumeration and mapping ii. Planning and upgrading iii. Community building activities	LCD G&S needs to add section 5 that should provide guidelines for participation
Introducing online participation platforms to provide for blended participation options.	Growth in use of information and communication technology plus the wave of Covid has showed that virtual spaces can replace physical meetings. These virtual spaces can be capitalised in spatial planning as they offer convenience.	i. Development of an app for participation ii. Development of an interactive website for spatial plans	LCD G&S needs to add section 5 that should provide guidelines for participation

CO-PRODUCTION PRECEDENT: COMMUNITY-BASED ORGANIZATIONS OF THE URBAN POOR IN INDIA

This precedent study highlights the importance of how residents can take a leading role by using their knowledge, experiences and capabilities to solve issues affecting them in their communities. This was chosen because Area 49 residents can borrow from this initiative in order to capitalise on their ways of solving disasters.

The self-enumeration strategy was initially devised by Indian pavement dwellers to support their requests for recognition, but it is now frequently used to support and clarify demands by underprivileged people. Scaling them up was intended to aid in their development into global networks that have disseminated these strategies from their informal settlements in India to other parts of the world. The survey, the map, and the plan which are traditional planning and governance tools, have been appropriated and used as a mechanism to advance the claims of marginalized groups to urban space in what could be described as a growing global self-survey movement among poor urban communities.

In India, NGOs have utilized the polls expressly to mobilize people and inform slum dwellers of a new identity based on citizenship as opposed to caste or religion, a practice known as establishing governmentality from below.

The organizations place a great priority on small-scale savings programs, which also underscore the importance of women as primary savers. Another custom practiced in India is precedent-setting, which is the community construction of hut and toilet models, frequently in the middle of busy public spaces and occasions. The destitute are simultaneously moved into the horizon of law on their own by the attachment of precedent to such models. Thus, there are verbal strategies as well as physical and organizational ones, such as self-surveys, enumerations, restroom festivals, and housing exhibitions.

The objective of the toilet festivals and housing shack displays is political; they serve to show that the underprivileged are capable of building their own homes and facilities and that the normal flow of expert knowledge may be reversed. These intercommunity learning techniques have actually been a major aspect of their work. Groups of the

impoverished go between locations to trade information and succeed in constructing, saving, and engaging with authorities. They contribute to demonstrating to individuals in positions of authority that the poor also travel and have wider connections, which lends an air of legitimacy. This is known as "trans-local urban learning assemblages of materials, practices, designs, knowledge, personal stories, and local histories," with the notion of assemblage emphasizing urban learning and alignment between the social and material at various sites.

4.4. Conclusion

In conclusion, addressing the language discourse that hinders sustainable transitions, reimagining water governance spatial planning, and enhancing resident participation in water governance issues are some of the interventions to enable the integration of SUDS in Lilongwe City's key spatial planning frameworks towards the better management and prevention of urban floods. These interventions are inspired by various precedencies realised through various courses of action. It can be noted that strategic planning is important in solving problems when state-led initiatives fail or if local government is failing. There is a need to act with the knowledge learned about SUDS thus far by presenting a shared, intelligent, and exciting vision for the future of Area 49. There is a need for multiple actors and stakeholders to coordinatively work together in order to implement these interventions which is the purpose of the fifth chapter.

CHAPTER 5: IMPLEMENTATION

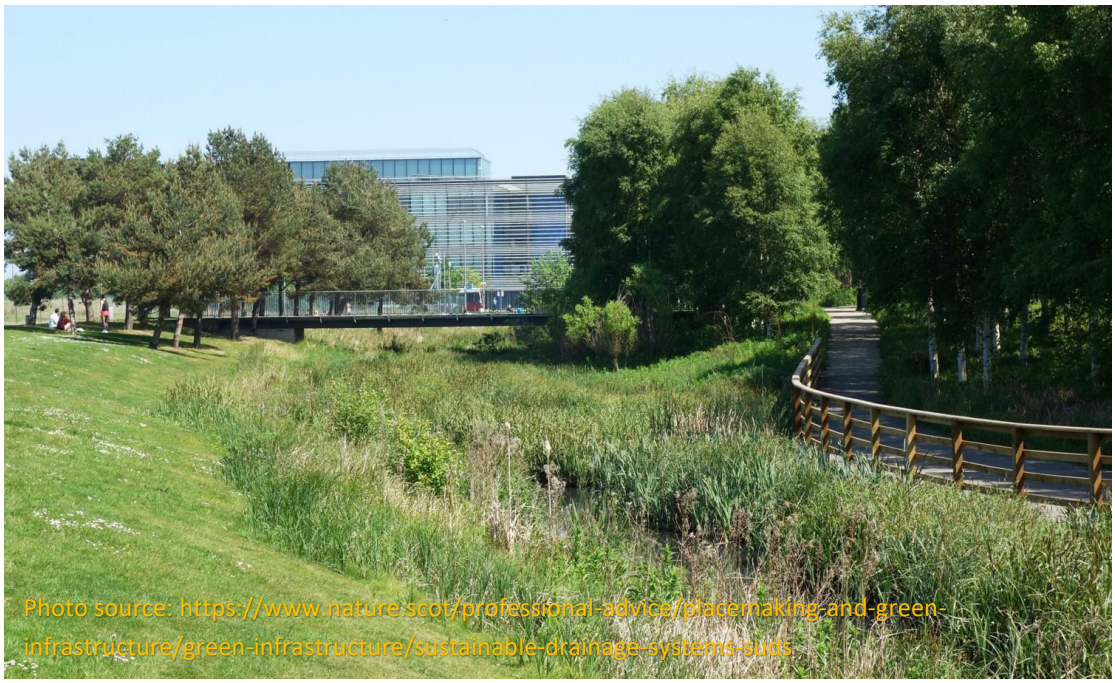

Photo source: https://www.nature.scot/professional-advice/placemaking-and-green-infrastructure/green-infrastructure/sustainable-drainage-systems-suds

AN IMPLEMENTATION PLAN FOR THE INTEGRATION OF SUSTAINABLE URBAN DRAINAGE SYSTEMS IN AREA 49, LILONGWE CITY

5.1. Introduction

This chapter's purpose is to outline the operational elements for the interventions identified in the fourth chapter in order to integrate SUDS in Area 49. An implementation plan considers a particular geographic area with high levels of need, offer multi-sectoral support and collaborate with many stakeholders. Being multi-sectoral means that support might come from areas like housing, livelihoods, water, and sanitation. The term multi-stakeholder refers to the active participation of various, diverse stakeholder groups that are present in the target region, including local government, civil society, international humanitarian and development actors, the private sector, and the impacted community (Urban Settlements Working Group, 2019). As a solution to the current problems, in this case, urban flooding, water scarcity, and lack of involvement are applied only to geographical locations within a particular context. Therefore, this implementation plan will focus on the needs of the people and entail meaningful, early, and ongoing interaction with all affected population groups in the target area. This approach aids in getting active engagement from all important parties although the types of participants and their levels of involvement will differ, they may include local, regional, and national government, civil society, academia, and the private sector.

The complexity of urban crises necessitates a deeper comprehension of urban systems, coordination with local government, and interventions across many sectors and scales, which is why it is necessary to shift from giving humanitarian response when floods occur to natural-based solutions such as SUDS to manage floods in urban regions. This implementation plan aims to unite a variety of actors with varying capacities to discuss the collective response, complement current governance frameworks, allow for the multi-sector and multi-stakeholder approach that Area 49 demands, lessen the emergence or reinforcement of tensions and inequalities and contribute to improving social cohesion, effectively focus resources, and enhance clarity (Urban Settlements Working Group, 2019).

In the previous chapter, three main interventions that will enable the integration of SUDS in Area 49 were put forward. These were around three themes of sustainable transitions language, water governance and participation. This chapter will set out how

to implement the ideas presented under those themes in the previous chapter. To achieve these interventions there are various projects that have to be carried out. To ensure sustainable transitions language is in line with the integration of SUDS, there is a need to define sustainability and resilience. In order to ensure that there is participation of the residents in spatial planning, there is a need to empower local committees in development and disaster risk management, formulate participation guidelines and introduce online participation platforms. Lastly, the quest for water governance in spatial planning will involve projects such as protecting wetlands, harvesting rainwater, creating a continuous green corridor, introducing pocket parks for leisure around wetlands and conservation of smaller green spaces, introducing rainwater harvesting, providing permeable paving on drainage along roads and introducing ecological corridors along river systems.

This chapter begins with an introduction by outlining the major initiatives that will be carried out in Area 49 and why an implementation plan is necessary. In order to ensure that the implementation process is strategic and that projects are prioritized according to the urgency of the issues they represent; the chapter also focuses on the essential phasing of the important projects. The chapter also describes the stakeholders, role-players, and partnerships that are needed to carry out the actions and funding activities, ending with a conclusion.

5.2. Phasing of Interventions

Project phasing, which designates the sequence in which projects will be implemented over the coming years, is a crucial step in the implementation process. The projects have varying timelines, are linked together, and all have the same goal of integrating SUDS in Area 49. Each action should therefore be aware of how the others are running in order to prevent adverse effects from one action's outcome on others. Following implementation, each project will need ongoing maintenance and upgrading to ensure that SUDS are continuously supported in the major spatial planning frameworks that directly address the context of Area 49. Frameworks for spatial planning and current knowledge should be the foundation for this.

Due to resource limitations and potential project inefficiencies, the execution of these projects will take place over the next 15 years. An implementation plan ought to be Specific, Measurable, Attainable, Realistic and Timely (SMART) therefore all the projects cannot be implemented at once but in phases. Realistically, none of the phases can be implemented at once as the role players will need to address constraints in terms of the resources available, local knowledge, and technical understanding of SUDS and their upkeep. To make it easier to organize and prioritise projects and track the process, the procedure has been divided into three phases referred to as terms. Short-term, in this case, is from 2024 to 2029, medium-term runs from 2030 to 2034 and long-term is from 2035 to 2039. The terms are divided into five years because the Lilongwe City Development Structure Plan is meant to reviewed every five years so it serves as point of reference.

The implementation can start immediately with addressing the language gap by introducing new sensibility and attitudes. This can start now because it does not need a lot of input activities to address the language discourse. As seen in the policy review in chapter 3 there is a need to sort that out. This can be dealt with from the intervention on language as suggested in chapter 4. Setting out terms such as sustainable development and resilience will help to align the agenda of SUDS in Area 49. This is a project that has to be done now not later. The important part is that this is to be reviewed in the USP which is due for a review every 5 years pending the next one that will be implemented in 2030. This cannot wait for the next urban structure plan as setting out what such terms mean will guide the implementation of SUDS in Area 49. Other spatial planning frameworks especially the DMP of 2023 already aim at achieving resilience of all climate-related infrastructure but it is not defined as to what entails resilience. So, the first step is to iron out what these terms mean as far as sustainable transitions are concerned. This has to be spelt out in the USP as it is the guiding spatial planning framework and as the DMP is recent it cannot be reviewed yet. This implementation plan is effective from 2024 to 2029.

A medium-term implementation goal is the project on participation. To successfully apply and integrate SUDS in Area 49 and the key spatial planning frameworks of LCC, there is a need to promote participation. One of the determining factors for

implementation should be the creation of a shared vision. Participating the community in the design and execution of the SUDS is important at all stages of the intervention, including planning, carrying it out, monitoring it, and evaluating it. The interventions aim to give voices that have hitherto gone unheard and unnoticed more prominence. This creates a space where the redefined vision for Area 49 may consider an awareness of the citizens' lived realities. The procedure would weave together individual tales about cultural heritage, history and water, enabling a group-based implementation strategy.

The integration of residents' lived experiences, local ways of managing disasters and indigenous knowledge have to be incorporated into the key spatial planning frameworks using participation. At the moment participation is not meaningful with residents claiming they do not take part in spatial planning matters. The relationship that people have with space is attributed to emotions, feelings, experiences and memories which cannot be side-lined in spatial planning. Therefore, it is essential to blend the expert's technical knowledge and residents' local knowledge. This intervention therefore cannot be implemented in the short run but rather medium-term. In an era of decentralisation, participation needs to be bottom-up not just top-down approach. Initiatives such as radicalism, insurgency and co-production ought to be promoted to allow residents to play a leading role in spatial planning. This however can only be possible if the spatial planning frameworks enable that thereby its implementation being fruitful yet taking time.

The last phase is the implementation of a long-term project on rethinking spatial planning and water governance. Implementing SUDS does not just help in managing floods, but in the long also helps in reimagining water governance at a time when Lilongwe City as a whole is facing water supply shortages. As discussed in the literature review, SUDS help improve water quality, quantity and amenity. Spatial planning can mainly deal with the quantity part thereby helping solve the water supply shortage. As such, this cannot be done in a few years, rather needs more time as water governance issues cut across various sectors and dynamics. Table 1 below therefore summarises the projects and timelines for implementation.

Much as the goals for achieving the interventions are short-term, medium and long term, the activities are intertwining. For example, participation is needed at all stages of implementation but with those activities some are medium and some short term. The same applies with water governance activities, for example roads are continuously upgraded, the permeable surfaces can be implemented now as well as rainwater harvesting can start soon as it is at small scale for individual units.

Table 4: Phasing Plan

Project	Short-Term (2024-29)	Medium-Term (2030-34)	Long-Term (2035-39)
Defining Sustainability			
Defining Resilience			
Empowering local committees in development and disaster risk			
Formulation of participation guidelines in the LCD G&S.			
Introducing online participation platforms			
Protecting wetlands			
Harvesting rainwater			
Providing pocket parks for leisure around wetlands and conservation of smaller green spaces			
Provision of permeable paving on drainage along roads			
Introducing ecological corridors			

5.3. Responsible Stakeholders and Funding

This section identifies the relevant players, stakeholders, partners and funding sources accountable for putting the initiatives in Area 49 into action. There are many significant actors in existence, and many of them are municipally-level government departments. Regardless of the existence of different stakeholders, LCC is anticipated to play a significant role in facilitating collaborations and project implementation. For the execution of the initiatives, certain new institutions have been proposed to work with existing ones such as community development committees and disaster risk community committees. The institutions that are being suggested are mostly at the local level and are designed to encourage public involvement and community involvement in the realisation of initiatives implementation, to ensure transparency and a constant flow of information from action execution to the appropriate players engaged.

The implementation of this project requires the input of various stakeholders including the officials at the city council, the private sector and residents just to mention a few. Since there is a lot of work to be done, it would be efficient to set up a task force to function as a response committee to the current climate crisis and the integration of SUDS in the key spatial planning frameworks of Lilongwe City Council. From the contextual analysis, it could be noted that there is a lack of coordination among various actors that are essential for the implementation of SUDS. Therefore, the task force needs to comprise of all those actors including professionals from all relevant departments of LCC such as Department of Estates and Development Planning, and Department of Disaster Management Affairs as shown in table 5. This can be best done by using the services of expert consultants who could be helpful in setting up this process and taskforce.

Research experts who can address challenges including water shortages, urban disaster risk management, ecosystem, indigenous knowledge systems, and governance structures will need to provide ongoing input as SUDS are implemented. Their effort ought to be focused on creating new knowledge and comprehending various viewpoints in light of climatic catastrophes like water scarcity and urban flooding in specific circumstances. Additionally, researchers can be used to help create context-

specific SUDS that can be applied in numerous locations throughout Area 49 and the entire city of Lilongwe. LCC already has a working relationship with Lilongwe University of Agriculture and Natural Resources (LUANAR) which can be capitalised on in these projects. This does not encompass all but rather opens a pandora box for all other universities and research institutes to come in.

LCC in the main financer for these projects. The primary source of income for the Lilongwe City Council is property taxes. The city council also receives money from the federal government, which generates roughly 2% of its earnings and some comes from its donors for the construction of infrastructure. The Development Fund for Local Authorities (DFLA), another source of funding, is available to the city council. All of these financial resources can be used to carry out projects that use SUDS as a means of mitigating floods in Area 49. This depends on LCC's budgetary strategy, but given that they are addressing grave challenges, they ought to be given special attention. The phasing plan must be spaced out over a period of fifteen years in order to adequately account for funding constraints.

It is also necessary to look into public-private partnerships (PPPs), which are alliances between a government agency and a private entity in which the latter delivers infrastructure or services that have historically been provided by the public sector. Particularly for the implementation of water governance projects, given that Area 49's primary source of housing is the private sector. PPPs may be used in the creation and administration of recreational pocket parks. PPPs can also assist in the provision of permeable paving. Telecommunication and network service providers can also be incorporated in the introduction of e-participation project.

Lilongwe City has a number of donors who function as its development partners whose current working relationships can be utilised in the implementation of these projects. For example, the World Bank which financed the development of the 2023 DMP under the Lilongwe Water and Sanitation and Water Project is one of the donors that can help in this case. Another one is JICA which financed the preparation and implementation of the 2014 USP and its 2010 study on Urban Development Master Plan for Lilongwe. The table 2 below, therefore outlines the responsible stakeholders and funding for the projects that will enable the integration of SUDS in Area 49.

Table 5: Stakeholder and Funding Matrix

Project	Responsible Stakeholder	Funding
Defining Sustainability	Proposed LCC Climate Crisis Response Task Force (LCCCCRTF) LCC, Development partners, Residents, Researchers	LCC, Development partners
Defining Resilience	LCCCCRTF, LCC, Development partners, Residents, Researchers	LCC, Development partners
Protecting wetlands	Lilongwe Water Board (LWB), Ministry of Water and Natural Resources, Department of Estates and Development Planning, Department of Disaster Management Affairs, Local disaster committee, Residents	LCC, Development partners, DODMA, Department of Climate Change and Meteorological Services
Harvesting rainwater	LWB, Ministry of Water and Natural Resources, Department of estates and development planning, Department of Disaster Management Affairs, Local disaster committee, Department of Engineering, Residents	LCC, LWB
Providing pocket parks for leisure around wetlands and conservation of smaller green spaces	Ministry of Water and Natural Resources, Department of Tourism, Department of Estates and Development Planning, Department of Disaster Management Affairs, Local disaster committee, Residents	LCC, PPP

Provision of permeable paving on drainage along roads	Department of Estates and Development Planning, Department of Disaster Management Affairs, Local disaster committee, Department of Engineering, National Roads Authority, Malawi Housing Corporation, Ministry of Lands, Housing and Urban Development, Residents	LCC, Ministry of Water and Natural Resources, National Roads Authority, PPP
Introducing ecological corridors	Department of Estates and Development Planning, Department of Disaster Management Affairs, Local disaster committee, Department of Engineering, National Roads Authority,	LCC, Ministry of Water and Natural Resources, National Roads Authority
Empowering local committees in development and disaster risk	Ministry of Local Government, Department of Estates and Development Planning, DODMA, Department of Disaster Management Affairs, Local Disaster Committees, Department of Information	LCC, Development partners, DODMA, Ministry of Local Government
Formulation of participation guidelines in the LCD G&S.	Ministry of Local Government, Department of Estates and Development Planning, DODMA, Department of Disaster Management Affairs, Local Disaster Committees, Department of Information	LCC, Donors, Development partners, Ministry of Local Government
Introducing online participation platforms	Ministry of Local Government, Department of Estates and	LCC, Development partners, DODMA,

	Development Planning, DODMA, Department of Disaster Management Affairs, Local Disaster Committees, Department of Engineering, Department of Information	PPP, Ministry of Local Government

5.4. Conclusion

This chapter has examined the important SUDS integration projects in Area 49's implementation phase. The chapter has demonstrated that the integrated SUDS implementation process is a crucial component of the plan's anticipated outcome, which attempts to manage urban flooding in Area 49. This chapter's implementation approach took into account funding sources, time constraints and responsible parties. The chapter also included a phasing structure that highlights financing sources for implementation and summarizes the project durations. The phasing shows that since resources and execution are limited, it is not possible to complete everything at once but rather in pieces.

CHAPTER 6: CONCLUSION

Photo source: https://www.thames21.org.uk/sustainable-drainage-systems/

REFLECTIONS AND RECOMMENDATIONS FOR INTEGRATING SUSTAINABLE URBAN DRAINAGE SYSTEMS IN LILONGWE CITY'S AREA 49

6.1. Introduction

In conclusion to this research, this chapter aims to provide a reflection on the findings and outcomes of this dissertation. This chapter summarises the five chapters, highlights the suggested recommendations, personal reflections, lessons learnt and areas for further research. This chapter starts by presenting the main research questions and research findings. This includes with it a summary of the literature review, a brief synopsis of the research findings which led to the interventions which will also be summarised and how these can be implemented. The other section is a personal reflection of the research process. This is followed by suggested recommendations and the last part is areas for future research.

6.2. Main Research Findings and Research Questions

From the introduction, the main issues that stood out are the climate crisis and increasing population growth, leading to the persistence of catastrophic events such as urban floods in Area 49. Nature-based solutions to urban floods such as SUDS are therefore necessary in preparing for future response to floods in order to prevent harm and inform wellbeing, health and safety. The challenge is that the current key spatial planning frameworks of Lilongwe City do not adequately integrate SUDS. This research therefore had the following research questions to see how SUDS can be integrated into these key spatial planning frameworks:

Main Research Question

How can the existing key spatial planning frameworks (Lilongwe Urban Structure Plan, Drainage Master Plan and Lilongwe City Development and Guidelines Standards) be improved to accommodate and integrate Sustainable Urban Drainage Systems (SUDS) as a way of managing urban floods in Area 49 in Lilongwe City?

Sub Questions

i. What is the current state of affairs in Area 49 as far as water, floods and social dynamics are concerned?

ii. What role can residents play in applying SUDS in urban flood management by considering their lived experiences and knowledge?
iii. What are the local ways of shared meaning in disaster management that can be integrated into SUDS and guiding policy frameworks?
iv. Do the existing spatial planning frameworks of Lilongwe City adequately address urban flood management and its mechanisms?

From these research questions, relevant literature was discussed to look at the definition of concepts, sustainable transitions, implementation and elements of SUDS, and indigenous knowledge systems. This led to the contextual analysis which made a number of notable findings. The main findings are that there is a lack of coherent language on sustainable transitions in the key spatial planning frameworks. There is also a lack of coordination among various role players and professionals necessary for the integration and implementation of SUDS. The DMP of 2023, proposes the implementation of climate-resilient infrastructure such as SUDS but this is not reflected in the 2014 USP and 2014 LCD G&S of 2014. Lastly, it was found that residents of Area 49 do not meaningfully participate in spatial planning matters. The residents have their own ways of managing disasters and drainage systems which are not recognised by LCC and but can be incorporated into the key spatial planning frameworks.

From the findings, three interventions were proposed in order to facilitate the integration of SUDS into the key spatial planning frameworks in order to manage urban floods in Area 49. The first intervention is the need to address the language of sustainable transitions in the USP (2014) in order to align it in the current issues and DMP of 2023. The second intervention is to reimagine water governance as part of spatial planning in an era when it can used as a tool to respond to climate crises such as water shortage and urban floods. Lastly, there is a need to have meaningful participation in planning matters by empowering residents to use existing participation structures among other initiatives. The implementation of these interventions depends on LCC taking a leading role together with all other relevant stakeholders. This also depends on the availability of resources such as funds and capacity which LCC can

capitalise from its revenue, development partners, researchers and Public-Private Partnerships.

6.3. Contributions of the Research

This study aims to add to the greater body of existing policies and frameworks for spatial planning related to SUDS and urban flooding that LCC possesses. The emphasis on Area 49 is meant to motivate and inspire the case for small-scale interventions in local communities where residents work together to solve problems that directly affect them by using their invaluable local knowledge and understanding of the local context, landscape, and water stories to create effective interventions such as co-production. A neighbourhood therefore becomes a meaningful scale of intervention when using small-scale interventions because SUDS are context-specific. The study also aims to contribute to a larger body of knowledge linking residents' relationships with their natural environment, minimizing the effects of human activities on ecosystem services and the implications for human life if these are not considered in governance approaches.

6.4. Reflection on the Research Process

Firstly, it was exciting to do research in SUDS which has been an area of interest for the last three years. What motivated the pursuit of this research most is the need to respond to the growing issue of urban floods in Area 49 which is a planned settlement and it is assumed to be perfect that most disaster risk response teams do not consider to have issues unlike the attention given to informal areas on flood response.

This was a thrilling experience, which can be considered as a learning process. Learning how residents can take part in implementing SUDS was so inspiring as it depicts what knowledge and capability the residents have. It is the researcher’s impression that the plans that LCC has do not seem widely known or communicated amongst the communities and citizens affected. SUDS is a big field that is gaining more relevance with the prevalence of water-related climate crises. One thing that could be explored more is how SUDS are site and context-specific thereby suiting the existing natural

environment in dealing with prevailing issues. SUDS do not just offer solutions but also provide an opportunity to reconnect with nature as part of it not only as a resource.

This research commenced with few expectations from what could be found from this research, especially from the LCC's part. Fair enough, LCC officials were so helpful and they are doing a great job that just needs coordination. On the part of the residents, there were high hopes that they would cooperate easily and give in a lot of input which was not the case. Due to issues of ownership and personal engagements, most residents seemed busy and unaware of what was happening in their neighbourhood. In addition, the available time was not adequate to build relationship and trust with the residents.

Despite getting this experience from those whom that the researcher managed to interact with, a lot was learnt from the rich neighbourhood that Area 49 is. It is interesting to learn from the efforts that these residents are making to manage disasters on their own. As a researcher the impressions that the residents gave is that are willing to take part in spatial planning initiatives. It was so touching talking to some respondents who have been affected by floods which was an emotional rollercoaster worth exploring at the same time motivating the significance of this work and research.

One of the setbacks in this research was the lack of data for neighbourhoods such as Area 49 which made the analysis difficult thereby not accurately reflecting the situation on the ground. All analysis was made with generalised data for the whole of Lilongwe City except for a few cases.

To the researcher, it does not appear planning matters are neglected by block leaders but perhaps there is no traction interest in such as unlike with community social welfare matters such as funerals than pressing issues such as planning matters despite being duly recognised in the structures of LCC.

6.5. Recommendations

The issue of urban floods is prevailing in Area 49 and many other parts despite not being fully addressed in the key spatial planning frameworks of LCC. This is why solutions such as SUDS are also not fully integrated. The lack of local area plans also exacerbates this issue as the only intervention that can be done is at the city level. The introduction of local area plans is crucial because they should be scaled to make it easier to identify neighbourhood and community size problems and priorities, such as urban flooding and water supply. Local spatial planning can empower and equip local governments, such as the LCC, to assess urban flood risk and then build appropriate adaptation measures utilizing technologies like SUDS that act and respond based on the site's features. Strategic spatial planning techniques must be developed immediately and tailored to the needs of nations with reactive planning systems that are experiencing fast urbanization (Spaliviero, et al., 2019). These techniques should make it possible to assess the urban system's geographic characteristics and meaningfully direct the implementation of national urban plans or strategies.

LCC can also consider the Spatial Development Planning (SDF) method, which is now being used in many cities for example in South Africa. The SDF technique aids in understanding the functions and connections between distinct urban settlements inside the territory and frames the territorial structure within the fluid and uncertain environment typical of nations dealing with unchecked urbanization.

The primary function of the SDF method is to assist countries that are experiencing rapid urbanization and have weak planning systems, making it difficult for those countries to implement sound spatial development strategies in accordance with established policy discourses or approved development strategies (Spaliviero, et al., 2019). This is a situation that is currently occurring occasionally in sub-Saharan Africa and, more generally, in the global South. The SDF method has the following capabilities: firstly, analysing a system of human settlements in a given territory; secondly, it helps in evaluating a shared understanding of the spatial structure of such a territory that empirically emerges from the analysis in accordance with a policy or strategy and; and

lastly, it aides in formulating strategic recommendations for spatial planning and development actions in accordance with identified priorities.

It has been argued that reforming their nations' planning laws is a necessary first step toward better urban development (Prasad & Nigam, 2023). Before drafting a law reform proposal, it is crucial to comprehend the political, economic, and social forces that guide the planning system's operation. A new planning law should be easy to create and put into effect in African nations, it is assumed far too frequently. It is stated that a careful and thoughtful approach to legislative change is necessary instead since the backdrop in many African countries is extraordinarily complicated. Therefore, there is a need for a realistic approach to direct the creation of new planning laws that can be modified to suit the unique needs of other nations.

There is a need to allow for LCC to work with civil society organisations on spatial planning matters. CSOs help in research, increasing community awareness and enhancing collaboration in the implementation of projects. For example, in Cape Town, South Africa, CSOs such as Ndufuna Ukwazi advocate for equality, spatial justice and inclusion of residents in pursuit of access to basic necessities for all, especially housing. They therefore have helped citizens in various campaigns aimed at responding to the lack of housing in well-located areas.

6.6 Areas for Future Research

Following this research results and lessons learnt, the main recommendations for future research are:

i. A research can be conducted on how to reimagine indigenous knowledge systems in the urban systems of Malawi. From this research, it was noted that urban residents in planned settlements are not considered in some planning matters. This has led to their indigenous knowledge systems not being taken into consideration. It is mostly in rural and informal settlements that are regarded to have a rich sense of place at the expense of planned settlements.

ii. Another area of research that can be pursued is how to decolonise water infrastructure and spatial planning systems in Malawi in an area of climate crisis to allow for response to prevailing issues from the existing context. For example, the problems being faced in water governance in Lilongwe City are different from those of Zomba City thereby the solutions to those issues are also expected to be different

iii. The role of spatial planning in water governance of Malawian cities is not well researched as these two are treated separately but need to be combined if water-resilient cities are to be achieved in a spell of increasing population and shortage of water supply.

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Appendix 1: Consent Form

SCHOOL OF ARCHITECTURE, PLANNING AND GEOMATICS
University of Cape Town
Private Bag x3, Rondebosch 7701
Centlivres Building
Email: Janine.Meyer@uct.ac.za Tel: 27 21 6502359

UNIVERSITY OF CAPE TOWN
Contact Details: mkombeziedda@gmail.com, +27656098416, +265882194462

Date: July, 2023

CONSENT FORM

My name is **Edda Olaheya Mkombezi** and I am studying City and Regional planning at the University of Cape Town.

I am doing research **on Applying Sustainable Urban Drainage Systems to Urban Flood Management in Area 49 Planned Settlement in Lilongwe, Malawi**. As part of my master's dissertation, I would like to ask you some questions to help me with my research. I will only ask you a few questions regarding your understanding and experiences of Sustainable Urban Drainage Systems.

Please note that your involvement is voluntary and I will only proceed if I get your permission. Please be aware that if you want to end the interview at any point you are free to do so. However, I would like it if you would agree to an interview so that you could help me. There is no financial obligation from the project therefore as a participant, you will not get any payment.

Permission to use the following in your dissertation:

- *My name* *YES* *NO*
- *My designation* *YES* *NO*
- *My words* *YES* *NO*

I would also like to record the interview for my use in the writing up of the research dissertation. This recording will NOT be shared and will be deleted when the

dissertation is completed. You will freely voice your opinions, which will thereafter be included in the primary research document. Your opinions and suggestions will be documented, used as a guide, and included in the academic community's body of knowledge about the topic. The questions I ask are only for research and they cannot directly benefit you or your community. To protect the information that will be collected, the data will be saved in a folder protected with a password.

The research has been reviewed and approved by the University Research Ethics Committee of UCT, and permission has been obtained to commission the interviews. All information collected in this study will be kept private in that you will not be identified by name. Confidentiality will be maintained as pseudonyms will be used in the final research report.

Your details will not in any way be revealed in my dissertation or any publication I produce. In case I do, I will seek permission and ask interviewees how I may refer them either by name, job title or whether they want to remain anonymous. The questions I ask are only for research and they cannot directly benefit you or your community. Confidentiality will be maintained as pseudonyms will be used in the final research report.

MY SUPERVISOR IS Tania Katzschner AND HER CONTACT DETAILS ARE: Tania.katzschner@uct.ac.za

or 021 6502381 (cell 0836347887)

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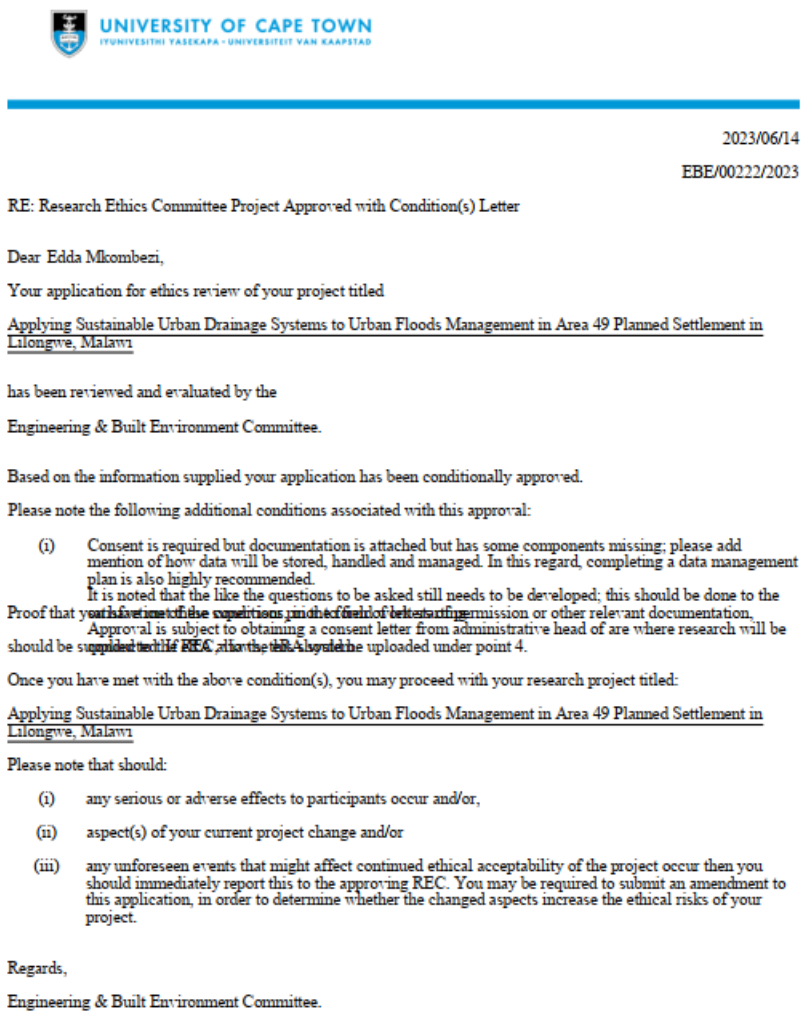
Signature and designation (interviewee) Signature of student

Appendix 2: Approved Research Ethics Clearance



UNIVERSITY OF CAPE TOWN
IYUNIVESITHI YASEKAPA • UNIVERSITEIT VAN KAAPSTAD

2023/06/14

EBE/00222/2023

RE: Research Ethics Committee Project Approved with Condition(s) Letter

Dear Edda Mkombezi,

Your application for ethics review of your project titled

Applying Sustainable Urban Drainage Systems to Urban Floods Management in Area 49 Planned Settlement in Lilongwe, Malawi

has been reviewed and evaluated by the

Engineering & Built Environment Committee.

Based on the information supplied your application has been conditionally approved.

Please note the following additional conditions associated with this approval:

(i) Consent is required but documentation is attached but has some components missing; please add mention of how data will be stored, handled and managed. In this regard, completing a data management plan is also highly recommended.
It is noted that the like the questions to be asked still needs to be developed; this should be done to the
Proof that you have met the conditions, including letters of permission or other relevant documentation,
Approval is subject to obtaining a consent letter from administrative head of are where research will be
should be supplied to the REC, after the RA has been uploaded under point 4.

Once you have met with the above condition(s), you may proceed with your research project titled:

Applying Sustainable Urban Drainage Systems to Urban Floods Management in Area 49 Planned Settlement in Lilongwe, Malawi

Please note that should:

(i) any serious or adverse effects to participants occur and/or,

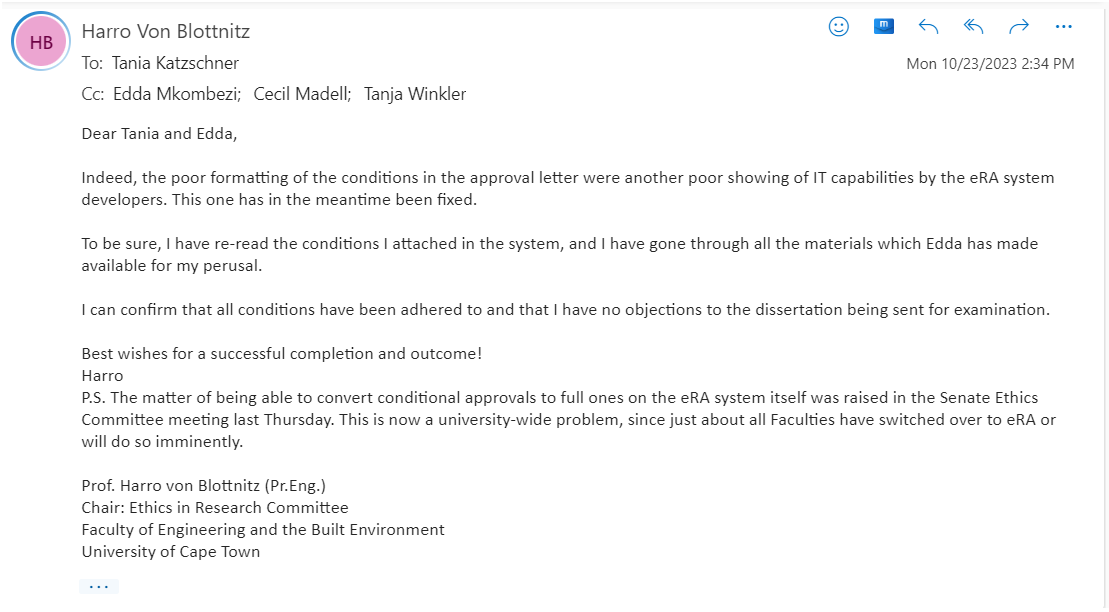
(ii) aspect(s) of your current project change and/or

(iii) any unforeseen events that might affect continued ethical acceptability of the project occur then you should immediately report this to the approving REC. You may be required to submit an amendment to this application, in order to determine whether the changed aspects increase the ethical risks of your project.

Regards,

Engineering & Built Environment Committee.

In order to get a full ethics approval, the researcher had to revise the consent form therefore the one attached in Appendix 1 is a revised one. Attached below is also a copy of email from the Faculty of Built Environment Chair of Ethics, Harro Von Blottnitz giving a full approval of ethics because of the condition were met and are attached below.



Harro Von Blottnitz

To: Tania Katzschner

Mon 10/23/2023 2:34 PM

Cc: Edda Mkombezi; Cecil Madell; Tanja Winkler

Dear Tania and Edda,

Indeed, the poor formatting of the conditions in the approval letter were another poor showing of IT capabilities by the eRA system developers. This one has in the meantime been fixed.

To be sure, I have re-read the conditions I attached in the system, and I have gone through all the materials which Edda has made available for my perusal.

I can confirm that all conditions have been adhered to and that I have no objections to the dissertation being sent for examination.

Best wishes for a successful completion and outcome!
Harro
P.S. The matter of being able to convert conditional approvals to full ones on the eRA system itself was raised in the Senate Ethics Committee meeting last Thursday. This is now a university-wide problem, since just about all Faculties have switched over to eRA or will do so imminently.

Prof. Harro von Blottnitz (Pr.Eng.)
Chair: Ethics in Research Committee
Faculty of Engineering and the Built Environment
University of Cape Town

Attachment 1: Full approval of ethics

PLANNING AND DEVELOPMENT

Your Ref:

Our Ref: LCC/PLAN/ADMIN/3

LILONGWE CITY COUNCIL
P.O. Box 30396
Lilongwe, 3
MALAWI
Cell: +265 (0) 999 964225

13th July, 2023

Ms. Edda Olaheya Mkombezi
C/o School of Architecture
University of Cape Town
P/Bag X3, Rondebosch 7701
Cape Town.

Dear Madam,

APPLICATION FOR CLEARANCE TO COLLECT DATA IN LILONGWE CITY.

We refer to your letter on the above-named subject.

Please be kindly informed that we have no objection to your request to conduct a research towards your Master's dissertation. You may therefore interview relevant Officers as well as have access to relevant secondary data and information that we may have.

We wish you all the best in your studies and please share the results of your research with us.

Yours Faithfully,

Dr. Macloud D.A. Kadam'manja
CHIEF EXECUTIVE OFFICER.

Attachment 2: Clearance letter to collect data in Lilongwe City

SCHOOL OF ARCHITECTURE, PLANNING AND GEOMATICS

University of Cape Town
Private Bag x3, Rondebosch 7701
Centlivres Building
Email: Janine.Meyer@uct.ac.za Tel: 27 21 6502359

UNIVERSITY OF CAPE TOWN
Contact Details: mkombeziedda@gmail.com, +27656098416, +265882194462

Date: July, 2023

QUESTIONS TO OFFICERS AT LILONGWE CITY COUNCIL

My name is **Edda Olaheya Mkombezi** and I am studying City and Regional planning at the University of Cape Town. I am doing research **on Applying Sustainable Urban Drainage Systems to Urban Flood Management in Area 49 Planned Settlement in Lilongwe, Malawi**. As part of my master's dissertation, I would like to ask you some questions to help me with my research. I will only ask you a few questions regarding your understanding and experiences of Sustainable Urban Drainage Systems.

Questions

i. Are you familiar with Sustainable Urban Drainage Systems (SUDS)?
ii. Does LCC have any specific plans to introduce SUDS in the city and Area 49?
iii. How do you think SUDS can improve water management and the general natural environment of Area 49 in Lilongwe?
iv. Do the existing policies (LCC Urban Structure Plan (2014), Lilongwe City Development Guidelines and Standards (2014) and Drainage Master Plan (2023)) incorporate SUDS?
v. How do the policies work? Which one is the main one? What is the implementation structure of the existing policies?
vi. If not, what can be done at this level to effectively adopt SUDS into the existing planning frameworks to suit the locational and context-specific knowledge of Area 49 regarding spatial planning and water management?
vii. How sustainable, helpful, viable and successful are the existing responses to flood disasters in the city?
viii. Does your department have specific frameworks that deal with disaster management such as floods and droughts?
ix. Do the existing disaster management frameworks align with the planning frameworks or how best can they be aligned?
x. How coordinated are the disaster management efforts at the city council level in terms of governance, knowledge systems and water management?

Attachment 3: Questions to Officers at LCC