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TOWARDS AN ARCHITECTURE THAT FACILITATES AN ALTERNATIVE URBAN AGRICULTURE WITHIN THE CITY OF DURBAN

A proposed mix use urban agricultural food production and research centre

By

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DECLARATION

I hereby declare that this dissertation is my own unaided work except where it has been otherwise acknowledged. It is being submitted to the School of the Built Environment and Development Studies, University of KwaZulu-Natal, Howard College campus, in partial fulfillment of the requirements towards the degree of Master of Architecture. This dissertation has not been submitted before for any degree or examination at any other university.

Signed September 2020

Sinegugu Maphanga

DEDICATION

This document is dedicated to my family my two mothers Zimbili and Makhosazane Maphanga and sisters, Langelihle, Nobuhle and Zanenhlanhla without your love and support none of this would have been possible, to my late grandmother Lefilina Maphanga I know throughout this process you were in heaven looking down on me and guiding me and I miss you every day.

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And finally, to everyone who has been my support structure and has contributed to this dissertation I thank you from the bottom of my heart.

ABSTRACT

It is estimated that more than half of the world's population currently lives in urban areas. As the urban population increases, numerous challenges have been documented with this rapid urban growth. For the urban poor who are in search of a better life these problems are compounded with other numerous disadvantages such as under- and unemployment, resulting in food insecurity. Food is regarded as a basic human right. In order for people to be regarded as food secure, all people should at all times have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences in order to have an active and healthy life. Historically, literature has predominantly positioned urban agriculture as a livelihood strategy in order to deal with these challenges. However, the growing interest in urban agriculture has recently moved beyond focusing on the urban poor, resulting in researchers discovering that in light of numerous global challenges, urban agriculture can also provide economic and environmental benefits. Thus, urban agriculture is not just seen as being a coping strategy for the urban poor but has also been documented to provide ecological benefits for the environment.

Bringing urban dwellers closer to the food they consume, to decease transportation costs and CO2 emissions has contributed to alternatives means of horticulture food production methods within urban areas. The concept of growing vegetation has no longer been perceived as an activity restricted for rural land. Further, the incorporation of green roof and indoor growing is no longer seen as an afterthought or a concept for the distant future, but rather a sustainable consideration for current urban environments. Underutilised and dilapidated buildings are now being viewed as opportunities for alternative sustainable uses. Between the needs of the growing urban population and the underutilised urban buildings, the research was undertaken to bridge the gap between these two urban problems. The research aims to explore unconventional ways of bringing alternative urban agriculture to the city, through the facilitation of the built environment. This enhances an already existing agricultural practice that can be beneficial to communities as tools of upliftment and for increasing food security.

To achieve this, the research investigates the concepts around urban agriculture as well as theories around enhancing the urban and built environment. The literature will further elaborate on the theoretical and conceptual framework. Investigating practical implementation strategies and technologies which can be used to bridge the gap between the built environment and horticulture food production, which is illustrated through precedent and case studies. Qualitative interviews were conducted with professionals who are involved in urban agricultural research or who have actively implemented urban agriculture to make sure that the analyses and the conclusions based on those

analyses were accurate. All the research findings determined the context and the site selection, which was then used to adapt into a building proposal within South Africa.

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Chapter 1

1.0 Introduction

History shows that most cities around the world have been planned around transportation, housing, recreational, mining, and sanitation needs. Surrounding rural land, on the other hand, was commonly designated to the growing and production of food, which would then be transported to the city (Steel 2006:79). There is an increasing number of people migrating to urban areas, thus resulting in the rapidly growing informal settlement inhabited by the urban poor, which target and covers urban greenspaces (United Nations Habitat 2005:4). Food consumption is evolving, and with it, its supply processes, suggesting that more food will have to be available to people who live in an environment that has traditionally been perceived as inappropriate for agriculture (Szabo 2016:30).

Globally, food production increases in the 20th century was attributed to higher yields per hectare as well as increases in the use of fossil fuels, which required various steps in the food production process (Verma 2015). In modern industrial agriculture, fossil fuels were used directly in the growing of crops. Indirectly it was used through the use of farm machinery and the production of fertilizers, as well as in the energy used to transport and process food (Verma 2015). With the global population forecasted to be 9.6 billion by 2050 as speculated by the 2013 United Nations report (United Nation 2013)., Verma (2015) stated that demand for food is forecast to increase significantly, with estimates that net global food production needs to be increased by 60–70 % by 2050. Households with insufficient income as well as food price hikes, link urban food systems to poverty and vulnerability, resulting in food insecurity. This can impact social well-being, health, nutrition (Brown 2014:11).

Land availability is decreasing while the population growth is increasing, thus there needs to be an alternative approach to achieve the expected increase in food availability and decreases in land availability for future global food security Verma (2015). According to Richard and Forman (2014), the density of buildings and ecological planning that arranges people's primary needs in proximity such as mixed-use buildings. Is crucial in creating a city in balance with the resources of its urban region. Ecological and sustainable strategies such as food planted inside underutilized buildings, growing in artificial or natural light, green walls, and urban greenhouses are becoming vital approaches to transforming cities to more sustainable and efficient consumers (Graham 2009:7).

According to Bell (2018:8) the field of urban agriculture has shifted far beyond a description of food production but has also shifted to a role of creating spaces for community empowerment and resilience. Through livelihood and social capital, it constitutes an alternative farming, illustrating other means in which an economy can function.

Allowing for urban agriculture on rooftops, within abandoned buildings and interiors of the built environment repurposes lost spaces for strategies such as food production. It gives residents access to locally grown produce that would otherwise have been imported from far away distances. Therefore, making vegetation a primary need as important as the built environment. Creating an ecosystem between building, nature, and a primary human need.

1.1 Motivation / Justification of Study

> 'Today cities fail to meet even the minimum standards of self-reliance. No city lives within its own means. Everything consumed is produced outside the city, and as a result, waste accumulates at an alarming rate'. (Despommier 2010:9).

A post-apartheid political dispensation has provided a new climate in which to reconsider the relationship between farming and South Africa's fragile ecologies (Mather1996). Today there is an urgent need for sustainable agricultural technologies and practices that do not have adverse effects on the environment. Across developed and developing cities, unused surfaces such as rooftops, abandoned buildings, vacant building interiors and unused plots of land indicate that there is a plethora of vacant spaces in the urban area, which present different opportunities for the built environment to incorporate different uses.

This dissertation sets out to investigate how underutilised urban buildings, pose great potential for adaptive reuse, as a strategy for alternative urban agriculture, Which could be achieved by reducing the footprint traditionally used for urban agricultural practices. As the world moves towards decarbonisation, energy prices are set to increase, which will have a negative impact on the cost of production and price of food (Verma 2015). Communities dealing with food security issues caused by high food prices and the use of fossil fuels for food production will be affected in a negative way.

1.2 Definition of the problem aims and objectives

The aim of this research was to explore unconventional ways of bringing alternative urban agriculture to the city through the facilitation of the built environment. The research unpacked whether enhancing the already existing agricultural practices beneficial to communities, could be used as tools of upliftment and increase food security.

1.2.1 Aims and Objectives

Firstly, the research intended explore how the use of the built environment within the city could create a social atmosphere that attracts, provides, and educates people on natural plant-based agriculture and food production.

Secondly, the researcher attempted to determine how the indoor-outdoor environment could incorporate growing plants for food production in a sustainable manner.

Finally, the research investigated sustainable ways in which the built environment could be used as a tool to facilitate indoor food production, as well as explored the benefits of growing produce in controlled indoor environments.

1.3 Setting Out the Scope

1.3.1 Delimitation of Research Problem

The study investigated various aspects that pertain to the facilitation of a design within the built environment. A built environment that would best facilitate the growing needs of plant-based foods in controlled, densely populated urban environments. In order to assist in the alleviation of food insecurity issues particularly for the urban poor.Through the use of international precedent studies and local and international literature, the research investigated successful urban agricultural projects, specifically how new technologies and adaptive reuse strategies in built environment helped in achieving the growing of crops in limited urban spaces. The research focused purely on plant-based agriculture and not on livestock farming.

1.3.2 Definition of Terms

Biodiversity:

Biodiversity is the variety of all living things; the different plants, animals and micro-organisms, the genetic information they contain and the ecosystems they form. Biodiversity is usually explored at three levels - genetic diversity, species diversity and ecosystem diversity. These three levels work together to create the complexity of life on Earth (Australian Museum, n.d.).

Hydroponic:

Hydroponics is a method of growing plants a minimal use of soil. This technique instead uses a mineral nutrient solution in a water solvent, allowing the nutrient uptake process to be more efficient than when using i.e. soil (Maximum Yield, n.d.).

Ecology:

Ecology is the study of the relationships between plants, animals, people, and their environment, and the balances between these relationships (Collins Dictionary, n.d.).

Urbanisation:

Urbanisation refers to the growth of towns and cities, often at the expense of rural areas, as people move to urban centres predominantly in search of jobs (Manitoba Education, n.d.).

Globalisation:

Globalisation describes a process by which national and regional economies, societies and cultures have become integrated through global network of trade, communication, immigration and transportation (MrGeoWagg Wordpress, n.d).

Horticulture:

Horticulture is the science, technology, and business involved in intensive plant cultivation for human use. It is practiced from the individual level in a garden up to the activities of a multinational corporation. It is very diverse in its activities, incorporating plants for food (fruits, vegetables, mushrooms, culinary herbs) and non-food crops (flowers, trees and shrubs, turf-grass, hops, medicinal herbs). It also includes related services in plant conservation, landscape restoration, landscape and garden (Fandom n.d,).

Zero-Acreage Farming:

The incorporations of agriculture in urban buildings, including open rooftop farms, rooftop greenhouses and indoor farming exploiting synergies between buildings and agriculture also ‘referred to as ‘ZFarming’ (Thomaier *et al*. 2014).

PFAL – Plant Factory Artificial Lighting

Refers to a facility that is thermally insulated for plant production and is commonly an airtight building such as a warehouse (Kozai 2016:43).

1.3.3 Stating the assumption

Fresh vegetables make up an important component of diversified diets, improving dietary quality. Through alternative methods of unconventional farming using the built environments flat roofs, adaptive reuse of buildings, and enclosed controlled environment, crops within the city can be grown to accommodate an exceedingly growing urban population.

1.3.4 Hypothesis

Alternatives methods of agricultural food production within the city's urban built environment can assist in alleviating food security for a growing urban population.

1.3.5 Key Questions

What lessons can be learned regarding successful urban agricultural projects and how have new technologies within the built environment, as well as in agriculture, aid in achieving the growing of crops in limited urban spaces?

1.3.5.1 Sub Questions

1) How can adaptive reuse of buildings incorporate urban agriculture?

2) What are the social, economic and environmental benefits of urban vegetation and agriculture?

3) What ecological means can be adopted to create a sustainable built environment that caters for human needs?

4) How can South Africa analyse and learn from international precedent studies?

1.4 Theories and concepts

There are several interrelated concepts that inform urban agriculture and architecture. The research focused on the theories and concepts around urban ecology, urban regeneration, wellbeing, permaculture, rights to food as well as resilience. These concepts and theories are a means of bringing about a credible response to the outlined research problem of creating an interconnected urban space that encompasses a holistic approach to the urban life and humans needs.

Theories

1.4.1. Urban Ecology

Marzluff *et al*. (eds. 2008:vii) describes urban ecology as '…the study of ecosystems that include humans living in cities and urbanizing landscapes. It is an emerging, interdisciplinary field that aims to understand how human and ecological processes can coexist in human-dominated systems and help societies with their efforts to become more sustainable'. According to McIntyre, Knowles-Yánez, & Hope (2008) urban ecology started as a discipline that aimed at trying to understand cities as super organisms. At its early stages it primarily focused on human city dwellers, whereas today it continuously evolves (McIntyre *et al.* 2008). Urban ecology also considers urbanisation as both a social and an ecological phenomenon, therefore making urban ecology an interdisciplinary field (McIntyre *et al.* 2008).The American and European definition is used commonly in modern urban

ecology, because it encompasses both human as well as non-human city dwellers as driving forces in the ecological system.The concept and principles of urban ecology are relevant for alternative means of sustainable urban agriculture strategies for this proposed research, due to urban agriculture being an important ecological tool that can be used for this very purpose (McIntyre *et al.* 2008).

1.4.2 Urban regeneration

The term urban regeneration has been referred to as different terms in various countries, from renewal, revitalization and even renaissance. According to Leary and McCarthy (eds. 2013), renewal has generally been used to define a physical response and regeneration or a holistic approach, yet both terms have been used interchangeably. Dominating world debates, the term regeneration has been a multi-disciplinary research field covering an array of disciplines such as community development, sustainability, urban design as well as city planning studies, due to its constituents to urban problems (eds. Leary& McCarthy 2013). In its holistic approach the term regeneration has generally been an area focused intervention aimed at sustainable improvements for communities and local people suffering from various forms of deprivation (eds. Leary& McCarthy 2013).

In the 1960s, the debate around urban regeneration started changing (Couch, Sykes & Cocks 2013). Urban heritage and conservation became a high consideration, as opposed to previous decades where such concepts were a low priority. The French concept 'Secteur Sauvegardé' (safeguarded sector) was introduced by Loi Malraux in 1962 (Couch *et al*. 2013).In Britain, local authorities designated a conservation area for the preservation of architectural buildings for the regeneration process to be adapted to modern requirements in a sustainable way. Later on concerns for the environment and sustainable development without compromising future generations were added as part of the conversation around urban regeneration (Couch *et al*. 2013).

According to Couch *et al*. (2013) in the historic, economic, social, and physical contexts, the urban regeneration experience in each country has varied. Stating that there were numerous similarities in the solutions each country chose for the problems faced by their cities, which can be implemented for the urban regeneration process (Couch *et al*. 2013). The first aimed at achieving compact sustainable forms and the other aimed at neighborhood renewal focused at the physical as well as social environments.

Concepts

1.4.3 Well being

Conceptually, as well as a form of measurement for human circumstances, well-being emerged as a response to the insufficiencies of mostly income examinations of impoverishment (Agarwala *et al*. 2014). Its publication is said to be embedded in the Human Development Index (HDI), which incorporates standards of living, education as well as different measures of health as a means of establishing holistic evaluations of the human condition (Agarwala *et al*. 2014. The idea is said to be powerful in that it has moved beyond traditional economics towards being a unifying concept (Agarwala *et al*. 2014).. Its broadened scope has brought about different considerations that go beyond consumption, income or poverty (Agarwala *et al*. 2014).

1.4.4 Resilience

According to Walker & Salt (2006) resilience thinking is about 'understanding and engaging with a changing world. Understanding how and why the system as a whole is changing, better placing it to build a capacity to work with change, as opposed to being a victim of it' (Walker & Salt 2006:14). White (2018) recommended the concepts of vulnerability, resilience and adaptation to bring about focus on the various and unpredictable socio-ecological interactions that make up urban food systems. In order to move beyond the conceptual equation that producing food equals greater food security. Through this lens of resilience, urban agriculture can then be seen an adaptive management means that deals with uncertainties, by bringing about diverse sources of food and increasing numbers of food sources to the city.

The concept has been linked to other factors such as strategic planning, climate adaptation, and regional economic development (eds. Brunetta, Caldarice, Tollin, Rosas-Casals, & Morató 2019). In terms of spatial planning, the concept acknowledges various forms of risks that are interconnected (eds. Brunetta *et al* 2019).Implementation of adaptive planning can become useful in managing and responding to risks caused by nature if location of such risks are known (eds. Brunetta *et al* 2019). The concept of resilience has been applied in many fields for its capacity to deal with complicated and volatile issues (Hosseinioon 2019.. Climate change has become a huge agenda globally, with researchers asking how it will affect cities and surrounding areas. For Barrico and Castro (2019) this has brought about concerns in the modification of weather patterns, increasing the vulnerability in these regions and communities.

1.4.5 Rights to Food

One of the obstinate shortcomings of the world's inability to sustain improved livelihoods, according to editors Lobell and Burke (eds. 2010), is the estimated billions of people in the world who have been said to live their lives in chronic hunger. Global improvements were made in the second half of the 20th century which brought about positive change in some developing countries, yet in others negative change has been recorded (eds. Lobell & Burke 2010). The concept of food security is documented as a complex product of social and natural systems. Effects of climate change, resulting in low agricultural yields, low rural income as well as low economic progresses, have affected the poor more significantly (eds. Lobell & Burke 2010). This concept identifies the shortcoming and challenges faced by humanity regarding food shortages, as well as the role urban environments can play in alleviating limited access to food especially among the urban poor (eds. Lobell & Burke 2010).

1.4.6 Permaculture

> ''Consciously designed landscapes which mimic the patterns and relationships found in nature, while yielding an abundance of food, fibre and energy for provision of local needs.' People, their buildings and the ways they organise themselves are central to Permaculture' (Holmgren 2002: xix).

Permaculture is a concept based on observing and learning from nature (Lockyer & Veteto 2013), It uses findings based on modern science, as well as lessons obtained from traditional knowledge for incorporation into global environments. According to Lockyer and Veteto (2013), the concept is regarded as a holistic approach to design, as it embodies a philosophy of positive environmental outcomes as well as grassroot teachings. Permaculture aims to give control over to communities by encouraging them to take ownership of their environment. Although permacultures roots stem from growing vegetables, its principles are used in design approaches in order to improve the built environment's relationship with nature and people (Morrow 2014). These principles aim to support local people by implementing waste management, reducing non-renewable energy, as well as through encouraging the design of buildings that use and produce renewable, energy (Morrow 2014).

By centralising sustainability in its approach towards water, shelter and food for individuals, permaculture aims to achieve sustainable livelihoods for various communities (Lockyer & Veteto 2013). The intentions of permaculture design are to have its principles work for the three elements: processes, people, as well as the built environment. The success of its implantation as a concept lies its sustainability, as well as how well it has contributed to society (Lockyer & Veteto 2013).

1.5. Research Methods and Materials

1.5.1 Research Methods

According to Kothari (2004), research is an original contribution to the existing stock of knowledge making for its advancement. It is the pursuit of truth with the help of study, observation, comparison and experiment (Kothari (2004:1). Research methods involve data collection, analysis, and interpretation that the researcher proposes for their studies. Shown in Table 1. (Creswell 2003). The researcher may adopt a quantitative, qualitative or mixed methods approach to collecting data. Creswell describes the 3 the different approaches as follows.

Quantitative Research Methods	**Qualitative Research Methods**	**Mixed Methods**
Predetermined instruments-based questions. Performance data, attitude data, observational data and census data. Statistical analysis.	Emerging methods. Open-ended questions. Interview data. Observation data. Document data. Audio-visual data. Text and image analysis.	Both predetermined and emerging methods. Both open and closed ended questions. Multiple forms of data drawing on possibilities. Statistical and text analysis.

Table 1 Quantitative, qualitative and mixed-methods procedures (Creswell 2003).

This research was qualitative in nature.

Qualitative research is a means for exploring and understanding the meaning individuals or groups of people ascribe to in a social or human problem. The process of research involves emerging questions and procedures, data analysis and the researcher making interpretations of the meaning of the data. The researcher engaged in this form of inquiry as it supported a way of looking at research that honours an inductive style, and the importance of rendering the complexity of a situation (Creswell 2007:4). Qualitative interviews provided the researcher with first hand engagement with individuals who have had exposure and understanding around the research problem.

1.5.2 Research Material

The research proposal used a qualitative research method approach in order to collate both primary and secondary information. The secondary research involved an extensive literature review of an existing body of knowledge in the form of books, which informed the researcher on theoretical and historical information around the research as well as precedent studies. Additionally, the author used journals and books in order to obtain recent knowledge on the discussions relating to the research topic, as well as electronic resources namely eBooks, internet articles and e-journals. These sources were used in order

to obtain knowledge which was not available in printed hardcopy. These forms of literature also provided a framework for the analyses of the case studies, as well as precedent studies.

The primary research involved the utilisation of the Durban CBD as a case study, which formed the location of the final research design. The case study was used as an existing, real-life, primary data study. It involved site visits and engagement with the building usages and spaces relevant to the research through first hand, written and photographic analysis by the author. Analysing various aspects of how the built environment can facilitate urban agriculture within the built environment. Observation was used as a means of critically analysing the case study sites. Specialist interviews were conducted with the Council for Scientific and Industrial Research as well as with The Green Camp Gallery Organization. Once the primary (empirical) and secondary (non-empirical) information had been observed and analysed, the data sources were then be combined and synthesised with the intention of informing the design process.

1.5.3 Case Study Description

The case study within this dissertation primarily focused on an existing urban agricultural project, which used adaptive reuse strategies to incorporate urban agriculture. The case study was located within South Africa in the city of Durban. This case study demonstrated how cities are actively providing strategies for food security and livelihoods for city dwellers. The case study analysed a catalyst private project that has started the urban regeneration processes of using buildings as multifunctional spaces for urban agriculture within the city's urban landscape as alternative methods of urban agriculture to the city centre.

Chapter 2

2.0 Literature Review

2.1 Introduction

For the purpose of this research the literature review was used to inform and gather literature on the research problem in order to find solutions. Published books, journals, internet resources and past dissertations were sourced to gather the literature. The structure of the review is interrelated to the key questions and sub questions that have also been informed by the theories and concepts.

Theories

2.2 Urban ecology

According to Richter and Weiland (2012) research on urban ecology began in the 16th century in Europe through the observation of nature in cities. Richter and Weiland (2012) stated that traditionally urban ecology included urban soil science, vegetation science and urban climatology. Today it is characterised as interdisciplinary due to its interface with social sciences, natural science engineering, and humanities (Richter & Weiland 2012) According to Spirn (2011), urban ecology is critical to the future of the city and its design as it provides a framework for addressing challenges that threaten humanity. These challenges include global warming, rising sea levels, declining oil reserves, rising energy demands, and environmental justice.

Niemelä *et al.* (2011) found that urban ecology is about understanding the relationships between social structures and vegetation in urban areas in order to support the development of sustainable management plans in urban open spaces. Adding that vegetation is as important as the built environment in defining the character of a city (Niemelä *et al.* 2011). For most urban residents, vegetation is usually part of the backdrop in urban settings rather than an integral and dynamic component (Niemelä *et al*. 2011).

2.2.1 Urban Ecology and Adaptation

> 'No ecosystem can exceed the limits of its biomass production, which is strictly regulated by the total biomass production, which is strictly regulated by the total amount of incoming energy, period. In years of high productivity, energy is used to its maximum efficiency, and in lean years, largely regulated by fluctuation in weather patterns, the result is lower bio productivity. Nature adjusts to a varying supply of calories. Cities do not follow this rule of nature, and therein lies the problem' (Despommier 2010:19*).*

Organisms have been known to modify their environments; the same is true for humans. Vitousek, Mooney, Lubchenco and Melillo (2008:3) found that no ecosystem is free from human influence,

pervasion or domination, specifically because humans directly dominate numerous ecosystems such as fishing, industry and agriculture. Worldwide cities offer attractive living environments for a large population, yet humans, as users and sources of disturbance in urban nature, play a key role in altering those urban environments (Richter & Weiland 2012).

The most documented signal of modern-day human alteration has been the increases in carbon dioxide (CO_2), which has been driven by fossil fuel combustion (Vitousek *et al.* 2008). Human caused global alteration and dominance mean humans cannot escape the responsibility of managing the planet due to the change's humans are making to the earth's ecosystems (Vitousek *et al.* 2008). Cilliers and Siebert (2012) stated that social well-being and mental and physical health affects urban areas. Health problems in urban settlements can be related to the proximity of living spaces to waste dumps industrial areas, overcrowding, as well as lack of access to food production and livelihood. Cilliers and Siebert (2012) further argued that the ecological problems of the urban environment can only be understood and resolved if the human problems within societies are dealt with.

2.2.2 Formation of new urban ecosystems

''To emulate the behaviour of an ecosystem means to live within our means with regards to recycling energy, water, and food, and in dealing in a realistic and responsible fashion with population'' (Despommier 2010).

Wu *et al*. (2012) described both natural and human activities as varying according to location and urban landscapes, this special heterogeneity is deemed profound in cities then in other ecosystems. In these urban environment's humans decide where and what to plant in relation to vegetation (Wu *et al*. 2012). These human activities are leading to significant losses of biodiversity (McIntyre *et al*. 2008). The geographic scale examples that occur in urban modification according to Vitousek *et al.* (2008:3) include replacing natural surfaces (grass, soil and trees) with urban surfaces (concrete, bricks, glass and metals) at various levels above the ground. Niemelä *et al.* (2011) added that these urban alterations are also seen when urban vegetation is replaced and covered by buildings as well as paved surfaces, decreasing the former surface while a new material is introduced. Therefore, a new environment is created as well as a new ecological environment (Niemelä *et al.* 2011).

These new materials that are introduced to natures' surfaces during the construction of new buildings are artificial and foreign to nature, and have been known to cause change, such as heat exchange, on the earth's surfaces. Both gaseous and solid pollutants are emitted due to the altered composition of the atmosphere, thus heat islands begin to form causing traps for the pollutants (Vitousek *et al*. 2008) . According to Nikolopoulou (2012) the most disruptive process in urban ecology is land

development, due to its alteration of natural energy and material cycle. Nikolopoulou (2012:117) regarded these urban environments as living laboratories and further stated that small- and large-scale interventions need to be used in order to improve environmental conditions, suggesting outdoor thermal comfort to mitigate climate change.

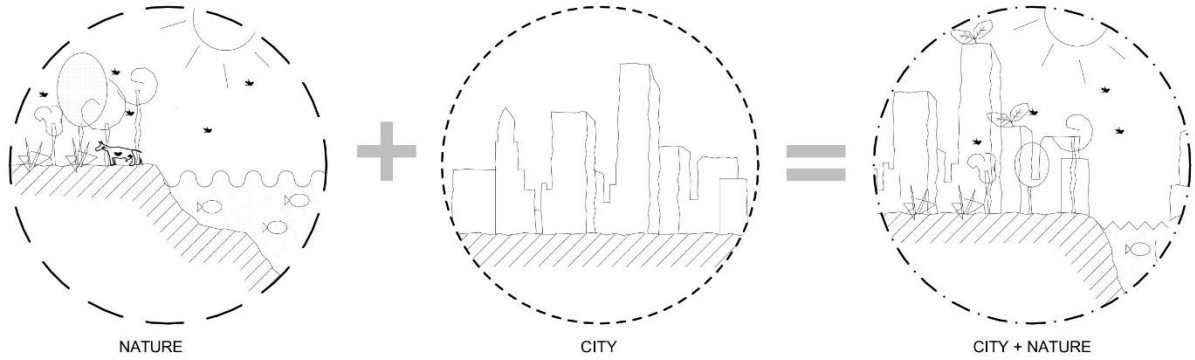


Figure 1 Diagram illustrating how nature should be part of the city for better development and quality of life for humans. Source: Author

Endlicher *et al*. (eds. 2011) stated that urban ecosystems offer a greater quality of cultural and social order functions, therefore social and economic aspects are of greater importance. Spirn (2011) contended that the city must be recognised as part of nature and designed accordingly. The city, suburbs, and surrounding countryside must be viewed as a single, evolving system within nature, as must every individual park and building within that larger whole. Endlicher *et al.* (eds. 2011) agreed that the main objective and goal in the researching of urban ecology is to ascertain solutions for better development and quality of life for humans. Endlicher *et* al.'s (eds. 2011) assertion is in line with Wu (2012) in that the ultimate goal of urban ecology is to help achieve urban sustainability. This requires that urban ecological studies not only investigate the ecology of cities but also the sustainability of cities; not only research cities in theory but also shape them in action (Wu, *et al*., 2012:47).

2.2.3 Nature and Human influence on building Ecology

''buildings that make oxygen, sequester carbon, fix nitrogen, distil water, provide habitat for thousands of species, accrue solar energy as fuel, build soil, create microclimate, change with the seasons and are beautiful – just like a tree'' (McDonough, Braungart, 2003).

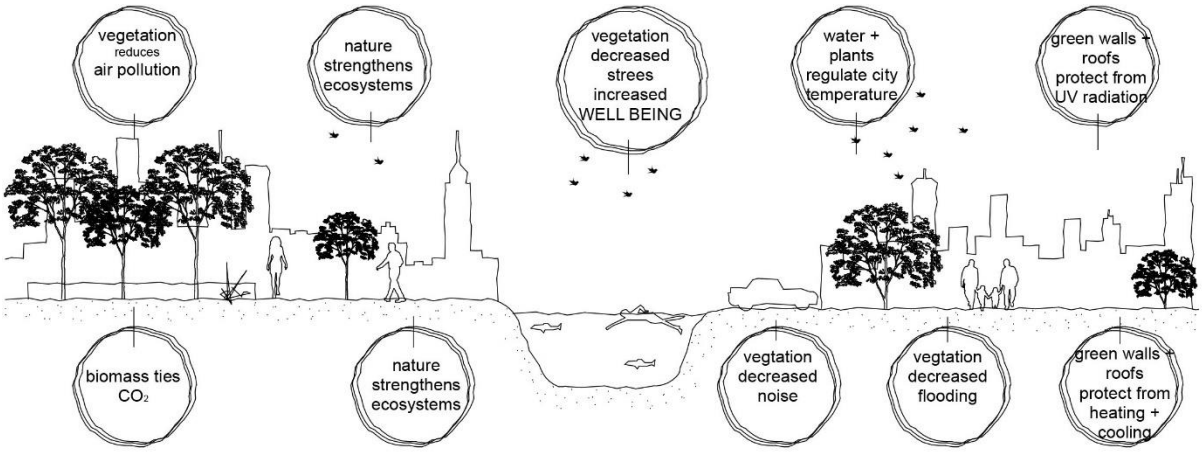


Figure 2 Diagram illustrating the benefits nature has for the urban environment. Source: Author

Graham (2013:1) stated that ‘‘building Ecology presents approaches to gaining knowledge about the environmental influences of building in a holistic framework’’. In the opinion of Caplan (2016), human ecological architecture is inherently contextual. This is due to the design process of addressing people and their environment, therefore making the relationship between these two factors reciprocal to one another due to each element influencing the other. The physical and cognitive interaction between the built environment and natural environment is evident in the physical and human interfaces. The built environment creates spaces which enable inhabitability and these spaces affect the natural environment and community well-being.

> *Buildings and their infrastructure constitute the built environment. We construct them for human benefit – to serve people. Symbioses with the natural environment are essential to their long-term success* (Caplan 2016).

The human need for shelter and protection from the natural world, along with the environment that is built, can become competing realities (Caplan 2016). In regard to human ecology, the infrastructure to achieve this through the built environment requires spaces that are beneficial to the human well-being. Graham (2013) described applying a life cycle approach to the creation of buildings for human occupation. The author stated that buildings have to be resilient to environmental conditions yet should also be able to cater for the diversity of human needs (Graham 2013).

Graham (2013:7) posited that the built environment represents a complex, human-created systems that is interconnected with other human and non-human systems which have other complexities. According to White (2002), when pertaining to ecological design and construction the industrial revolution launched new materials to mitigate harm on the environment. When pertaining to the

concept of ‘green architecture’ it is categorised into ‘green light’ as well as deep green. According to Boschmann and Gabriel (2013:222) ‘light green’ falls under the commonly known global understanding which entails visual mechanisms and technology that demonstrates innovative technology, highly advanced insulation systems, state of the art heating systems, roof top photovoltaic solar panels and low energy lighting, to name a few.;

These approaches are conceptualised as eco-technic, which describes an approach that suggests that technology is the best way to solve environmental problems (Boschmann, Gabriel, 2013). Eco-technic further emphasises energy efficiency that adopts: quantitative measuring of outcomes and a universal approach to technology and design, while pushing a global vision, influencing a culture of new buildings which can be perceived as superior to reused structures (Boschmann, Gabriel, 2013:223). Due to its complex nature, Shelton (2007) identified this approach as non-robust architecture. Further, the author described it as narrow indicator for performance despite its ability to achieve a variable level, which can reach higher levels in some instances (Shelton 2007).

Boschmann and Gabriel (2013 categorised ‘deep green’ as a concept that puts low technology on the forefront placing regional characteristics as its main approach to sustainability. Instead of constructing green outcomes through new buildings and technology, this concept aims to design for and around local conditions, thus incorporating knowledge from past generation building methods. This is achieved through the conservation of existing buildings, adapting them to new natural systems that meet lighting, cooling and heating needs (Boschmann &Gabriel, 2013) This concept views the local, natural world as fragile, while having an interdependence between living and non-living things. It further views the concept of sustainable architecture as an approach that should promote harmony with nature, while reducing its ecological footprint and limiting its interference with nature to ensure the protection of biodiversity. Boschmann and Gabriel (2013) stated that the ‘deep green’ concept should most importantly embrace the concept of place. Its construction should also be informed by cultural values, its people and community, and by the characteristics of its region. In order to make use of local materials to create an appropriate design for its regional climate, this idea advocates for adaptive reuse, suggesting that buildings can be adapted to suit new environments while still being sensitive to the building history and character (Boschmann &Gabriel 2013).

Caplan (2016:1) states the built environment, is an integral part of human ecology, alters our living environment in material and experiential ways, shaping the character of human experience, the physical, mental and economic wellbeing of individuals and the community at large. The concept of being ‘green’ has predominantly been an afterthought considering the impact the built environment

has on the overall environment and welfare (Caplan 2016). However, today there is a design consciousness to fulfill living green in the present day and for the future.

It is clear that under the banner of ecology, which included urban, building and human ecology, the research finding reveal that sustainability can only be achieved through human behavior, due to humans being in control of the environments they occupy.. In urban ecology, green infrastructure has been promoted by different organisations and has been adopted by an increasing number of cities. Although urban ecology looks at incorporating green spaces into the built environment, focus has predominantly been in the incorporation and preservation of vegetation in open spaces therefore, highlighting its health, social and recreational benefits. The research finding provide conceptual guidelines for systematic approaches in urban agriculture, as opposed to merely providing examples of the incorporation of existing practices into the built form.

The rationale the researcher has for embracing and promoting urban ecology is underpinned in the benefits it has for the future of humanity. The ideas that come with urban ecology can be adapted to behaviour and settlements in order to meet the challenges faced by city dwellers. For the built environment, human and building ecology looks at the environment created by the built environment and how these environments can affect the overall human experience. It further emphasises the importance of sustainability in order to achieve better living conditions that cater for people's livelihoods. Providing a framework that deals with conditions that are vital for the wellbeing of human occupation. It provides suggestion for building materials as well as efficient energy use as well as guides on how humans can create spaces for the future and not just for the present. Embracing the idea of reuse and adapting existing built environment into new living conditions.

2.3 Urban regeneration

Cities are constantly undergoing change and they are constantly adjusting to new circumstances (eds. Couch, Fraser & Percy 2003). Thus, cities are never static, having evolved to becoming more than just centers of manufacturing and production, but to centers of consumption (Couch *et al*. 2003). Couch (1990:115) stated that in the building and rebuilding of cities, a process of urban design has always been implied. Historically, this process has periodically been conscious, grandiose and comprehensive. Most towns and cities throughout history have followed this organic growth pattern. Frequently, the functional and aesthetic results of this organic process have justified few design criticisms, until these places have been overwhelmed by sudden accelerations in the rate of urbanisation or the intrusion of non-local materials, building methods or investors without local awareness or sympathy (Couch1990:115).

Couch *et al.* (2003) described the role of regeneration as being concerned with the re-growth of economic activity where such economic activity has been lost. Regeneration further occurs where the environmental and ecological quality and balance has ceased (Couch *et al*. 2003). In order to enhance the quality of life of a community, the shaping of attractive and unattractive urban buildings and spaces through renovation that is centred on sustainable urban regeneration is crucial. For this to occur, a plan should be put in place for future visions in urban spaces (Horita, Koizuma, Manabe, Sugisaki, & Nagayama 2009). In the decision-making process, consultation is important for market research during the planning phase. The process allows all parties involved to set out objectives as well identify the key problems in order to establish the perceptions of all the relevant actors that would will be affected in the urban regeneration process (Couch, 1990).

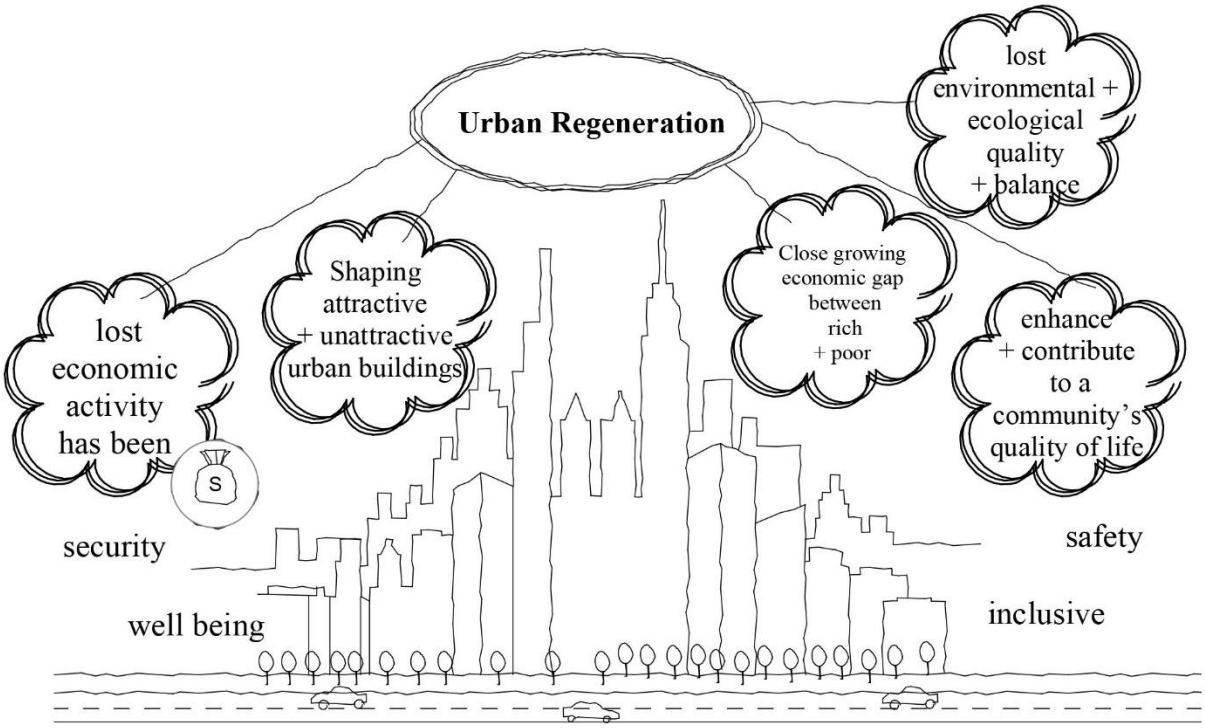


Figure 3 Diagram illustrating some of the urban problems that urban regeneration focuses on, to create better urban communities. Source: Author' interpretation

A plan has to be implemented in order to deal with the issues affecting specific areas. These plans should include the preservation, repair and reconstruction of the built environment, as well as recreational spaces and pedestrian friendly open spaces for communities (Horita *et al*. 2009). In order for these to be tackled, a great deal of planning by various actors is fundamental for both the betterment of communities and for their inclusion in the process (Ditto 2009). In this way, communities can weigh in on the relative importance and severity of different problems, thus ensuring that appropriate priorities and solutions may be devised (Couch 1990). During the stage of policy formulation, it may again be necessary to seek specialized information and expert assistance in the analysis of situations and issues (Couch 1990).According to Kubisch and Stone (2001) the growing

economic gap between the rich and the poor has been due to the social devastation that has occurred in global urban areas, as well as the lack of social capital. Social capital aims to promote and maintain the overall health of all community members in order to build inclusive communities where everyone benefits not just the wealthy (Kubisch, Stone, 2001).

In the 1980s in Europe, the focus on regeneration projects was primarily centered on the economic and physical aspects of renewal in degraded inner-city areas. This focus was later overtaken by a more integrated approach to urban redevelopment in the 1990s (Colantonio & Dixon 2011). The new approach to regeneration involved linking the rising level of environmental improvements and economic activities to wider cultural and social elements. (Colantonio & Dixon 2011).

According to Colantonio and Dixon (2011), if regeneration is unsustainable then it must have an alternative approach, which could include addressing issues of unemployment. Reduce crime rates and enhance education. Transform the urban fabric through infrastructure provision by redeveloping abandoned, derelict buildings and land as well as improve housing. Colantonio and Dixon (2011) further posited that in order for the regeneration process to be successful the following actions should be taken: First, the strengths and weaknesses of a city, community or area should be identified; second, realistic goals should be formulated, and; third, one should ensure that the citizens are empowered through social and corporate responsibility.

2.3.1 Urban Regeneration in South Africa

In the context of post-apartheid South Africa, the transition from apartheid to post-apartheid brought about the urban regeneration process, with the aim of providing improved economic growth and socio-economic transformation (Houghton 2009). The regeneration efforts in South Africa have been primarily aimed at breaking down spatial segregation in order to create urban spaces that are more functional for all citizens (Grest 2002). However, South Africa still faces major concerns pertaining to the strengthening of the urban economy, high poverty rates and chronic unemployment. These concerns have an iterative impact on the livelihoods of South African citizens, and thus food security of the nation as a whole.

Oaña (2009) asserted that urban interventions should be rooted in continuous bottom up approach by incorporating local participation by the affected communities. The bottoms up approach along with stakeholder engagement will then bring about success in the urban regeneration process Oaña (2009). In Oaña (2009) experience this type of approach showed that the more engaged the community the more sustainable the project became. By having the community's involvement in the infant stages of

planning as well as having a visions for the future, this allows for communities to share their inputs and offer their local resources to make the regeneration process a success

Due to spatial geography of urban apartheid, Donaldson *et. al.* (2013) noted that the historically neglected urban spaces of apartheid are still being neglected in post-apartheid South Africa. In 1994, the first democratically elected South African government launched numerous economic strategies targeting areas with the highest potential for growth. In 2001, the government launched the Urban Renewal Programme, an ABA which aimed to renew six key nodes over a space of ten years (Donaldson *et al*. 2013). The purpose of the programme was to address underdevelopment and poverty, which emphasised government planning and execution (Donaldson *et al*. 2013). The regeneration process has resulted in attention being focused on national level policy changes to overcome and address years of inequality and discrimination (Lund 2003). However, at the grass-roots level, many people have focused on reshaping their built space to cater for their needs in order to make a living for themselves (Lund 2003:2).

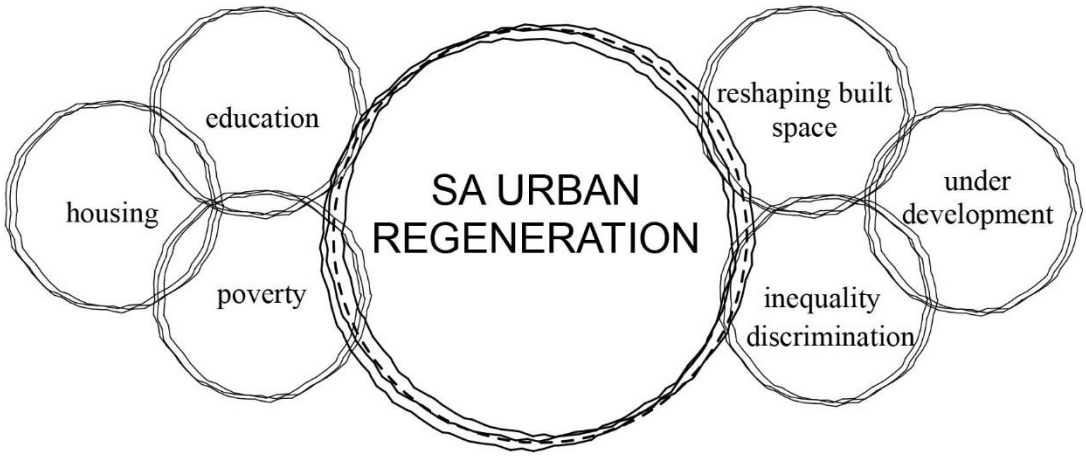


Figure 4 Diagram illustrating some of the key focuses for urban regeneration in South African as per the Urban Renewal Programme (ABA). Source: Author' interpretation

Due to the rise in engagement levels of European communities in the 20th century, the regeneration process had become qualitatively different (Donaldson *et al*. 2013). In the South African context, the ABA, which factored in geographical area interest groups and community stakeholder engagement, became a regeneration process that embraced economic, social and physical development. The ABA further cut across government responsibilities including, but not limited to: housing, education and economic development (Donaldson *et al*. 2013).

2.3.2 Urban Regeneration in eThekwini Warwick Triangle

The context of this research proposal is situated in the KwaZulu Natal Province, which has large unemployment and poverty rates, as well as a circular migration between rural and urban areas (Lund 2003. The location of the study is situated in the city Durban, which is the third largest city in South

Africa and is the economic engine of the province (Lund, 2003). Since the birth of democracy, the city's policy has included developing poor and rural areas and communities, with its informal employment estimated to include domestic work and work in subsistence agriculture (Lund, 2003).

The biggest regeneration effort in Durban has been the regeneration of Warwick Triangle (Grest 2002). The area incorporates three distinct areas: the Warwick Triangle, which is the old residential area; Grey Street and the cluster of streets branching off from the triangle, where there is more formal business, and; the main street trade and transport hub, which through the Project's life became known as Warwick Junction (Grest, 2002). The primary reason for choosing the Warwick Triangle was due to the areas being a high transportation node, carrying over 400 000 commuters into and out of the city. The area is known for its city market area, which has informal trade surrounding it, its proximity to the city centre, and for being one of the only areas which remained mixed during the apartheid era (Grest 2002). During apartheid the government's views on black, informal traders was repressive and harsh, with many restrictions (Grest 2002. The racial restrictions put constraints on the vibrant local market (Lund 2003). The projected White European city, which aimed to show progress and order, was preserved while the black people, who were mostly poor, were relegated to the periphery (Lund 2003). On the streets of the Durban city the traders were a small example of the part in which the white control of the urban space was illustrated (Lund 2003).

Historically, Warwick was known as one of the areas which had a mix of races during apartheid (Grest 2002). Due to its close proximity to the Durban city centre and the Indian spice markets, Warwick Triangle became a lucrative area for the working class from 1900-1939 (Lund 2003. Post-1994, the area offered new opportunities, leading to influx of informal traders, and thus challenges, into the area. With the increasing urbanisation of the area came an urgent need for urban regeneration. The goals for urban regeneration of the triangle focused on problem solving on all levels including four major aspects: safety for all those who use the space; increasing opportunities through trading and employment; the quality and cleanliness of the environment, and; diversifying the type of facilities and services available in the area (Grest 2002). The resource allocation and infrastructure for traders in Durban has been ahead of others within the province. With the 'New South Africa' came many promises of change and development, however, the result was a slow implementation process. This has been due to the energy and time required to bring about these changes from the time apartheid ended (Lund 2003).

A study conducted by Skinner (2000) found that, out of the four major South African cities (Johannesburg, Pretoria, Durban and Cape Town), Durban had established the best support from departments and had thus allocated more infrastructure to developing traders in the city (Skinner 2008). The urban regeneration process in Warwick, according to Grest (2002), illustrated the local

government's recognition of its citizens, creating a mutual understanding and interest through discussions and negotiations with its citizens. Couch (1990) noted such robust stakeholder engagement as a key process for urban regeneration.

The built environment's components of regeneration focus on providing facilities most needed by the people who use the spaces daily. The provision of trading facilities, particularly shelter for the traders, was an important element in the regeneration process (Skinner 2008). The derelict building which housed the fresh produce market, popularly known as the Early Morning Market, was renovated (Skinner 2008). In the 1990s the department market spent ZAR13 million renovating an old building which housed traders (Skinner 2008). A shelter with storage and ablution facilities, which accommodated 550 traders, was built to improve the working environment of traders (Skinner 2008). The regeneration process allowed informal traders the opportunity to continuously engage and negotiate their needs and priorities with the city councils. The interventions were made in close collaboration with 350 to 700 traders (Skinner 2008).

The urban regeneration of Warwick provides a framework that has worked in the context of its surroundings. In terms of urban agriculture and the built environment, the researchers design proposal will aim to further empower people within the city to better their livelihoods. To achieve this the researcher will create spaces for teaching the local community suitable ways to grow their own vegetation. Traders will therefore maximise their profits by cutting out the transpiration costs required to obtain fresh food produce from the farms. Within the built environment the underutilised buildings in the city provide opportunities for optimal utilisation decreasing abandoned spaces.

Concepts

2.4 Well-being

According to Atkinson, Fuller and Painter (eds. 2012 existing research for human wellbeing has been attributed to various factors such as: 1) employment, wealth and income; 2) health, social belong and education, and; 3) social order, leisure and recreation. According to McMichael and Scholes (2005) wellbeing for poor people is the minimum requirement for a good life. The authors further expressed the importance of an adequate livelihood that ensures people can provide for themselves as well as for their children (McMichael & Scholes 2005). According to Summers, Smith, Case and Linthurst (2012), the constituents for the wellbeing of humans is similar to those of Maslow's Hierarchy of Needs, with the first level being food, water, shelter. The following levels then constitute environmental needs, economic needs and subjective happiness. Figure 2 below depicts Maslow's original five stage model for the hierarchy of needs.

According to McLeod (2017:3) Maslow's original 5 stage model for the hierarchy of needs included:

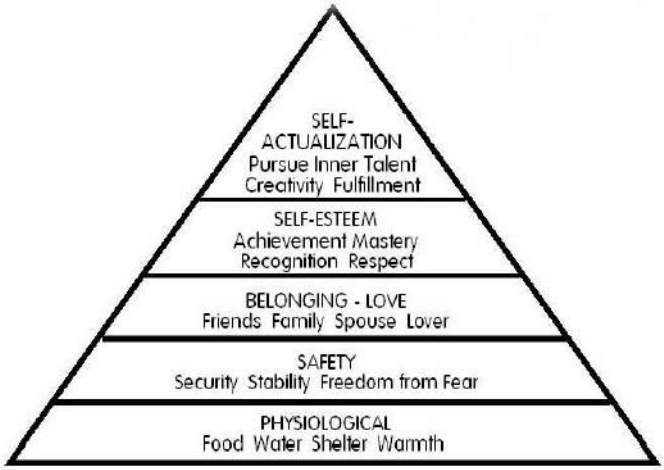


Figure 5 Maslows hierarchy of needs. Source: McLeod (2007:3)

Firstly; Biological and Physiological needs e.g. food, air, drink, shelter, sex, warmth, sleep. Secondly, Safety needs e.g. protection from elements, freedom from fear, order, security, law, limits, and stability. Thirdly social Needs; belonging, love and affection, from family, work group, romantic relationships, Friends. Fourthly Esteem needs e.g. self-respect, achievement, independence, mastery, independence, dominance, status, prestige, respect from others. Lastly Self-Actualization needs e.g. realizing personal potential, self-fulfilment, seeking personal growth and peak experiences.

The establishment of the Well-being in Developing Countries Research group (WeD) at the Bath University in the United Kingdom was to conceptualise a methodological framework for comprehending the cultural, as well as social well-being. In developing countries the research moved beyond income, poverty, and further established a combination between the resources an individual can obtain. Once in possession of those resources it became about what they were able to achieve with them, as well as what goals, including needs were they able to meet. Lastly What attached meaning do they give as well as the progress they engage in afterwards.

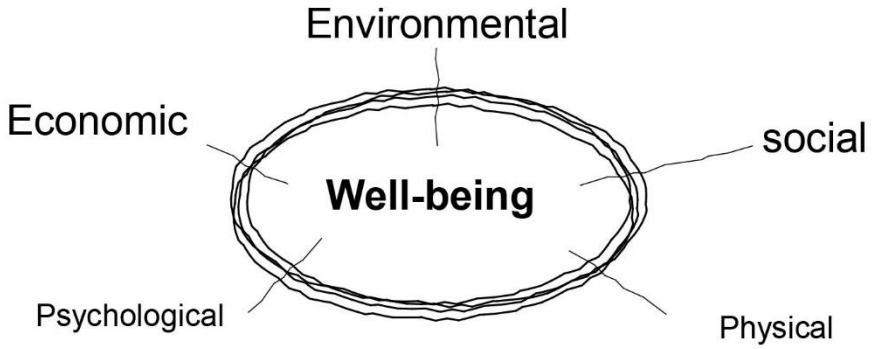


Figure 6 Factors that could influence wellbeing. Source: Authors interpretation

The group based their research on the theory of human need, which differentiates the local wants to the universal needs that can be achieved through various social and cultural methods. According to the findings conducted by the WeD understanding the concept of well-being also entailed additional resources that do not include physical possessions such as natural resources. Environmentally, the concept of environmental well-being can be interpreted as minimising the individual, community, as

well as the nation's ecological footprint (Summers *et al.* 2012). Since the environment has an impact on well-being as well as livelihoods (Agarwala *et al.* 2014). The literature by eds. Atkinson *et al*. 2012 has shown that, regardless of income and better health, well-being has also been attributed to greener environments, reducing loss of life and aiding in life expectancy among the rich and poor (eds. Atkinson *et al*. 2012. Environmentally Atkinson *et al.* (eds. 2012) suggested that well managed, high quality green spaces can be the foundation of sustainable areas, as well as become the healthy and economically competitive places in buildings as well as cities.

An epidemiological study in the Netherlands revealed the effective relationships between people inhabiting environments and a large percentage of green spaces, which contributed to their general health. In the US a similar study was carried out where communities with abundant green spaces had better health especially among the elderly and lower socio-economic (Gallaher 2017). In light of climate change, the adaptation of green spaces has become one of its mitigating factors, supporting biodiversity, absorbing and managing surface water it also assists in reducing urban heat islands while advocating a socio ecological strategy for human health and wellbeing (eds. Atkinson *et al*. 2012). Natural environments have been said to be ideal for urban environments regardless of any socio-economic status (Maller *et al.* 2005)

Even though income plays a large role in well-being, other factors are also considered Gallaher (2017). shows that there is no straightforward correlation between well-being and poverty. Gallaher (2017) and Maller *et al.(* 2005) also demonstrates that a universal definition that goes across disciplines, scale and culture have remained difficult to find. While frameworks for understanding well-being have emerged continuously over the years. In the researchers findings the concept of well-being indicated that in order to comprehend the concept well-being needs to be understood broadly, the outcomes have been that institutions, various individuals as well as various disciplines have developed their own definitions in order for well-being to align with their purpose and context. In those definitions overlapping is evident as well as unique perspectives (Agarwala *et al*. 2014).

The various factors that influence well-being indicate that no singular approach can be viewed in isolation, resulting in conceptual frameworks being merged as an attempt to bring together several factors, resulting in well-being becoming a contested and broad term with no single definition. Various literature has interpreted well-being in different ways (Summers *et al.* 2012:328).
From the researchers finding the commonality in the concept has been its ideals of creating and sustaining balanced human needs and environments. Ensuring that the basic needs from the Maslow's hierarchy of needs are met while also ensuring that the environment inhabited by humans is conducive to those needs. The solutions for creating a sense of wellbeing in some cases is primarily directed at external factors and how these conditions can be eradicated or made conducive for human

consumption for the betterment of individuals and communities. For the built environment as well as urban agriculture, it puts the concept of human well-being to the forefront of what should be considered in order for these basic human needs and conditions to be met.

2.5 Resilience

Walker and Salt (2006) introduced the concept of resilience thinking in order to understand social systems, by having dual approaches. The first approach was described as crossing the threshold to another regime and the other using the metaphor of adaptive cycles (Water & Salt Year). The authors described adaptive cycles as 'how an ecosystem organizes itself and how it responds to a changing world' (Walker & Salt 2006:75). Eraydin and Taşan-Kok (eds. 2013:) asserted that in 1981 Timmerman was one of the first authors to link climate change and resilience and defined it as the capacity of the system to absorb disturbance. From that, other research scholars have concurred and have highlighted the characteristics of resilience as being the means of being able to cope with externals shocks.

Bullock (2017) defines resilience in ecology as the capacity for an ecological system to resist change or to recover, using various state or government variables such as community composition, and population size. When pertaining to food security resilience, Bullock (2017) stated that the concept can be used in several contexts, making an example of an international contextual development that considers social structures as well as capacity building. Also linking the population growth to food supply and maintaining agricultural production under climate change Bullock (2017).

Reid (2006) stated that humans are living beyond their means on this planet, as though resources will never run out, while demand is proving to be out of balance with the supply. The surrounding landscape may appear constant daily, yet it is changing incrementally. The concept of resilience is about the maximum a system can handle when faced with disturbance. It is about bringing about an approach that manages resources together with natural and human systems. Complex systems continue to modify while trying to absorb disturbances without changing to different forms of authority or control (Reid 2006). It contains several interlinked concepts and involves a new way of looking at the world (Walker & Salt 2006:). However, when applied in context to the system researchers are interested in, it provides valuable insight (Walker & Salt 2006:).

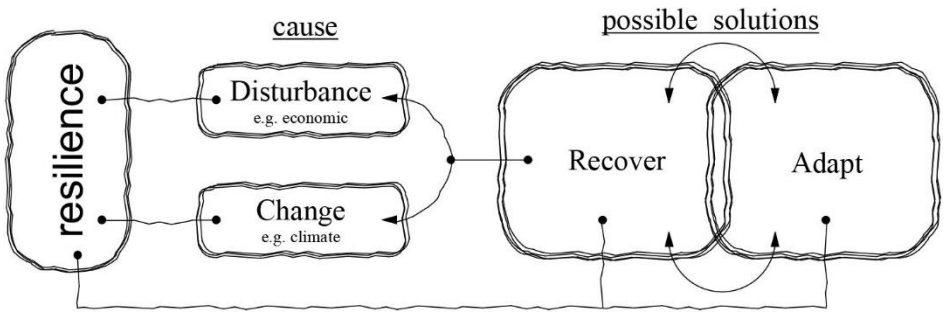


Figure 7 Diagram illustrating possible causes and coping strategies within the concept of resilience. Source Authors interpretation

Eraydin and Taşan-Kok (eds. 2013) stated that urban land use planning has traditionally been concerned with minimising disturbances and negative effects thereof. The concept of resilience thinking has expanded to include activities that occur after disturbances and, accepting that change will happen, is therefore necessary to simultaneously find means to reduce these risks and put in place systems that can better prepare humans to absorb these changes (eds. Eraydin & Taşan-Kok 2013).

When pertaining to food systems resilience can be understood as the capacity for a system having the means to adapt to new conditions or remain stable without experiencing disastrous changes in its basic functionality. A resilience analytical framework accesses the health of a system and its capability to withstand shock should it occur. According to Pingali *et al.* (2005) resilience should be based on diversity strengthening, which focuses on strengthening and supporting local knowledge, supporting traditional networks, restoring community institutions, and working on the farmers' capability to adapt and the community's ability to find adaptable solutions to difficulties.

The concept of resilience has been promoted by governments and international organisations in order to assist communities dealing with urban risks (Brunetta *et al*. 2019:10). However, Brunetta *et al*. 2019). Also argues that the concept is conservative in the way in which it promotes a return on pre-crisis conditions at the expense of transformation (eds. Brunetta *et al.* 2019:11). The unplanned expansion happening rapidly is revealing that a large number of people are going to be affected by natural disasters and climate change (eds. Brunetta *et al*. 2019:28). In this regard, the concept is viewed as positive because it suggests flexibility, staying power and adaptability to urban conditions (eds. Brunetta *et al.* 2019:28).

According to Pingali *et al.* (2005:) vulnerability is 'the dynamic social production of resilience' as well as the means of adapting, managing and recovering from risks in order to recover for better livelihoods. Adding that the how and why is important when dealing with food insecurity in community resilience and should be considered especially by organisations that deal with crises rather than short term needs (Pingali *et al*. 2005). The Food and Agriculture Organization is known for

supporting the agricultural sector through the process of rehabilitation as well as in government and institution buildings i.e. healthcare, educational, and recreational buildings, resilience has had an important role for the organisation's agenda (Pingali *et al*. 2005). Resilience also recognises the needs and roles of local governments, humanitarians, and non-governmental actors (Pingali *et al*. 2005).

For a city to be deemed resilient, it must contain a sustainable network, made up of: physical networks such as buildings, roads, and infrastructure, and; human communities such as organisations, schools, task forces, neighbourhoods (Barrico & Castro 2019). Without these, the authors believe communities will be vulnerable to circumstances of climate change and disasters (Barrico & Castro 2019). Further, planning for these circumstances, including putting in place adaptation strategies for climate change, is required (Barrico & Castro 2019). Finally, cities should be easily accessible, enjoyed by all, and should have equal use (Barrico & Castro 2019). Today the realities of climate change are evident: while natural disasters and the risks thereof have always been present, the frequency, speed and scale of such disasters are constantly growing, rendering these changes unpredictable (Barrico & Castro 2019). AS such, resilient thinking has become the lens through which the world should be viewed in order to deal with the multifaceted, ever-changing challenges faced by urban dwellers.

Although the debates around sustainability have attributed to the concept of resilience, new features must be considered (Cruz *et al*. 2013). The shift from sustainability to resilience 'lies in the consideration of urban areas as complex adaptive systems' (Cruz *et al*.2013:66). Some decisions may be considered more resilient than others, especially in light of the fact that there is much uncertainty surrounding urban future (Cruz *et al*. 2013). Understanding that these uncertainties exist is a necessary step in constructing coping conditions to reduce vulnerability (Cruz *et al*. 2013). As climate change increases and available land for growing vegetation become scarce, food security is threatened. Bullock (2017) found that a merged ecological approach is needed in order to achieve a holistic interpretation that considers nutritional and productional diversity at various scales.

2.6 Rights to Food

> Food security is a situation that exists when all people at all times have physical, social, and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (Food and Agriculture Organisation 2001).

The concept of food security has been on the international agenda as far back as 1948, when the Universal Declaration of Human Rights affirmed that ''Everyone has the right to a standard of living adequate for the

health and well-being of himself and his family, including food'' Article 11 of the (ICE) International Covenant on Economic (Armar-Klemesu, 2000:99).

The issue of food security is found in Section 27 of the South African Constitution. Here, the Constitution states that every citizen has the right to have access to sufficient food and water, and that the state must, by legislation and other measures and within its available resources, avail to progressive realization of the right to sufficient food' (Integrated Food Security Strategy- South Africa, 2002:05). Due to the complex nature of food security and the human right to food access, the topic cannot be studied in isolation due to its intertwined nature, affected by numerous differing factors such as rural and urban development, changing household structures, health, access to land, social protection and income (Altman, Hart & Jacobs 2009).

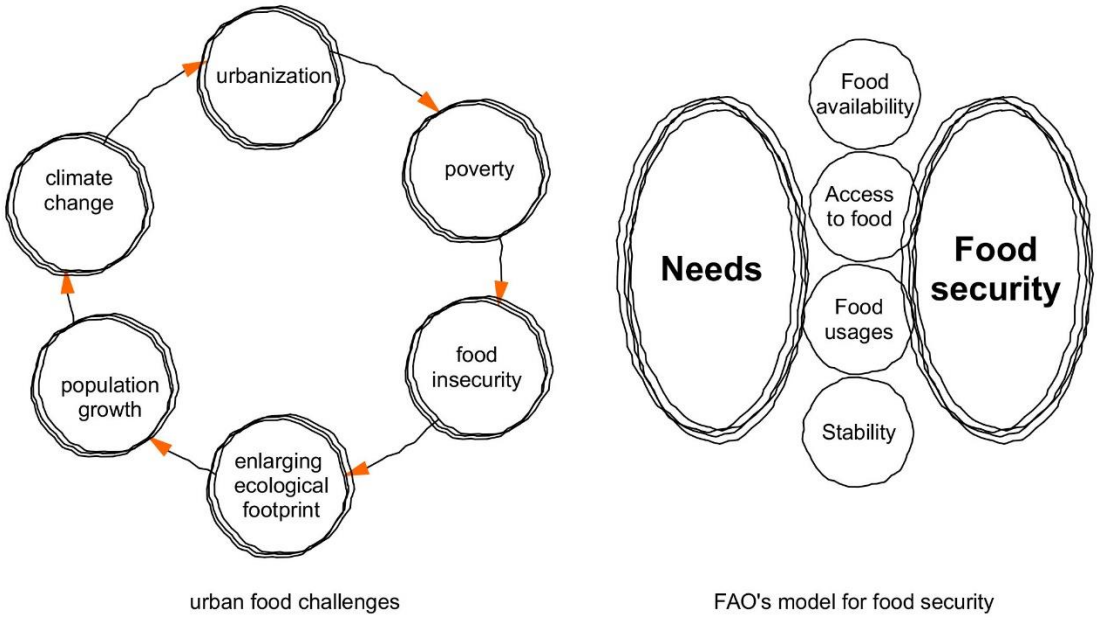


Figure 8 Diagram illustrating the Urban Food Challenges and the Food and Agriculture Organisation's model for food security. Source: Authors interpretation

South Africa ranks as one of the countries with a high rate of income inequality, as well as a high level of poverty in comparison to other middle-income countries (Altman *et al*. 2009). Although, as a whole, South Africa is deemed food secure, there are households within the country that are food insecure. The Reconstruction and Development Programme (1994), which identified food security as a basic human need, recognised poverty and food insecurity as the resulting legacy of several centuries' worth of colonial and apartheid policies, socio-economic and political order. These policies were designed to create conditions that were unfavorable to the well-being of black people in all aspects, specifically in what was formerly known as homelands which refer to people's native land (National Department of Agriculture 2002).

A moderate loss in agricultural, rural and entrepreneurial skills and experience, and capital caused a decrease in African farming. The industrial development that then occurred in South Africa became the reason that contemporary poverty and food insecurity among black people in the country was created (National Department of Agriculture 2002). In the year 2000, 14.3 million South Africans were said to be vulnerable to food insecurity. Among these, were women, children and the elderly according to Statistics South Africa 2000. With the lack of purchasing power due to the lack of sufficient income, and within the previously marginalised social groups, black households have the lowest standard of living in comparison to Indian households and house hold with Coloured people which is a South African race group that is a mix between black and white people and (National Department of Agriculture 2002). Today income security by means of social grants has been one of the means in which the country has provided improvements in household food security since 2001, yet studies have shown that employment is essential to improving household incomes (Altman *et al.* 2009).

Although there is a link between poverty and income, household food security is not entirely solved by own food production by poor households, therefore not necessarily equating to food security. Households that partake in their own food production may do so for recreational purposes or additional livelihood strategies or as a survival strategy for deep poverty (Altman *et al*. 2009). Lobell and Burke (eds. 2010) state not all unhealthy people are necessarily food insecure, a healthy status can also be a primary contributing factor to food security. An insufficient intake of the right nutrients can be detrimental to the human body, therefore the right nutrients are essential in order for the body to function optimally. For those who do not farm, food insecurity is a matter of access due to food availability being reliant on sufficient income and affordable food prices.While social safety and employment opportunities affect access to food, so too do issues of land ownership, and market access and poor or inadequate infrastructure (Gibson 2012).

At the time of writing adequate amounts of food was being produced globally. For global governments it is the rapid population growth and the future demands that will come with the growth that is of great concern. Therefore, the rapid population growth means there will be a need for rapid increases in food productivity Giménez (2010). These predicted increases in food production will have to be achieved sustainably and will require rethinking on how this will be achieved effectively. Giménez (2010) describes some supermarkets as stating that they are reshaping their food systems to provide better environmental benefits, yet those very same supermarkets have been at the forefront of wasteful practise and affecting the environment Giménez (2010).

When pertaining to food policies, trade and supporting local community agriculture in the urban and peri-urban areas some countries have created fair trade networks to forge sustainable food chain networks to replace industrial food production and forms Giménez (2010). These policies also include food sovereignty – characterised by 'secure access to food across both local and national markets, and produced in ways that support socially and ecologically sustainable development' (eds. Lawrence, Lyons & Wallington 2010:2). The agricultural sector in most research has primarily been associated with livelihood in developing countries. Yet, in developed countries agriculture has become less important as countries industrialise. New technologies and demand have also affected the agricultural food systems for the rest of the world. As wealthier consumers become more conscious about the food – in terms of personal health and environmental and ethical implications of food – evolving changes in the global food of developed countries are beginning to occur (Boye & Arcand 2012).

With 70 to 80 per cent of households purchasing their food from supermarkets and other food suppliers, better consumer education, as well as lower food costs, could enable households to intake a variety of nutritious food.

Some supermarkets standardise their food prices, failing to consider food affordability for the less fortunate. Understanding of these food pricing systems and their constraints is required in order to put in place adequate interventions (Altman *et al*. 2009. Within the Durban CDB, street trading is an important activity for household well-being (Skinner 2008). A large percentage of street traders are the sole bread winners for their families and have been recorded to having three to four other dependents mostly selling food (Skinner 2008). Population growth, unemployment, and global warming are all factors that affect global food security, particularly in developing countries due to their population having more poor people (Skinner 2008). According to the researcher's findings ensuring that every human has access to food is the responsibility of policy makers, government institutions, the private sector and all global citizens.

As it pertains to the built environment, the researcher believes it is not enough to merely install supermarkets, which require transportation of distant goods, in communities. Instead, emphasis must be placed on the construction of buildings that bring communities closer to natural sources of food in order to achieve nutritional health benefits. The raw production of natural food must be the focus in the construction of the built environment in order to create employment, and thus a decent household living wage. Further, these spaces, through skills transfer, could contribute to the development of sustainable communities that are self-reliant.

2.7 Permaculture

‘Permaculture involves the integration of ecological design principles, the ethics and values of working with nature and the detailed situation and site-specific practical realities of life. In trying to combine these three very different spheres of human activity, there is constant tension and the need to re-assert balance.’ (Mars:1996)

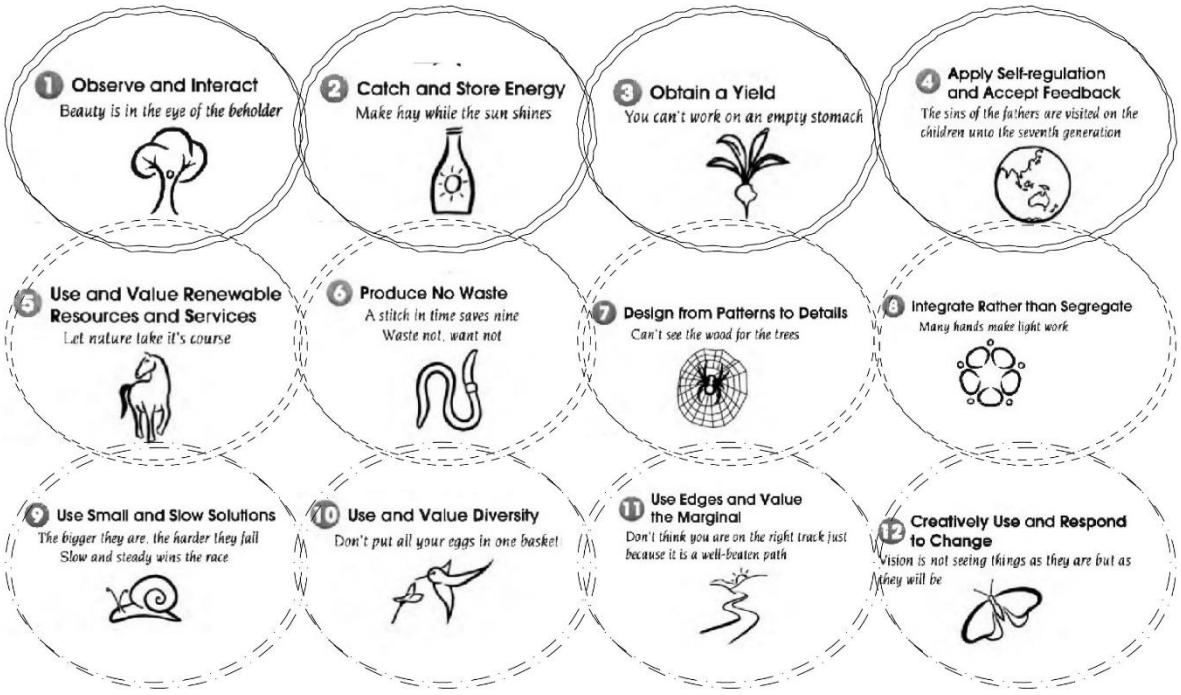


Figure 9 Diagram illustrating David Holmgren’s 12 Permaculture Design Principals. Source (Holmgren 2002).

The conceptual and practical rubric for permaculture was initially developed in Australia by Bill Mollison and David Holmgren in 1974 (Veteto & Lockyer 2013). As a form of conscious design that involves a functional relationship with nature (Veteto & Lockyer 2013). The concept of permaculture designs was to merge all the constituents of an ecosystem in a holistic manner for a more sustainable way of living. Although its origins may suggest otherwise permaculture is not just about gardening.

According to Lockyer and Veteto (2013) permaculture is both a sustainability movement and a development philosophy that has ethical principles and techniques. Permaculture models its designs for buildings, agro-ecosystems and communities based on the observation of nature, viewing human creations and their activities as part of a natural world Veteto (2013). It is an adaptive concept that emphasises bioregional and local practice and perspective. It is viewed as a concept that incorporates all the characteristics of human settlement as well as human well-being Veteto (2013). From the 1970s onwards, permaculture has developed to also encompass water harvesting, buildings, finances as well as alternative and appropriate technology and is regarded as a harmonious integration of design with ecology Veteto (2013).

The integration of ecology and design is the main driver behind permaculture, its principles take on nature's way of adapting, and then using permaculture to solve the problems that confront nature and humans (Mars 2005). To achieve successful design principles permaculture design promotes the creation of a self-managed system where human insight and intuitions is used to solve problems (Mars 2005). Mars (2005) described good design considerations in permaculture as strategies that use land in a sustainable manner where pollution and waste are minimised. Permaculture includes systems where food production is done in a healthy manner, promoting restoration in abandoned or degraded landscapes, as well as conservation of indigenous and endangered species. Lastly, permaculture design considers a good balance between the built environment and all living things including minimal consumption of energy (Mars 2005).

According to Mars (2005), permaculture attempts to enhance the human interaction with the environment to bring about sustainable living. Ecological design promotes immediate as well as future benefits for the people. Permaculture further promotes the use of local materials and sustainable sources of power that use appropriate technology and systems that require minimal maintenance and that can be easily monitored. Through the promotion of social, cultural and legal consideration, permaculture design can produce greater environments that empower people to solve their own design problems and apply solutions to their everyday situations (Mars 2005). In permaculture design and systems, water is the most important priority, placing emphasis on theoptimal reuse, retention and harvest of water.

There are three ethical principles of permaculture. According to Holmgren (2002) these include caring for the earth, caring for people, and the application of limitations for reproduction and consumption, which takes into account the redistribution of surplus.

> Good design depends on a free and harmonious relationship to nature and people, in which careful observation and thoughtful interaction provide the design inspiration, repertoire and patterns. It is not something that is generated in isolation, but through continuous and reciprocal interaction with the subject. Permaculture uses these conditions to consciously design our energy descent pathway (Holmgren 2002:13).

The overall aim of these design principles is to develop closed-loop, symbiotic, self-sustaining human habitats and production systems that do not result in ecological degradation or social injustice.
The research considers permaculture design principals as vital for building in urban environments. Globally the urban environment undergoes the most transformation due to its growth rate and requires detailed consideration in its expansion in order for it to a sustainable space for human inhabitation.

2.8 Conclusion

As stated in the literature by Mars (2005).) humans are the greatest destroyers of global ecosystems, yet studies and observation research by Holmgren (2002) reveals that humans can learn important lessons from the way nature operates and adapts. These lessons can enable designers and inhabitants to strategise how to incorporate and care for the environment. As global conditions change, the ability to adapt and rethink the way buildings function is vital. Buildings can no longer be viewed as structures to house single uses, but rather as structures that house multiple functions, including giving back to nature. In redesigning buildings for multi-purpose use, it is critical that they be designed to operate and generate their own energy, thus creating their own life cycles.

The concept of resilience thinking encourages humans to better plan for future urban climatic disasters due to climate change. Better planning and consideration will allow designers to create urban spaces and buildings to incorporate urban food production as a way to protect crops growing in climate conditions that could become unfavourable. On the other hand, through the theory of urban ecology, teaches creators of the built environment that all that is taken from nature should be replaced or preserved for future generations. This way of thinking is evident through initiatives such as green architectural practices. Global standards that are being created through green design allow creators to question how they view the changing world, how they view buildings, and the city as a greater whole.

Even though it poses greater questions and resilience has its own complexities, it has also brought about new technologies which allows the possibility of practices such as growing in enclosed urban buildings. Advancement in technology has also allowed favourable living conditions to be met through these types of green innovation. Although opposing arguments state that using nature is still the greatest standard of achieving green design, technology allows green design to occur when natural conditions are unfavourable.

The same way nature changes, the city and its inhabitants are also constantly changing and adapting to meet global needs. Regeneration is then inevitably required, especially in cases where new sites are developed and old infrastructure is left abandoned. These spaces are usually targeted by the urban poor who adapt these spaces to suit them. However, without proper planning and regulation these spaces become forgotten spaces of poverty and crime, riddled with drugs. Urban regeneration seeks to redefine these spaces for the intention that people moved to the city for which is employment and a means to a better life.

Informal trading is one of the greatest examples of African cities and their resilience. The regeneration of Warwick junction in Durban South Africa is one of the prime examples of how locals and professionals can come together to meet the needs of its city inhabitants and users. The project recognised the selling of food as major part of trading and income in the city. Food is a basic human right and the lack of its affordability for the urban poor is global crisis. This crisis has led to many turning to urban agriculture as a means of food security. For urban agriculture and the built environment, the researcher design proposal proposes to further empower people within the city to better their livelihoods by teaching them to grow their own vegetation for them to trade, maximiaing their profits and cutting out the unnecessary transportation costs required in transporting fresh foods from the farms. The current condition of underutilised buildings within the city provides opportunities for alternative food production where food can be grown in closer proximity to where it is consumed. This can therefore benefit the environment as well as the lives of poor urban dwellers who come to the city for a better life and livelihood.

Chapter 3

3.1 Urban Agriculture as a means to Food Security

Internationally the commercialised proposal of agriculture as a concept was referred to by Marx as a metabolic rift of industrialised people's divorce from nature (Bellwood-Howard & Nchanji 2018). This was brought about when production and consumption were isolated through commodification and divisions of wage labour between rural and urban areas internationally (Bellwood-Howard & Nchanji 2018). Associated with the rural environment, agricultural activities have mostly been confined to the rural context to feed the urban population. For some developing countries this has not been the case, due to the consequences of scarce infrastructures. With 85% of poor household income estimated to be spent on food purchase (Bellwood-Howard & Nchanji 2018)..

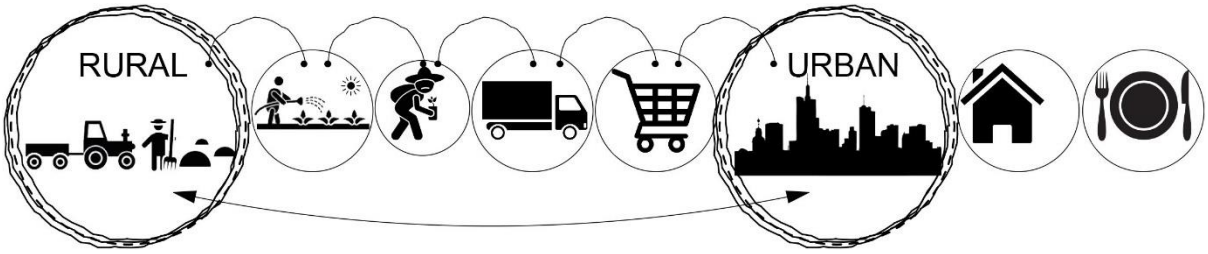


Figure 10 Diagram illustrating Rural to Urban food journey. Source: Author's interpretation.

The majority of urban agriculture has been said to belong to the poorest population, favouring social improvements (Orsini, Kahane, Nono-Womdim, and Gianquinto 2013). In sub-Saharan Africa, urban agriculture has been present since the colonial era (McLees 2017). The significant role and awareness of urban agriculture since the early 1990s caught the interest of the International Development Research Centre (IDRC Canada) which supported a worldwide initiative in agriculture research (eds. Prain *et al*. 2010). Following the Consultative Group on International Agricultural Research (CGIAR) interest in Africa's, urban agriculture became their priority research study area through a program called 'Urban Harvest.' which brought about research centers in countries such as; Niger, Senegal, Kenya and Argentina amongst others (Orsini *et al.* 2013).One of its importance focuses was not only the localisation of agricultural produce within the city boundaries but its ecological benefits through decreasing city waste. The decrease in city waste would mean improving air quality as well as improve biodiversity. This would then lead to educed environmental impacts for food storage and transportation (Orsini *et al.* 2013). In African countries such as Uganda and Ghana where the urban poor spend most of their income on feeding themselves, this makes them vulnerable to macroeconomic fluctuations such as rising food prices (Orsini *et al.* 2013).

The rural to urban migration transition has reflected a poverty driven livelihood strategy according to Prain, Karanja and Smith (eds. 2010) which has evidentially shown increases in urban poverty as

cities and towns have grown. This relationship is said to be complex, with estimates of urban poverty regarded as underestimated due to factors of higher costs of living and services found in urban areas. Historically, African cities have been influenced by European settlement and colonial governments. These European economies brought in the concepts of urban and rural to divide their colonies in an effort to keep the urban town services to the colonist (eds. Prain *et al*. 2010) With regards to food, the relationship dynamic brought about a study in the 1980s. This study brought about information from African cities about the state of agriculture (eds. Prain *et al*. 2010).

The proximity to markets is regarded as one of the factors that brought about further research on urban agriculture in both the global north and global south, as a means of bringing production closer to its consumers. This could then be a lens to which the multifunctionality of urban agriculture can be seen (Howard & Nchanji 2017:. Although there have been many advances within the retail and selling industry in terms of the built environment, a large portion of the world sell their goods informally on the streets, more particularly in Africa. A large portion of informal trade takes part in retail, making the streets a vibrant characteristic of African cities (Skinner 2008). According to Data Research Africa (1998:12), in the Durban areas there are over a thousand traders operating within the inner city and the majority of them being women, who have been recorded to be mostly selling food.

White and Hamm (2017:19) found that a large group of households in 11 countries in Southern Africa acquired their food from informal sources with 32% doing so on a day-to-day basis, which is higher than other food sources. Central to the urban economies, open air food markets have played a role in the lives of people in the global north and south. In the United Kingdom and United States, urban agriculture has played a vital role in the social life of its residence (White& Hamm 2017).

Bell (2018) described urban agriculture as contradictory, viewing it as both radical and neoliberal. Urban agriculture is viewed as radical by the researcher in its opposition to what a normal city should be, look like or how its inhabitants should behave, allowing for a neoliberal agenda to be pursued (Bell 2018:6). This is predominantly evident in cities where the state or government has failed or has been absent in supporting marginalised people. In other instances, urban agricultures is corporatised, seeing profit from production showing little unity in scale and organic movement to date. For the marginalised, urban agriculture moves its approach from a problem-based statement to solutions-based focus, highlighting the creative powers of disadvantaged people in cities worldwide and their capacity to make cities work despite their chaotic conditions.

3.2 Integration of Urban agriculture in Uganda and Kampala

The important role agriculture and urban agriculture have on livelihoods and the economic benefit they possess have influenced African countries such as Uganda into incorporating agriculture into their Ugandan primary and secondary school levels. Agriculture is taught to students as a national policy in order to bring about a public awareness of the importance of agriculture to the national economy. By the 21st century, the teaching became a vocational education, where previously it was taken as an extra-curricular activity (Baseke *et, al.* 2010). Baseke *et, al*. (2010) argued that urban farmers in Uganda aimed to satisfy their income and food needs with inadequate support, whereas in the urban schools only the basic skills are taught without linking the teachings to the surrounding circumstances.

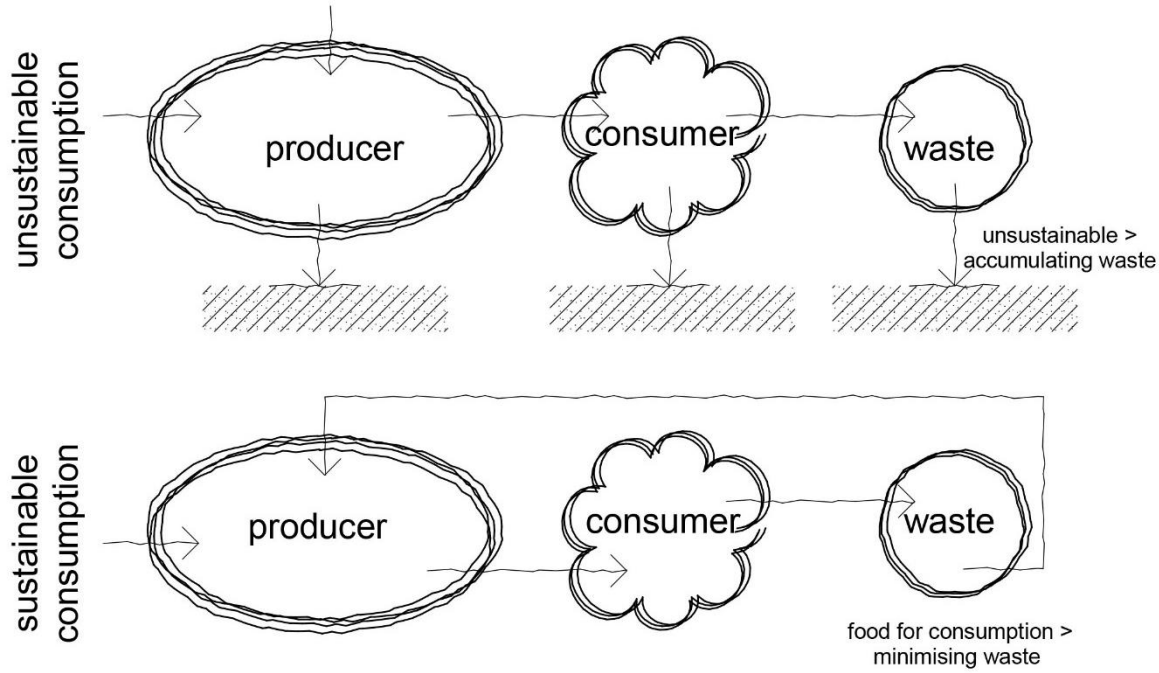
In Kampala, a rapidly growing African city, Nyapendi *et al.* (2010:139) found that urban agriculture offers the city opportunities while simultaneously creating limitations due to inappropriate regulations. The city's lack of service and inadequate maintenance undermines the sustainability of the sector's fundamental part of the food system. Nyapendi *et al.* (2010:148) added that the formal markets, which are the largest in Kamapala, include fresh food markets for middle to low income households, clothing, as well as markets that sell various types of farm produce. Few farmers partake in the growth of leafy vegetation for commercial use, even though these take a shorter time to grow than other crops. The reason for these only being grown for home consumption has been attributed to the lack of organised markets in Kampala.

3.3 Agriculture and sustainability

According to Paoletti, Stinner and Lorenzoni, (eds 1989) agricultural practices have been known to adopt the use of chemical fertilisers and pesticides to produce crops. This originally occurred in Europe and the United States during the 1960s and the Green Revolution, with significant increases in the use of fossil-fuel. Agricultural chemicals are increasingly targeted as the cause of pollution in water resources (Paoletti, Stinner, Lorenzoni, eds. 1989). Zilberman, Khanna and Lipper (1997) prescribes sustainable agriculture as a policy approach that maintains environmental quality while on the other hand maximizes economic benefits. This approach is argued to be more capital focused yet also encourages new scientific development. In order to achieve this sustainability Zilberman *et al.* (1997) stated that economic motivation and encouragement in the development and adaptation in precision technologies should be developed.

The human consumption in the world per capita was estimated to be approximately 18% higher than in the previous 30 years (Zilberman *et al.* 1997). Despite this increase in production being achieved, it has had numerous negative results. Food access and health problems vary in each country, for

example, poorer countries experiencing malnutrition and other richer countries experiencing overeating (Zilberman *et al.* 1997).



Sustainable agriculture is as said to be embraced by a diverse group of people and is sometimes contradictory in its interpretation.

As people become more conscious of sustainability and want greener futures, they strive for healthier environments in order to achieve a better quality of life. The ways in which to go about achieving a better way of life is commonly debated in terms of what exactly that future will look like.

. The motivation and pursuit are commonly due to the dissatisfaction of the world's current state of affairs. When it comes to modern agriculture, some economists are concerned about the quality of the environment and the constant environmental challenges that come with modern agriculture, while others are concerned about the impact science-based technologies and modernisation will have on lifestyles and cultures.

The traditional rotation of crops in organic farming has previously had a significant role in sustainable traditional agricultural practices, yet Zilberman *et al.* (1997) asserted that the key to sustainable farming is not in technologies of the past. In the 100 years of agricultural practices, the changes that have come about have been due to social needs. Modern scientific research is regarded as one of the most important contributors to the mitigation and identification of negative impacts of modern agriculture. The concerns about the environment have culminated in the technologies and developments focusing on both preventing and remedying future occurrences (Zilberman *et al.*1997:65).

Modern technologies that have previously been environmentally objectionable have been documented to be the outcome of little scientific knowledge and understanding when it comes to the dynamics of interdependent food production. Multi-crops that are environmentally and economically viable are regarded as a challenge. These systems are constantly being developed and will continue to do so in future. New technology development requires a two-way process consisting of a combination of a bottom up approach, and a more scientific, cutting-edge knowledge approach. Local and indigenous knowledge is regarded as important and should be recognised and incorporated in developing nations, yet new technologies are deemed important to achieve the increase in agricultural productivity necessary to maintain an even more subsistence income for a rapidly growing population (Zilberman *et al*. 1997).

The adaptation and development of precision technologies are essential in reducing the environmental side effects of agriculture and promoting sustainable systems. Precision technologies increase yields, which impact costs increasing returns while requiring human and physical capital. Emphasis should be placed on researching policies which could enhance broad-based adoption of such technologies.

3.4 Indoor Agriculture and Architecture

The incorporation of agriculture in urban buildings i.e. open rooftop farms, rooftop greenhouses and indoor farming, are terms which are also referred to as ZFarming (Thomaier *et al*. 2014). This type of farming according to Thomaier *et al*. (2014) has become a sustainable way to exploit synergies between buildings and agriculture (Thomaier *et al*. 2014). Dating back to the Roman times, the concept of growing vegetation in controlled environments existed. The Roman gardens grew cucumbers. These cucumbers were grown in wheel charts and laid outdoors during the daylight and kept wrapped in oiled cloth indoors at night under controlled conditions.
During the 16th century in Italy, the first modern greenhouse was constructed, later spreading to the Netherlands and then followed by England (New World Encyclopaedia 2017).
According to Hongladarom (eds. 2015) the growing of food has traditionally been dependant on season and place. Hindering particular foods from all year-round food production due to seasonal factors. This then led to the introduction of industrial technologies during the modern era. Therefore, the concept of farming indoors is not new. Despommier (2010) found that commercially viable crops such as strawberries, tomatoes, peppers, cucumber, herbs, and a wide range of spices, have made their way from commercial greenhouses to the world's supermarkets, in ever increasing amounts over years. Faced with climatic uncertainties, dwindling resources and increasing pressure on land, Despommier (2010:5) found that more fresh produce farmers worldwide have turned to enclosed agriculture techniques. The advantages of such agricultural techniques include increased yield, a

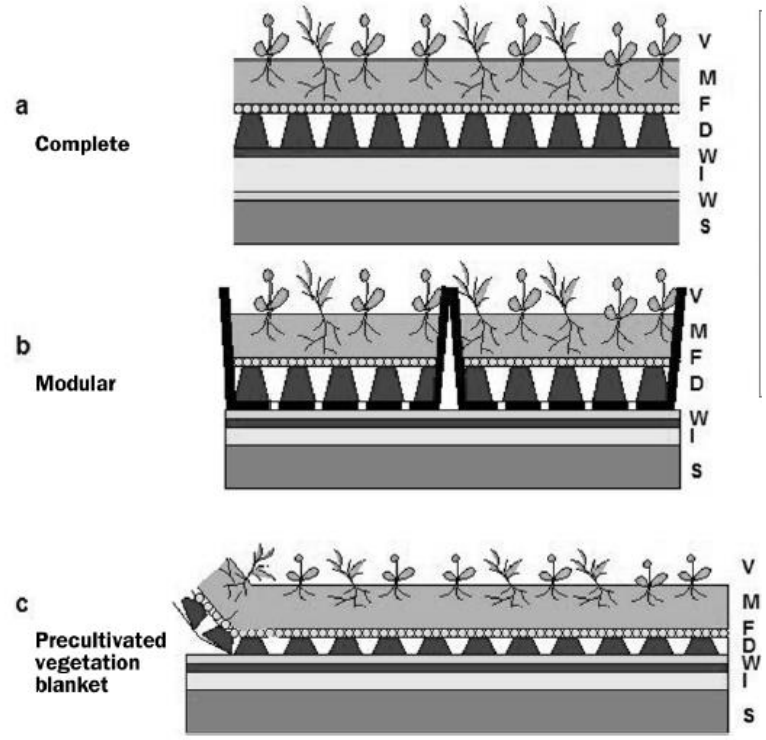
controlled environment, efficient water and fertiliser use and technologies which continually improve Despommier (2010).

3.4.2 Rooftop Agriculture and Vegetation

In the 20th century the modern gardens originated in Germany where vegetation was planted on roofs in order to prevent damage on roof structures caused by solar radiation. Oberndorfer *et al.* (2007) described the green roof concept as a modern modification of those roof gardens, containing a shallow substrate requiring minimal maintenance and functionally and more user friendly than living roofs. The green roof technology is embraced due to its diverse environmental benefits. These technologies sparked technical guidelines as well as interdisciplinary research. Thereafter leading to elaborate versions being planted in private home, office parks as well as international hotels (Oberndorfer *et al*. 2007).

Urban areas are dominated by nonporous and hard surfaces, this contributes to heavy water runoff during rainfall. This can overwhelm existing storm water management systems, causing sewage overflow into rivers and lakes. With sedimentation, erosion and exacerbating flooding, urban runoff can be high in pollutants, causing harm to wildlife habitats as well as contaminating drinking water. Roof gardens help control storm water management, enable urban habitat provision and energy conservation lowering energy demands, especially in warm weather by reducing the heat transferred. Oberndorfer *et al.* (2007) stated that native plants have been deemed the most ideal and sustainable for planting on roof gardens, yet they can also be considered not ideal due to shallow substrates. If designed and integrated accordingly, the underutilisation of numerous urban flat roofs poses a variety of benefits for urban dwellers to plant vegetation and possess numerous ecological and environmental benefits for the urban environment.

Vegetation planted on urban roofs provides urban dwellers with fresh vegetation in close proximity to its consumers, decreasing the need for transportation from far way rural distances. The planted vegetation produces oxygen benefiting the health of all urban dwellers. For the built form planted roofs reduce the heat of the building, therefore reducing the energy costs. Environmentally it reduces ambient temperature that the urban environment creates and ecologically it creates and brings back habitats for wildlife that was lost when the building is erected. Below the diagram illustrates a typical composition of how this can be achieved.



V - Vegetation
M - Growing medium
F - Filter membrane
D -Drainage layer
W -Waterproofing / root barrier
I - Insulation
S -Structural support

Figure 11 Types of conventional green-roofing technology systems. Source: Oberndorfer *et al.* (2007:827)

Figure 12Types of conventional green-roofing technology systems. Source: Oberndorfer et al. (2007:827)

a. Typical complete system illustrates roof membrane is installed as an important part of the roof.
b. Modular system illustrates trays are installed above the roof system.
c. Pre-cultivate vegetation blanket illustrates drainage mats, plants, growing medium and root barriers integrated into existing roof.

3.5 Alternative agriculture

One of the most competitive branches and benefits of urban agriculture according to Eigenbrod and Gruda (2014) is the production of urban horticulture. Although vegetation requires high water usage, it is the more common and profitable than other crops. The advantages of vegetables include special nutritional values; minimal added processing once harvested, and; a short growth cycle, which means demand can be supplied for quicker (Eigenbrod & Gruda 2014).

As a means of addressing low soil fertility as well as the limited availability of water, new technologies have been developed to maximise the cultivation of limited urban spaces and the impacts of horticultural production for the health of humans as well as the environment. These technologies address the need for integrated, local agriculture using natural substrates, different kinds of composts, and soilless systems in densely populated contexts (Orsini *et al.* 2013:713). These systems can be found in urban rooftops around the world (Orsini *et al.* 2013:713).

Organoponic is a popular practice commonly used in Cuba. The practiceis regarded as one of the most efficient forms of alternatives means of vegetation growth in urban agriculture. The organoponic system is used when there is no chemical input and where soil fertility is low. The system was pioneered in the 1959 Cuban revolution, where the organoponics plant growing system was a means of overcoming food scarcity in the city of Havana during the county's food crisis (Smith 2011). This system is highly suitable for developing countries, especially if there is inadequate infrastructure or access to fertilisers. Government officials in Cuba promoted this form of farming, which is why the yield cultivation and area was recorded to have increased by 17% between the years 1994 and 2001 (Eigenbrod & Gruda 2014:489).

The sustainability of this farming method lies in the fact that it does not rely on fertilisers, making it an ecologically friendly option.. These crops are grown in containers such as plastic buckets and tyre while the bedding for the growing uses organic matter or compost, such as kitchen waste and decomposed leaf litter. This method has further been adopted by Venezuela. The rganoponic method is regarded as a simplified version of the hydroponic system in that it is more organic and entails the use of compost made from sugar waste as an alternative to chemicals. The produce grown then provides for households, school canteens, working refectories and hospital products, which are managed by cooperatives or individuals (Orsini *et al.* 2013)

Figure 13 illustrates organoponic farming method in Cienfuegos, Cuba

Another technology is the plant factory with artificial lighting (PFAL), ‘’an airtight facility that is thermally insulated for plant production, such as a warehouse. PFAL has also been referred to as a vertical indoor farm in the United States, and Canada, which is a similar concept (Kozai 2016). According to Kozai, Nui, and Takagaki, (eds. 2016) the origin of the technologies used in the PFAL was established in the United States, the most significant being the hydroponic system, which was invented from the origins of a research for plant nutrition.

Hydroponic systems are regarded as a sustainable form of plant production in indoor farming as well as in the plant factory artificial Lighting (PFAL) systems. There are various types of hydroponic

systems, commercially the most popular for vegetation growth is referred to as the deep flow technique which has a nutrient solution that is supplied to plants. When water levels in the culture beds are lower than the set value, these are supplied and recirculated at the foot of the plants at constant intervals and times. Another system is referred to as the nutrient film technique. This system works on reticulation, returning the nutrients to the nutrient tank when not absorbed by the plants. The nutrient solution and water can therefore be easily estimated by the measurement of the loss of the nutrient solution in the tank (Kozai 2016).

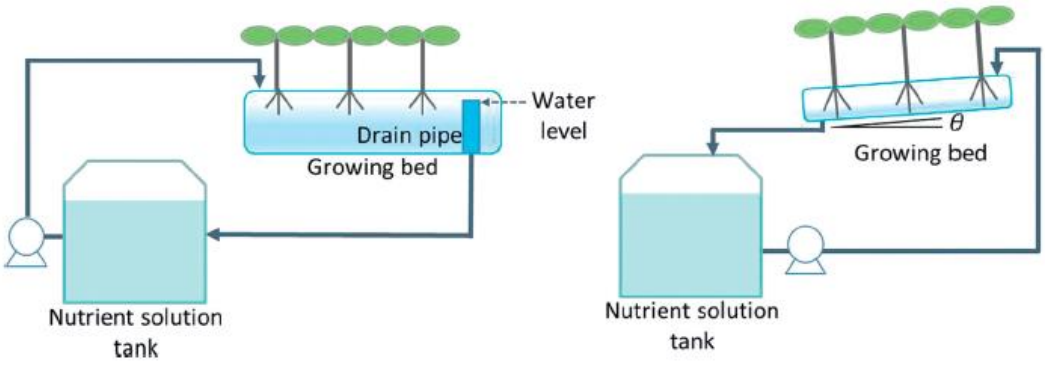


Figure 14 Schematic diagram of the deep flow technique on the left as well as the nutrient film techniques on the right (Kozai, 2016:214).

In the Netherlands, a light emitting diode also referred to as an LED solution was developed for horticultural applications, proving its commercial feasibility. The incorporation of these new growing systems and the use of these factories has been documented to have created new business and market opportunities, but are not viewed as replacement for existing open field production or greenhouses. However, such growing systems have become popular in Asian countries for commercial production. The advantages have been that firstly they can be built anywhere, they do not require soil or natural light. Secondly the external environment does not affect growing therefore, all year production is possible. Thirdly manipulation can occur by means technical enhancements for the growing environment. Fourth is the avoidance of pesticides. Lastly Transportation can be reduced due to the fact that it can be grown in close proximity to where it is consumed.

Taking into account and understanding the various factors that affect plant growth, such as the environment, is pivotal to the design and operation of a PFAL. Artificial lighting enables the modification of environmental conditions for desired responses for plant growth as well as the humidity and air speed. When designing spaces for indoor vegetables, there are considerations that designer need to consider. One of those considerations is the spatial layouts for cultivation beds and equipment needed in order for the operation to be efficient (Kozai 2016).The flow space for workers

needs to be designed accurately in order for the interior to be utilised efficiently, and most importantly there needs to be a high level of sanitation for food safety (Kozai 2016).

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3.6 Conclusion

The erecting of greenhouses has primarily been on the periphery of city spaces, however, the urban environment can adopt design principles that were primarily used for greenhouses. Such principles can be incorporated into the (re)design of already existing or new structures, thus bringing food production into urban spaces. With sustainability at the forefront of cities and the built environment, building-integrated agriculture characterised by acreage or the non-use of land for farming activities has become of great interest for alternative urban agriculture.

Thomaier *et al*. (2014:48) suggested that the incorporation of vegetation in the urban landscape provides residential, commercial or mixed-use buildings spaces that can serve as recreational spaces where residents or employees can grow their own food and enjoy a green oasis close to their homes or workplaces. Not only does it bring food to the centre of where it is consumed in cities, but it suggests that developing multi-functional buildings with integrated farming also calls for putting in place urban policies and land use planning, particularly concerning zoning codes

The recognition that buildings have a role to play in reducing greenhouse admissions and that derelict buildings create opportunities for adaptability, suggest that reduced carbon admission is possible if buildings are adaptively used instead of unnecessary demolition processes and new building construction. These buildings create opportunities for new uses as demand for space in cities become more difficult. The cost and limitation of urban land, as well as the need to bring food closer to the city to reduces CO^2 emissions into the atmosphere. Practices such as indoor agriculture, greenhouses, roof top farming and other alternative means of agriculture using technology are beneficial to the urban environment as vegetation absorb CO^2 and release oxygen in its photosynthesis process. Incorporating these two conditions will create better urban environments that are beneficial to all city inhabitants, while simultaneously bringing food closer to urban population for the urban poor, decreasing food prices.

Chapter 4

4.1 Precedent studies

4.1.1 Introduction

The selected precedent studies were chosen from international examples to see how designers outside of the South African context have dealt with the concepts and theories in the literature, as well as the other literature in the previous chapters. The precedents demonstrate similarities, as well as differences, in their environmental and architectural approach. They were chosen to show how different contexts have dealt with the research problem and how they have adapted it to their context to further add to the literature in order to generate helpful guidelines that can be used in the architectural design research.

4.1.2 Lufa Farms in Montreal Quebec, Canada

Architect	:GKC Architects
Client	:Fermes Lufa Farms
Location	:Montreal Quebec, Canada
Construction Period	:2010
Cost	: USD2 million

4.1.2.1 Introduction / Background

In 2009, clients Mohamed Hage and Lauren Rathmell rented a greenhouse space at McGill University to learn about sustainable hydroponic farming and to do various tests on the system. These tests helped the duo develop sustainable farming and responsible agriculture methods. The husband and wife team along with Yahya Badran and Kurt Lynn then co-founded Lufa Farms in 2009 with a vision of revolutionising urban agriculture (Magder 2018). In 2010 Lufa Farms started construction on their first rooftop greenhouse. It was the world's first commercial rooftop greenhouse on an industrial building, located in Montreal, Quebec. The rooftop greenhouse would provide high-yield and year-round farming in a smarter, more sustainable and commercially viable way. The building required minor adaptation to hold the greenhouse, which included structural reinforcements, separate stair accesses, a freight elevator, and a 140 000 litre reservoir. The planning would take up to four years (Carrot city 2014)

4.1.2.2 Urban regeneration

The site is situated in the Montreal, Quebec metropolis which is part of a large city situated in Canada. Montreal was the economic capital of Quebec, with a population of 1.6 million. The city had a cultural diversity with the influx various immigrants, but remained as a hallmark for its French civilization and British influence (Burnet *et al.* 2016).

The building was located in an industrial area in Ahuntsic, within 8kms of down town Montreal. The site, two storey building, had been recently renovated with a well-constructed flat roof, which was constructed to take an additional third storey. However, it was never built. Later GKC Architects was appointed on the project. The planning phase tackled technical challenges more than the design (Montreal Lufa n.d). Within this dynamic and culturally diverse city, the design of the urban greenhouse introduced a different type of regeneration. It successfully localised the growing of vegetables minimising food miles, maximising access and taking what is described by the architect and clients as lost space on urban roof tops. The architects believe that these spaces within the urban environments should be utilised to create a sustainable environment and future through urban agriculture for local communities.

Figure 15 rooftop greenhouse

4.1.2.3 Resilience and rights to food

'We would only need to convert the rooftops of 19 average-sized shopping centres to grow enough veggies for all of Montreal. Every new greenhouse we build gets bigger, better, lighter, and cheaper, so that urban rooftop farms can become a must when building new structures' *(*Montreal Lufa n.d.).

The concept of the rooftop farms was not to replace local farms or food makers, as this was not practically viable. The clients' aim was to build a healthier, more sustainable local food system in order to develop a community of hundreds of neighbourhood pick-up points to get food from their rooftops to the community as directly as possible. The vision was efficiency, convenience, and community-building. This also included a fleet of electric cars to supply eco home delivery. Opening doors for community visits and open houses, for people to know their farmer, know their food, and know where and how their vegetables are grown (Montreal Lufa n.d). With the urban agricultural farm situated in close proximity to home and local markets, the cost to purchase decreases resulting in affordability, especially for disadvantaged local community members. Food proximity and production benefits all communities in various ways. Firstly, with access to local greenhouses, communities are educated on the growing process. Secondly, local greenhouses can provide access to practical examples and growing knowing, particularly for individuals interested in growing their own vegetable gardens. The enclosed greenhouse also means all year-round food production, regardless of weather, ensuring communities have consistent access to local produce.

4.1.2.4 Permaculture

Landfills are one of the largest producers of methane, a powerful greenhouse gas. The Lufavores famers believed that organic waste should be composted, instead of it adding to the problem. In an urban agricultural setting, the challenge of space for the compost arises.

To meet this challenge, the Lufavores farmers composted their green waste on site where they or worked with municipal partners to ferry green waste to composting sites. By harvesting to order for each day's baskets, they ensured their vegetables were as fresh as possible and that they eliminated waste from farm to table.

The design principles used to achieve an ecological outcome while saving energy was the primary focus for the greenhouse design. By building on top of an existing building it reduces the effects of heat islands. This resulted in a fully automated and operable glass structure for summers with automated thermal screens to ensure heat is not lost in the night and in winter. Based on a five circuit heating system, different mechanisms were designed to enable a microclimate to be adapted to each

plant. Prime consideration also included rain water retention as well as filtration of the green house water in order for it to be reusable (Carrot city 2014).

4.1.2.5 Urban Ecology

The construction of the greenhouse on an existing building is in line with Spirn's (2011) theory that stated that in order to achieve a sustainable ecology within the urban environment, human needs need to be met. This design approach achieved this while also reducing the building's ecological footprint by constructing the greenhouse on an already existing building foot print. The design encompassed synergies between the existing building and the new greenhouse in order to optimise the energy performance in order for it to compete with other regular farms (GKC n.d). The greenhouse also used half of the heating required for ground level greenhouses due to the following factors: Firstly heat from the building below is used to save on the greenhouse above, while also serving as a protective buffer from the climatic environment above to lower the existing buildings heating needs. Secondly heat is only applied and artificially generated on cold winter nights by using gas heaters. In the city the night-time temperatures are higher than in the country side due to thermal mass heating from the adjacent as well as other city buildings. Fourth point is that energy curtains are used which are automatically utilised during cold nights which help insulate the space to prevent heat loss. Lastly the plant transpiration is utilised in summer to cool the air to reduce heat islands which are created by the tar roof which lowers the energy used to cool the building below the greenhouse (Montreal Lufa n.d).

Figure 16 indoor vertical farming

Figure 17 racks of vegetation ready for packing

A sustainable ecological approach to design and functionality drove this urban agricultural farm. The architects and technical team ensured that the greenhouse would function sustainably, minimising harmful effects on the environment and local communities. An ecological way of design is followed. According to the researcher the cost to ensure such an adaptive design and the feasibility in developing countries such as South Africa requires a close study in terms of the returns such a roof top green house buildings would have over a long period of time .

4.1.3 Pasona Urban Farm, Tokyo Japan

Architect	:Kono Design
Client	:Pasona
Location	:Tokyo, Japan
Construction Period	:2010

4.1.3.1 Introduction / Background

As young people migrate to cities, the concern for future agriculture also grows (Allen 2013). Through the years, various concepts and building prototypes have been designed and forecasted for the distant future. For a Tokyo based office, Pasona, this concept and idea became a reality (Allen 2013). The design of the Pasona recruitment firm was part of a renovation of a 50 year old building. The renovation for the nine-storey office building required the superstructure and the building's envelope to be kept, although part of the client's brief required a total redesign and relook at the building's façades, auditorium, offices, and cafeterias. It further required the provision of roof garden, as well as urban agricultural facilities. The design resulted in a 3995 square meter building, dedicating parts of it to green vegetation and urban agricultural spaces.

Figure 18 External view of Pasona Urban Farm. Source: (Andrews, 2013)

Urban ecology

According to Spirn (2011), urban ecology is critical to the future of a city and its design. Japan relies highly on imported food due to their limited arable land, with only 12% of it being suitable for cultivation (Allen 2013). Because of the scarce availability of land, coupled with the decline in agriculture, the client understood that opportunities for jobs in agricultural farming had become scarce, therefore the client's aim was to cultivate and educate a new generation of farmers. This would be achieved by offering lectures, public seminars and internship programmes to empower students. On top of this, the programme offered financial advice in order to promote traditional and lucrative business professionals in the sector for business opportunities. All of this was done to reverse the decline in farming and to ensure a sustainable future for food production.

Permaculture design.

> 'It is no longer sensible to ignore the possibility of sudden and prolonged changes in the biosphere due to the unknown effects of modern activities. Design of support systems with maximum flexibility and diversity is the best response to a potentially unstable environment (Holmgren1996:7).'

Practically, permaculture encompasses various sustainable design strategies, in order to create a harmonious integration between design and ecology. According to the researcher the use of this

concept is evident in the architect's design approach, which integrated nature in its spatial planning. The architect took the problem which was the lack on arable land in Japan and solved it by incorporating it into the design using the principals found in permaculture.
This ecological integration is also practical in that the food harvested within the office spaces was served in the office cafeterias, making it the biggest farm to table project in Japan. The staff, who worked within the building, maintained and harvested the with the support of agricultural specialists (Andrews 2013). This ecological approach to design minimised wastage and transportation costs. The project made a reality the concept of a full circle ecosystem, where the production and consumption of food was done in the same space.

Figure 19 vegetation integrated within the office's circulation spaces.

Adapting to an urban environment's demands and using the lack of arable land to grow vegetables within the city to solve a problem that confronts humans and the earth as a whole, can be seen in the internal garden view captured in Figure 6. The principles obtained from the concept of permaculture is well represented in this design. The use of the concept is evident in both the client's vision and the architect's design approach. The environmental constraints of the city, as well as the geographical location for agriculture, has led to the incorporation of vegetables within this built environment. The design took advantage of this problem and solved it through integrating vegetables with the building's interior and exterior envelope, while simultaneously creating good working conditions for its

employees. The gardening aspect of permaculture has not been used traditionally. Instead, the use of artificial lighting to generate the photosynthesis process was implemented. Further, hydroponics were used instead of soil in some of the internal spaces With these technological advancements and methods, nature's lessons have been taken into account and adapted according to the new conditions.

3.1.3.2 Well-being

The literature researched on well-being under the literature review stated that the biological need for food and shelter for an adequate livelihood is an important aspect of achieving well-being. This includes protection from the earth's harsh elements, as well as social needs required by humans. The literature further added that environmentally, well-being includes minimising the globe's ecological footprint, caused by the effects of climate change. The adaptation of green spaces to support biodiversity has become a mitigating factor to this global issue.

The incorporation of vegetables within the building's offices was in line with the client's vision, which was to create new farmers in the urban areas of Japan. The client wanted to bring about a new interest within the agricultural lifestyle and space, while also bringing about change in the way local people thought and spoke about agriculture. Further, the client's vision was to create a community of people who had a rooted understanding and interest in the environment (Andrew 2013), which would in turn benefit them environmentally. According to Gallaher (2017), abundant green spaces bring about better health among humans especially among the elderly and lower socio-economic classes. The clients need to have a visual intervention e.g. seeing the vegetable growing process, encourages urban communities to grow their own plants and vegetables. Farming by actively engaging people in a visual manner within their busy day to day lifestyle, also brings the effect of biophilia into the office environment therefore achieving better working environments. Andrews (2013) stated that the maintenance and harvesting of the indoor crops encouraged the employees to become more socially active, which has led to better teamwork in the workplace. When it came to the rentable office space, a significant part of it was lost but the client was more concerned about the benefits of urban agriculture as well as the green spaces for the betterment of the employees and their work environment and engagement (Kono Design n.d).

Figure 20 Lighting details and how light is strategically paced for the vegetation as well as internal spaces,. Source: (Allen 2013)

The architect's focus was not to impose the standards of what 'green' should be, but rather focused on encouraging a change in the way people thought about their environment in their everyday lives. The importance of not merely thinking about natural resources from afar but rather actively engaging with nature was also part of the architect's focus. Therefore, the project aimed at striving to inspire other offices to embrace this type of design to encourage young urban dwellers to rethink about agriculture in order to reinvigorate it in rural areas (Allen 2013).

3.1.3.3 Rights to food

'To be self-sufficient is to have the ability to produce all requirements and needs; food, tools, clothing and shelter' (Holmgren1996:12). '

The office headquarters dedicated 20% of their 215,00 square meter office space to planting and growing fresh vegetables, making it one of the largest indoor urban agricultural farms in Japan. It incorporated the use of hydroponic mixtures as well as soil-based farming (Allen 2013). The incorporation of vegetables into the architecture consists of a double skin green façade, which created a balcony where oranges as well as flowers grew. Externally, the building appeared as if it was wrapped with green foliage. Internally, fruit trees were used as partitions. In the office's seminar rooms, bean sprouts were grown on the underside of the benches. Inside the offices and conference rooms, tomatoe vines could be found suspended above the table.

The design required ducting and piping to be rerouted to the buildings perimeter in order to achieve a maximum ceiling height. The height enabled the building to achieve climate control. Observation and tracking of the humidity and temperature for adequate airflow into the building was required. For the safety of the employees to achieve a conducive working space as well a suitable space for the growing of vegetables.

Hidden between beams on the bottom vertical edges were lighting fixtures which the internal space between the beams a light cove. These light coves were used throughout the office spaces from the second to the ninth floor, which resulted in a 30% reduction in energy (Andrews 2013). The indoor spaces required a warm environment for plant growth, which resulted in the working spaces becoming uncomfortable, which the architect regarded as the building's greatest downfall (Allen 2013).

3.5 Conclusion to Precedent studies

The chosen precedent studies demonstrated how the concepts and theories in the literature review can be incorporated into practical building environments in a manner that is sustainable, using existing buildings and adaptively reusing them to grow vegetation that provides fresh produce for local communities. These spaces not only provide food security by feeding their local communities, they are also ecologically beneficial to the urban environment in that they create biophilic spaces for locals to experience and be a part of. The localisation of food production in these controlled buildings means communities are less likely to be affected by natural disasters and the harsh realities of climate change. This ties into the Walker and Salt's (2006) definition of resilience thinking, which advocates for adaptable solutions that reduces humans' carbon footprint in an ever changing environment The architectural responses from the architects and clients that incorporate vegetation into the built environment illustrates how vegetation serves multiple purposes that go beyond simply providing food. These responses demonstrate how the growing of vegetation brings communities together in a social manner while also locating people closer to their food source. Although some of the conceptual permaculture design ideas, principles and ecological thinking has previously been seen as an idea for the distant future, these examples establish that they can be implemented currently. Despite the fact that the indoor growing technology is still being constantly improved, such case studies show how the built environment can be utilised effectively in the urban environment. In these urban building typologies, the regeneration is evident in the forward thinking by both clients and architects who have redefined urban spaces and taken control of them, illustrating forward thinking that can improve the lives of urban dwellers and their environment.

Chapter 5

5.1 Case Studies

The chosen case study reviewed an organisation initiative that was not lead by professional architects but individuals who found opportunities in unattended abandoned buildings in urban and peri-urban areas. These individuals started to make a difference in their communities by utilising the physical structures of the built environment as opportunities for alternative use. Innovative forms of urban agriculture began to take place as a means of securing food in the urban environment. Even though the approaches are varied, their overall objectives were similar. An urban precinct/building was chosen in South Africa. Instead of focusing on the final product, the case study also analyses on how the built infrastructure was re-adapted into its context, as this is one of the many means in which alternative urban agriculture can be adapted usefully.

5.1.1 Green camp Gallery: Umbilo, Durban South Africa

Organization : Green Camp Galley

Founder : Xolani Hlongwa

Construction : 2013- ongoing

Location : 246 Umbilo Rd, Bulwer.

Introduction

'consider a dilapidated building with few broken windows. If windows are not repaired, the tendency for vandals is to break a few more windows. Eventually, they may even break into the building, and if its unoccupied, squatters move in and light fires inside. This attracts more crime, drug and prostitution destabilizing the neighbourhood' Xolani Hlongwa Green Camp Gallery Founder

The green camp gallery was located within the Durban suburb of Umbilo, which was both an industrial and residential suburb that housed offices, shops, stand-alone homes, and flats. Among these spaces were abandoned and derelict buildings which had been left unattended. This resulted in homeless people taking occupation of the buildings. In 2013 Xolani Hlongwa, a 43-year-old former ballet dancer turned social activist, found one of these abandoned corner buildings at the industrial end of Umbilo, Berea in Durban. The concept of starting the green camp gallery came about from his travels, as well as the difficulties he had witnessed from traveling across Europe for 16 years. Due to various circumstances, he felt these experiences were designed to bring negative impacts into his life, which resulted in him being homeless. Through his journey he stumbled upon an abandoned building

in the Durban suburb of Umbilo which he occupied for years before starting the urban regeneration project through the Green Camp Gallery.

Urban regeneration

Located within downtown Durban the Green Camp Gallery is surrounded by a mix of middle- and upper-class communities, uneducated labourers, students as well as petty criminals. The site was occupied by a group of male squatters and was a hot spot for drug related activities. It would become catalyst for change and regeneration with a long-term vision, aimed at broadening people's thinking as well as educating them on how to live within their communities and environments sustainably. Hlongwa described the concept of the Green Camp Gallery as an ''urban farming, urban renewal project that entails applying indigenous knowledge systems that are based on Hlongwas ideas which mostly include renewing the inner environment'' (Sosibo 2018). The work done by Hlongwa on 246 Umbilo Road was far more than what met the eye. His concept and implementation demonstrated regeneration within an environment faced with urban decay and where ecological balance had been lost. It redefined its position through its adaptative reuse, reshaping what was once seen as unattractive into a space where people could gather and learn. The model aimed to create an interaction with the local environment and create reverse gentrification. Unlike gentrification, the vision was to create a space for people who come from broken environments like the founder himself; which would resulting in a sustainable balance that improves people's livelihoods and communities.

Figure 21 site location plan source: South Africa-V n.d.

Urban ecology

This project, according to the founder, consisted of a ten-year plan that was grouped into three stages: recycle, rehabilitate, and stimulate. These stages were further broken down into years**.** The first three years fell under the recycling stage, which entailed recycling and reusing the existing building both internally and externally. Their definition of recycling was further redefined to have a new meaning; by recycling they aimed to bring back the dignity of space, while also reclaiming it. The fourth to sixth years fell under rehabilitation. t=The individuals involved wanted the recycling process to give birth to rehabilitation., Once this was achieved it would lead to the stimulation process which took indicated the final six to ten years. Through this ecological approach, the vision, implementation, and design hoped to bring about other similar projects to create sustainable communities.

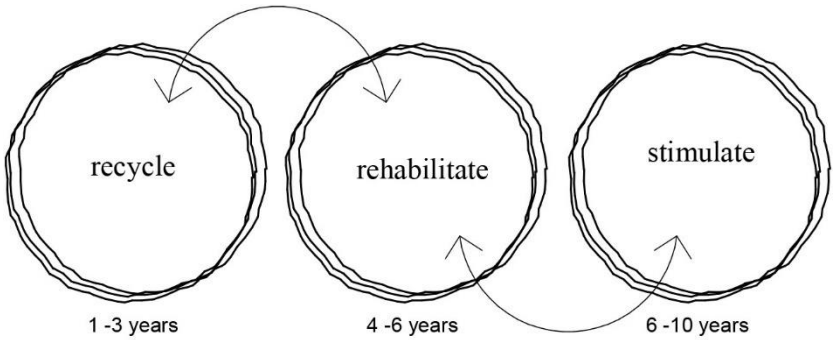

Figure 22 Diagram illustrating the Green Camp Gallery's 10 year cycle plan. Source: Author

Figure 23 Views of the adaptively used building using materials that were left over from the abandoned house as well as materials that were donated to the Green Camp Gallery by various organisation and people in order to create artistic pieces to plant in. Source: Author

Rights to Food + Resilience

The Green Camp Gallery addressed issues of food security and caring for the environment. This was done by approaching the problem at the grassroots level. Through the restructuring and cleaning of the abandoned property, the Green Camp Gallery illustrated how urban farming, creativity and social responsibility could positively transform neighbourhoods previously plagued by urban decay, crime,

and social disintegration. Resilience was demonstrated through the capacity to adapt to new conditions, which further educated people on how to grow their own food through recycling and community support.

Integration of Permaculture Design and Urban Agriculture to Achieve Well-being

Hlongwa was an advocated for recycling and observing nature. The activist asserted that he had learnt many lessons from his observations of nature. The concept of permaculture design aims to integrate components that have been learnt from existing ecosystems in order to provide guidelines for the creation of a sustainable design method. This was evident in the Green Camp Gallery. The space was a hub for urban agriculture or urban farming, as the founder referred to it. It further served as a space for rehabilitated art. The gallery space utilised used materials that were left over from the abandoned building, as well as material that was donated to them by various organisations and people, to create artistic pieces to plant in, such as old shoes. Both the internal and external spaces intertwined as one moved from office spaces to the gardens, to the shops, and finally, to the private spaces. Old materials were rehabilitated and recycled in order to show people and the community how to do so in a creative manner. What was once a derelict, crime ridden site housed art exhibitions, movie screenings and gardening workshops. It became a place where neighbourhood children could play in. Food grown within Green Camp Gallery was bought by local restaurants, informal traders and markets.

Figure 24 Vegetation grown in recycled tyres

Figure 25 Outdoor courtyard space created as a hub for urban agriculture which they refer to as urban farming as well as a space for rehabilitated art in a form of a stage for outdoor performances. Source: Author

Figure 26External close up view of the Green Camp Gallery entrance. Source: Author

Figure 27external street view of the Green Camp Gallery. Source: Author

Figure 28 Vegetation grown in recycled pot plants Source: Author

Figure 29 Fresh vegetation grown from the green camp gallery packed and ready to be sold to surrounding restaurants and informal traders. Source: Author

Conclusion to Case study

In a country faced with many challenges, this case study has raised critical issues that affect individuals and communities. The case study exhibited how individual can take ownership of these problems, and thus putting responsibility in the hands of all global citizens. Further, the case not only demonstrated ways in which humans can use their environment to better suit them, but also illustrated one can manipulate one's built environment in a more ecological manner. The approach to design was holistic, taking into account the human need to exist in an environment that caters to all needs

required for a better livelihood. The use of vegetables and recycled materials to define spaces, as well as a combination of roofed and unroofed spaces, demonstrated allowing surrender to nature, allowing new ecosystems to form yet providing shelter for its cofounder activist and the visitors who used the space. The theories and concepts used to analyse this case study reveal great lessons which can be taken to better the future of South Africa. Through the analysis it is evident that no space is left undefined, and in its current form it is subject to change in which lies the freedom of adaptation and the beauty of the space.

6.0 Conclusion and Recommendations

6.1 Introduction

Various chapters within the presented research have discussed primary data, secondary data, theories, concepts, precedent studies as well as case studies. Based on the findings, each chapter has been concluded. The concluded resolutions in each chapter tested the hypothesis which states *'Alternatives methods of agricultural food production within the city's urban built environment can assist in alleviating food security for a growing urban population'*. This chapter seeks to illustrate how these findings come together to form a holistic body of work that aims at answering both the main as well as the sub questions while proving the hypothesis. This was dine in order to generate design principles and strategies for the final architectural design intervention that proposes a mix use urban agricultural food production and research centre within the city of Durban, South Africa.

6.1.1 Conclusions and Recommendations

This research was undertaken due to the fact that incorporating alternative means of urban agriculture using technology and indoor farming was perceived as a concept for the distant future to deal with future consequences projected to be issues of food security. According to the researcher the research findings have shown that this is a current concern that will inevitably affect the future more severely if it is not researched and implemented sustainably today., The research thus sought to bridge the gap between the built environment and traditional agriculture practices. This approach was taken because traditional agricultural food production was still reliant on large plots of land on the outskirts of the cities. Yet a large portion of the world's population lived in cities with numbers predicted to continuously increase with time. In Africa, moving to the city is a means to a better life, yet a large percentage of urban migrants experience food insecurity, forcing dwellers to grow their own food either for personal consumption and/or for sale.

The issues of food security in this research were aided by the concepts of well-being and resilience. Well-being deals with the provision of an urban environment that caters for basic human needs (food and shelter, as supported by Maslow's theory on The Hierarchy of Needs). Resilience focuses on the importance of planning for a changing global environment which may affect human living conditions and the environment humans rely on to produce food. These concepts form part of the key principles for the research design. They provide insightful guides that support the built environment's facilitation for indoor food production, which come with the benefits of growing in controlled indoor environments. The aim of the research was to establish a need for the creation of controlled environments as a means of protecting and planning for social disasters.

Although the main question posed in this research was to uncover lessons which can be learnt from successful urban agricultural projects and how these new technologies within the built environment as well as in agriculture have aided in achieving the growing of crops in limited urban spaces.
The literature in the research revealed that adaptation and using the city's existing infrastructure and resources is that one of the sustainable way to achieve an ecological urban environment that caters to its inhabitants. This approach enhances already existing agricultural practices that can be beneficial to communities, as tools of upliftment and increase food security.

In the unpacking of the need for urban agriculture the research revealed key links between the conceptual and theoretical frameworks discussed in the literature review, demonstrating through precedent and case studies how the built environment can incorporate vegetation into different types of buildings. The links between urban agriculture and ecology revealed the importance of putting back ecosystems that are beneficial to the environment. Where life cycles are removed, the urban ecology theory encourages urban designers, architects and other building professionals to be aware of their natural environment and the benefits these environments have on the overall well-being. The buildings they design should take its lessons from the natural environment whether a building is new, derelict, or underutilized. Permaculture also demonstrates the importance of incorporating vegetation in the urban spaces.

The findings in the precedent studies and case study can be used by professionals in the built environment to produce architecture that is functional for creating food production in spaces that have a limited urban footprint. Although the theories used look at the urban environment from a broad perspective, the urban regeneration theory encourages city planners and even architects to use a bottom up approach in catering for the needs of the urban poor. Even though in food trading spaces urban dwellers have informally created their own urban environment to suit their livelihood needs, these also become lessons for professionals in their aim of formalising these spaces.
This was successfully done in Durban's Warwick Junction regeneration initiative, revealing the importance of inclusion in designing for people so that they have a sense of ownership in the environment that is being created. This is in line with the aim of the research which was how use the built environment within the city to create a social atmosphere that attracts, provides and educates people on natural plant-based agriculture and food production.

The precedent studies provided practical guidelines on how the built environment can be a multifunctional space for agricultural food production, which can provide good practice lessons for

consideration in the researcher design proposal. It simultaneously demonstrated how adaptive reuse can incorporate urban agriculture, while also providing social, economic and environmental benefits for the urban environment. The adaptation to already existing, underutilised buildings within the urban environment become a sustainable strategy, due to the buildings envelope already being already constructed. This cuts out further environmental disturbance that come with new buildings.

The adaptation introduces a new use that is relevant to the demands and needs of a growing urban population, as well as the needs of the urban community. These building also have social benefits and help to retain the national heritage of the building.

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Appendices

Council for Scientific and Industrial Research Interview

INTERVIEW SCHEDULE FOR PROFESSIONALS THAT SPECIALIZED INSIGHT ON WITH URBAN AGRICULTURE

Name of persons interviewed and positions held:

Mr Boyse Pillay: CSIR Manager CSIR (ECD)

Mr Francois J Prinsloo: CSIR Business Development Manager

Dr Blessed Okole: CSIR, Research Group Leader, Agro-processing

1. **What is your involvement in creating a more sustainable alternative agricultural that can be incorporated effectively in the South African context.?**

Mr Boyse Pillay - CSIR is a research and development organization that also focuses on implementation. The majority of the CSIR organization focuses on research and development we focus on implementation.

We want to takeout the research outcomes so that it becomes beneficial to industry, society and communities. We do a lot of economic development work we call "enterprise development". We focus a lot on economic development, we also have a number of sectors that we focus on such as agriculture and agri-processing in one. We focus on agriculture, manufacturing, green economy, waste management, renewable energy, mining, chemicals, ICT, built environment. We have generic tools and processes that we use to then create economic activities in those sectors.

We have developed a very strong interest in sustainable farming systems. We have conceptualized a sustainable farming system, research development and implementation platform that we are close to finalizing the concept. We hope to establish that at this year's CSIR with a number of external players. Also, in terms of sustainable farming systems we have colleagues that focus on precision agriculture which is looking at, earth observation using both big data and small data which is using satellite imagery and drones, that's roughly what we do.

2. **What are some of the ways you are implementing alternative and sustainable agriculture that can be used in the urban environment.**

Mr Francois J Prinsloo - We looking at ways and means that we can actually get sustainable farming technologies out into industry, quite often you will find that people have followed

conventional farming methods for years and years, everyone knows how to do that. But when you start to look at the newer agricultural practices there is quite often a lack of areas or expertise that people can look at that where you can go to and talk to people to find out that okay, if I want to put in a vertical farm what type of growing conditions are there, what are the costs what are the technologies that are there? what do I need to operate it This sustainable farming? Our research and development platform we are looking at establishing is there to create a platform that people can actually access to actually give them information on how best to utilize their funding, where to get the necessary expertise if they get the funding. That they don't go into something with no background knowledge.

You will often find that something will fail and they don't have that support that you need. So, from our side the sustainable platform that you are looking at initially is that they are areas like the agricultural research council that are looking at conventional farming methods so we need to look and see where does the CSIR expertise lie and where can we best add value. One of the things we have decided to look at is initially as far as sustainable farming platform is concerned is that we have started to focus on vertical farming and on aquaponics / aquafeed and then to eventually see how do we eventually see how do we integrate these two with each other, cause what you find quite often is something like a vertical farm is quite often focused on vegetables and food etc. But it does not look at the protein source. Now if you look at aquaponics typically like fish farming shell fish farming etc. there you start adding the protein source. The ways and means are that you start integrating these two to start basically creating a circular system where the waste from the plants can produce aquafeed that is used to feed the fish and the fishes waste can be used to fertilize the plants. So, what you do is that once you start integrating these technologies together you can get a system that is totally self-sustainable so the waste in minimized.

3. **What are your views on the concept of vertical faming within the built environment is it sustainable?**

Mr Francois J Prinsloo - Currently with the normal vertical farming there is waste being produced and you need to get rid of the waste. If you can recirculate the waste and use it for something else you can basically start minimizing the costs. One of the big things with vertical farming is you mentioned now closed environments for agriculture. Closed environment agriculture as you ae aware is like green-houses someone just putting a plastic cover, putting a garden over a roof. Vertical farming is the next level where you start really utilizing technology to improve the growing conditions. You can get almost 30 to 40 increases in your productivity because now you completely controlling the lighting, temperature and humidity. and you can optimize these growing conditions. You can manipulate plants into growing in the night because by the controlling the lighting by increasing the

growing cycle. You can tailor the lighting conditions to really optimize the nutritional value and everything else.

One of the key issues is this vertical farming platform is the cost and its rather expensive at the moment. But there is potential for it and people are constantly improving it. If you look 10 to 15 years ago it was extremely expensive now there are certain crops where it's making economic sense to them and especially if you go to some of the first world countries like Singapore, Japan and the Netherlands. Wherever they have limited arable land available or they have limited area, the people are starting to move more and more towards these types of solutions of smart farms. Where you can improve productivity is a small area. You can imagine that eventually that you have the arable land of one hector eventually it can become cost effective, you can completely cover that vertical farmers and you can take that one hectare and you can make it produce the same as 30 hectares and if you look at population growth after a while we will start to run out of space.

4. **What kind of environment do you feel are best suited for growing indoors and what do you think is the biggest driver for these forms of alternative agricultural strategies?**

Mr Boyse Pillay - What we are looking for is a system that is totally enclosed you have controlled systems where it controls the lighting but also it controls the energy use, so you have an energy lighting system that you can start to incorporate a local grid. So that you put in renewable energy. There are many reasons to put in these systems but the biggest driver which is the only main one which is water scarcity, so this system uses 96 percent less water. and it recirculates, given the situation in the country water scarcity is the overriding driver, there are many other reasons why but water, many South Africans don't know or realize where we are in terms of water in the country. and the buildings energy system, how do you start to integrate that in a building so that if let's say you have peak times and off peak you have cheap electricity too. Vertical farming uses a lot of energy because of the lighting. So how do you then design systems and put in renewable energy already on a building. Whether its wind, a combination of solar panels that's the excitement when you can start to intergrate that into a building.

Mr Blessed Okole - From an architectural point of view when you are designing a building how would you make is water efficient to recycle water is an important consideration.

Mr Francois J Prinsloo - That's where the CSIR expertise lie we have people here that are from the energy centre that are experts in renewable energy. We have people from Future production who are experts in robotics and automation. If you look in the current vertical farm you still have people

walking in between and you have to have a passage but when you start looking for systems in a building where you start integrating automated pickers and sensors you can use that additional space where currently a human being is walking, you can put an extra tray of vegetables there. So the big thing there is you've got these systems that start optimizing the picking as well where you have sensors that monitor plant for plant whether that plant is ready for picking or not. To get the optimal conditions of the plants and the nutritional value of the plant. The CSIR has even now started developing systems where they are working with the wine farmers in the Western Cape where they have developed a system that monitors the sugar content in the grapes.

The management of the data you need the management of the crops and water trying to get this big data together and try and see how do you optimize your processing of that data to get conditions that best suit the growing processes and improvement.

Mr Boyse Pillay - 4IR technology needs to be built in the artificial intelligence and key repository of data so that you can constantly use past performance to optimize the production system.
The future of food production system the future is the network of food production systems worldwide. You can network to Dubai if they need so many tones of lettuce at certain times you can literally order it through the network from a different system. So that's where there is a lot of research being done there, especially in the United Kingdom on network systems. If you are designing a building you would need to bring that into the design.

On robotics we currently have in most of the greenhouses in Holland nobody plants a tree it's all automated. Everything is automated. You need to look at the front end as my Pillay spoke about the harvesting side. The preparation side you have to look at how you can do that because you want an efficient system all of it has to be efficient. How you bring your inputs and how you take out your outputs

Mr Francois J Prinsloo - When you have a proper vertical farm you have controls in place you can basically be pesticide and herbicide free. So what you have is controlled access, the less people come in the better and in some cases some of the vertical farms go through airlock system
Blessed
Building must be airlocked to control pests into the building
Mr Francois J Prinsloo - Once we have the different systems such as old building and old mines design systems for different application as as rural areas, industrial areas, townships that's where migration is taking place. So different types of systems we want to look at.

5. **In future how can you ensure that farming in cities is controlled and effective.**

Mr Francois J Prinsloo - What's important is to have the repository information so that you don't have or do the same thing over and over again. If someone says I want to do this where has someone done something similar previously and I think that's the biggest thing is to try and build a data base of how to utilize a mine how to utilize a building, if you have a certain type of building and want to incorporate it you have systems that are suited for that type of building. And looking at areas and see what is the need, if a farmer has put in leafy vegetable why put in another one right next door rather try and see what other crops they are(has put in certain crops in a nearby area see what other crops can be grown).

Mr. Blessed Okole - with crops you have to look at high value crops it is very important, high value short term crop and the cycles should be short and the value should also be high

Mr Francois J Prinsloo - The most important is the issue of water shortage, sometimes you are willing to pay more to get something you couldn't feed yourself with in any other fashion especially in places where there is no arable land.
When you run out of water or you have limited water source how do you manage it? You need to have a vertical farm, one that can still feed us, otherwise we are going to starve to death then that starts to look at the wellbeing of the population. Funding then needs to be put in place otherwise people have no food. We have saved money but people are starving

Mr Boyse Pillay - The cost of the system is very high at the moment but when the CSIR was advocating for renewable energy 25 years ago they said the same thing and now it's cheaper, we must not be constrained by those kinds of issues because at the end of the day the water scarcity relates to food security. We wont have food if we don't have water.

6. **What do you feel are the environmental benefits of urban agriculture?**

Mr Boyse Pillay - The carbon footprint is going to be reduced because you can grow where your consumers are so logistics work. Growing in let's say in Limpopo then getting the produce down to cape town woolworths for example so that they can distribute it all across their stores, the carbon foot print is huge. Whereas now you grow where you live. I think we will see in 5 to 10 years where people can grow their own food and have their own vertical farms at home, that's the vision. That if I, there are certain vegetables we eat but there are certain herbs that we use in our cooking, so with agriculture you can grow it at home that's where it's going.

Mr Francois J Prinsloo - There are certain store in japan where now where they have little vertical farms inside the stall that's growing.
As **Boyse** mention with energy as well that 20 years ago nobody had solar panels on their roofs, now people have them and we predict vertical farm is the next thing. You have your little 2- or 3-meter squared area which might cost you one hundred thousand now to put it there but you will totally be self-sufficient, you are not using as much water, your electricity bill is being dropped by the use of solar panels. It will start with you little vegetable garden that you have and you will use a lot less water that you have, home grown vertical farm

Mr Boyse Pillay - But I think there's another trend that is very important to consider which is once you have the vertical farm then having a processing unit next to it, so the trend for the health conscious, people are saying internationally that very soon people won't be taking normal supplements they will be having a shot of juice in the morning to meet their nutritional needs, the absorption in terms of our bodies is much greater. Many people are not processing the supplements and I had an interesting discussion on Friday when Ken and Janine Scofield (a geneticist) they are doing work on the effects of traditional European developed medicines, drugs for cancer treatment and what they found is the African genetics are 30 percent of the continent people can, not be absorb them. Drugs are designed for European and American but they are not absorbing the nutrients, the active ingredients so that they can cure cancer or breast cancer can be cured its just passing through so they are doing work on the liver system and genetic finger printing to say how can you put together a decision making tool for doctors so that they dispense the right medication for the right illness

Mr. Blessed Okole - That personalized medication that's where it's going to go. And Europeans are almost there now and in SA that the right way to go about it. If you look at finger prints you can say what is going to work for you
Mr Boyse Pillay -That is where the future is going to go. They want to set up a system where you can do a or send a swab and they can analyse it and know your genetic make-up so they can give you the right treatment.

7. **Ideally where would you like the food you eat to come from?**

Mr. Blessed Okole - I'd like to see what I eat, everybody likes to see what they eat.
Mr Francois J Prinsloo - everyone now read the labels on their food, you don't need a label when you see the food that is being grown.

Mr Boyse Pillay - With food it's about going back , if you look at villages across the world people who grow their own food live longer and are healthier and I think that's where we should be going back so that if I want I can have my own vertical farm at home and I have a variety of things, then I know what inputs are going in there in terms of pesticides if even any. Then I know that the food I grow is fine.

Mr. Blessed Okole - Also having vegetables and herbs, everybody should do that I have mine all the herbs I have I grow, its easy and it bring joy to know you did it yourself and its growing,

Green Camp Gallery Interview

1. **What does urban agriculture mean to you?**

To me urban agriculture means the ability to prepare for a role in the future of a country that is currently so unstable climate wise, financial wise, landscape wise. Urban farming for me covers all this together.

2. **What do you feel are the benefits of growing food within the city Centre?**

As Green camp my understanding and what this means for us and why we are doing it and the reason we choose this medium of communication it is not for the outcome of the food security. I am driven by a sense of identity so that's the main core of why we are doing this, its about identity. Once you identify yourself with farming by yourself, by the idea that you could do it within the urban space, you are coming a long way of deep searching within yourself.

What we are doing is called "urban farming" it's called urban farming because it's an English term but we regard it as building food sources, because food is health. Its food health and living because we cover homeless people so that the city does not have to stress about them.

3. **How do you think architecture can help in facilitating the growing of plant-based crops within the built environment?**

For green camp perfect architecture is an unfinished architecture. it's a broken-down architecture that allows identities that were not allowed in before, moving away from one-way thinkers and elitist design. It's about dismantling, and representing indigenous knowledge system as a way of doing things before the industrial revolution came with industrial thinking and then building things in a normal type of thinking so that we can rebuild again. So, if we can revisit those moments and borrow from that then we can recognize that it is inevitable that we are putting life into something that has been stagnant by reintroducing nature to it. By allowing nature to be part of the architecture, it allows nature to heal at the same time since we have a crisis of food, it creates urban farms.

4. **Who do you think will benefit the most if food was grown where people live?**

Households and families that live in those areas will benefit the most because they will get direct sources of food. When you talk about urban farming you talk about organic foods, from organic we borrow the concept of permaculture, its another symbol of borrowing from the past and not planting for the masses but planting mono and not using pesticides and chemicals to control one crop, but with permaculture you use the natural cycle and ecosystems, you don't use pesticides instead of using chemicals you have chickens that pick some of the bugs for food, we use our worms to food and recycle kitchen waste, the whole ecosystem takes care of its self. We finally have frogs that is the

symbol that the whole ecosystem is finally complete, so in the urban space how can we grow enough food to have a variety with all nutrients for a family. Through health we can take the right decisions that are not rushed into false fantasy. Green camp is saying we need to following recycling, rehabilitation, stimulation.

5. **What do you feel are the environmental benefits of urban agriculture?**

It cleans the air, it purifies the air and regulates the environments temperature; it makes cities greener and more attractive, urban agriculture brings back nature, and that will create a better urban environment. I feel it will make humans calmer and people will think clearer.

6. **Do you feel growing plants within the built environment is a feasible way in helping alleviate food security for the urban poor?**

Yes.

7. **Ideally where would you like the food you eat to come from and why?**

I am about balance; health is the number one priority. If there is health, longevity and strength theirs some sort of happiness and food is somehow linked to that. Health is organic to me, anything that is organic is the basics for me anything that is processed is not healthy for me so I don't want that for myself so obviously I want to grow my own food, that is what I want to do.

8. **What kind of green spaces would you like to see in the inner city?**

I feel the inner city should be green all over, I think pavements should have fruit trees, if we have that why would people be hungry? If they can just pick them on West street or Smith street. The foods are also colorful and beautiful making beautiful gardens so why not plant them in the city and let the people get fed.

9. **What kind of impact do you feel green urban spaces would have for people living in the city especially the urban poor?**

Healing

Design report

PART TWO
DESIGN REPORT

Table of Contents

Chapter 1

1.1 Introduction

The proposed design is a mix use food production and research centre. The building is centred around food production as well as teaching aspiring farmers on the agricultural food growing process.
This will be achieved by adaptively reusing an existing dilapidated building in the Durban area Berea which is currently utilised by urban squatters. The dilapidated buildings surroundings and street edges are utilised by numerous informal traders who sell various forms of fresh food produce as well as other products as a means of income. The aim of the design is to bring the growing and teachings of fresh food farming closer to urban consumers in a sustainable manner, using new indoor growing technologies. Potentially new urban famers will learn new skills which they can take to start their own business. Alternatively the vegetation that will be grown within the proposed building will be sold to the local community as well as surrounding areas. This process will reduce the urban carbon foot print that occurs when vegetation is transported into the city from farms outside of the city.

1.2 Project Description

The context and site location of this proposal is crucial to the project in that it has to address the urban problems surrounding food security within the city. The chosen site is in close proximity to Warwick avenue which is Durban's largest informal trading hub. It is also surrounded by the early morning market which houses traders who sell various produce. The vegetables are imported into the city.

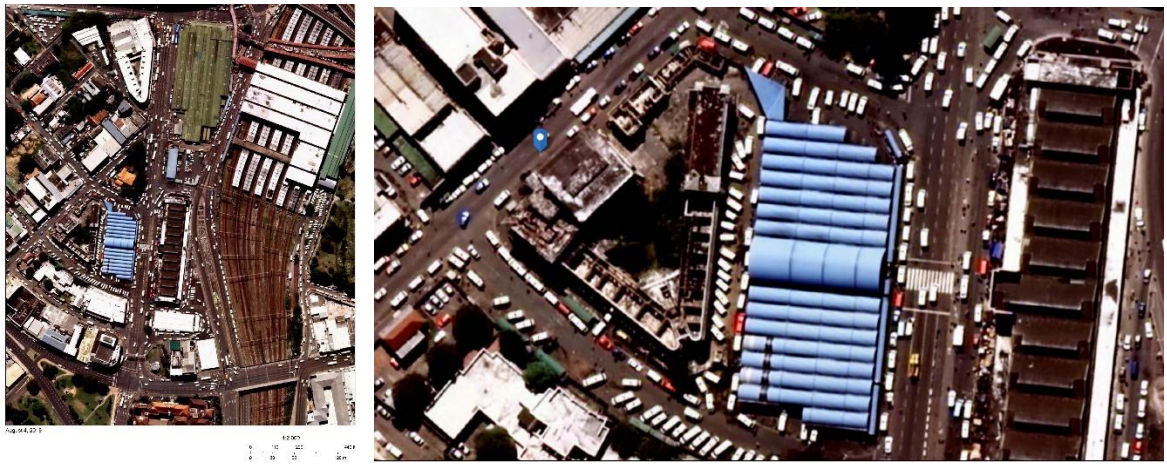


Figure 30 Site location Map

The project is envisioned to be part of the Department of Agriculture and Rural Development skills development project. The department is envisioned to help lead and facilitate the teaching of

alternative means of agriculture to potential farmers. The Council of Scientific Research who have an agricultural division will facilitate with research in agriculture and agri-processing as well specialize in strategies to implement sustainable farming methods. Teaching new technologies that require minimal water use. The researchers will form an integral part of the running of the facility. Lastly SAB will have offices within the facility they are currently looks into innovative ways to help tackle youth unemployment effectively in South Africa. Their Urban Agriculture initiative is one such initiative which involves commercial hydroponic farming. This initiative closely aligns technology and food security, as well as consumer education to facilitate job creation amongst young unemployed graduates. Through the facilitation by the Department of Agriculture and Rural Development the scheme will identify agri-entrepreneurs who will use this facility to grow their business. The produce will be sold to restaurants and local communities around the city and the profits will go to the entrepreneurs themselves to assist them in managing their businesses.

1.3 The Client, Client Requirement and Schedule of Accommodation

Figure 31 Figure 19 Agriculture & rural development (left), Council for Scientific and Industrial Research (middle), South African Breweries (right)

All the functions of the building are set out to meet the operational functions for the clients' needs in order to facilitate the running of the building. The functional component of the spaces that will be occupied by the general public on a daily basis require a strong link between the surrounding community areas and the building.

Agriculture & Rural Development Policy framework

The NGP set targets of increasing the smallholder sector by 300 000 households, ensuring 145 000 additional jobs in agro-processing, and upgrading conditions for 660 000 farm workers.

The NGP provides the following broad policy guidelines for agriculture, forestry and fisheries:

- *Restructuring of land reform to support smallholder schemes with comprehensive support around infrastructure, marketing, finance, extension services, etc.*
- *Upgrading employment in commercial agriculture, especially through improved worker voice*

1.4 Selection Criteria

The site selection for the proposed agricultural food production and research centre had to be in the city in close proximity to food traders as well as in an underutilised site that had great potential to house food production as well as teach people within the city to grow their own vegetation. Within the

chosen area a few kilometres away from the site is the Durban University of Technology which teaches Horticulture and this building can be an extension to the university and host public workshops and teachings. Food produced within the building can be sold within the building as well as to the existing formal and informal stall that are around the site.

1.5 Design principals

Adaptive reuse -The site is located on 44 lacers in Berea. Currently situated on the site is an abandoned building which is utilized by squatters. In close proximity to the site is Warwick Junction, the Early morning market, the English market as well as other various street traders who sell fresh produce with they get from farm located out the outskirts of the city who then transport the produce using up fuel and energy emitting Co2.

Building outcomes.

Linking – linking people to local food source

Materiality

Materiality current building is constructed using a combination of face bricks as well as bricks which have been plastered and painted


Figure 32 Existing building materials

Visibility will be created by the design of an urban greenhouse – The proposed attached transparent building will great a sense of visibility, so people can see the growing processes,

Glass as opposed to plastics such as polyvinyl chloride, poly methyl methacrylate, polycarbonate etc will be used due to its thermal properties, the vertical farm growth also means you can yield more per square foot area

photovoltaic cells will be incorporated to generate power for when there is insufficient light, in these cases additional electric light energy will be used for the plant growth.

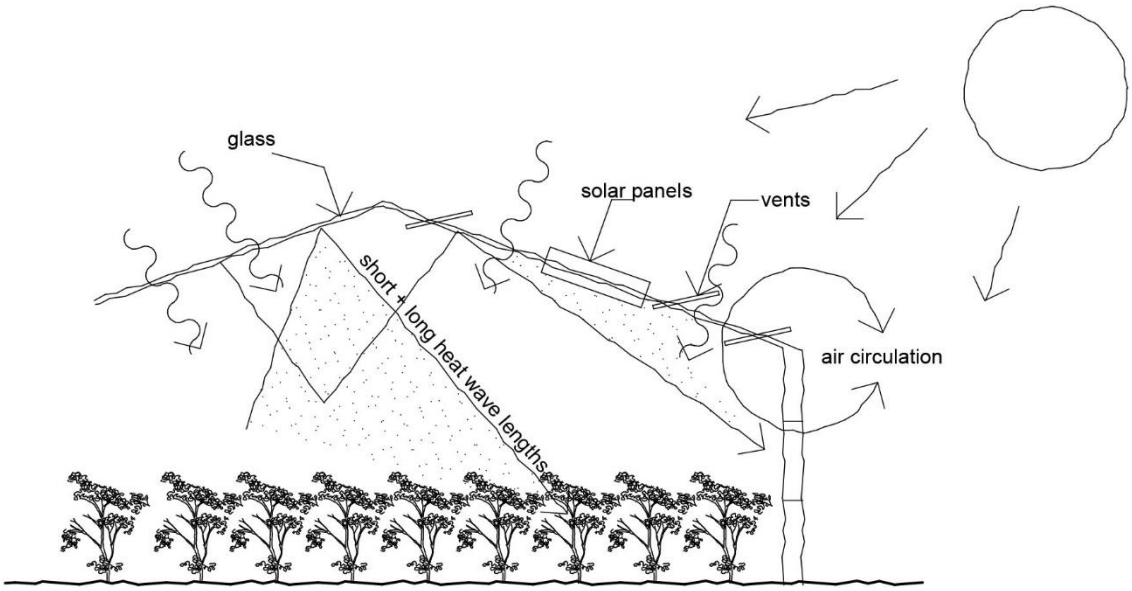


Figure 33Design consideration for the greenhouse design. Source: Author

Area schedule

Ground Storey	
Public building	
Room	**Area**
General Entrance lobby / Reception	170 sqm
File room	8 sqm
Reception Ablutions	5 sqm
Switch Room / IT room	15 sqm
Restaurant	250 sqm
Kitchen	63 sqm
Restaurant Ablutions	53 sqm
Store room	19 sqm
Switch Room / IT room	23 sqm
Welcome Centre / Information Centre	124 sqm
Seed storage	119 sqm

Female Change rooms	27 sqm
Male Change room	23 sqm
Disabled ablution	3 sqm
Trading shop x 5	270 sqm (total combined)
Soup kitchens / trading shop with Store Rooms x 7	339 sqm (total combined)
Meter Room	64 sqm
Water storage	133 sqm
Delivery Room	60 sqm
First Story	
Vegetation store room	335 sqm
Green house	800 sqm
Monitor Room	169 sqm
Open Plan offices	449 sqm
Unisex Office Ablutions	26 sqm
Teaching space 01	188 sqm
Teaching space 02	61 sqm
Teaching space 03	39 sqm
Teaching space 04	64 sqm
Store room	22 sqm
Female ablutions	14 sqm
Male ablutions	14 sqm
Disabled ablution	3 sqm
Store room	30 sqm
Second Story	
Vegetation processing room	150 sqm

Storage room	163 sqm
Open Plan Offices	409 sqm
Workshop room	205 sqm
Lecture room	80 sqm
Teaching room	39 sqm
Teaching room	63 sqm
Female ablutions	14 sqm
Male ablutions	14 sqm
Disabled ablution	3 sqm
Store room	30 sqm
Third Story	
Residential units x 5	
Open plan kitchen + Living room	30 sqm
Bedroom	18 sqm
Bathroom	8sqm
Other units	
Open plan kitchen + Living room	48 sqm
Bedroom 01	20 sqm
Bedroom 02	14 sqm
Bathroom	8 sqm

Chapter 2

2.0 Theories

2.1 Urban Ecology / building Ecology

‘‘buildings that make oxygen, sequester carbon, fix nitrogen, distil water, provide habitat for thousands of species, accrue solar energy as fuel, build soil, create microclimate, change with the seasons and are beautiful – just like a tree’’ (McDonough, Braungart, 2003).

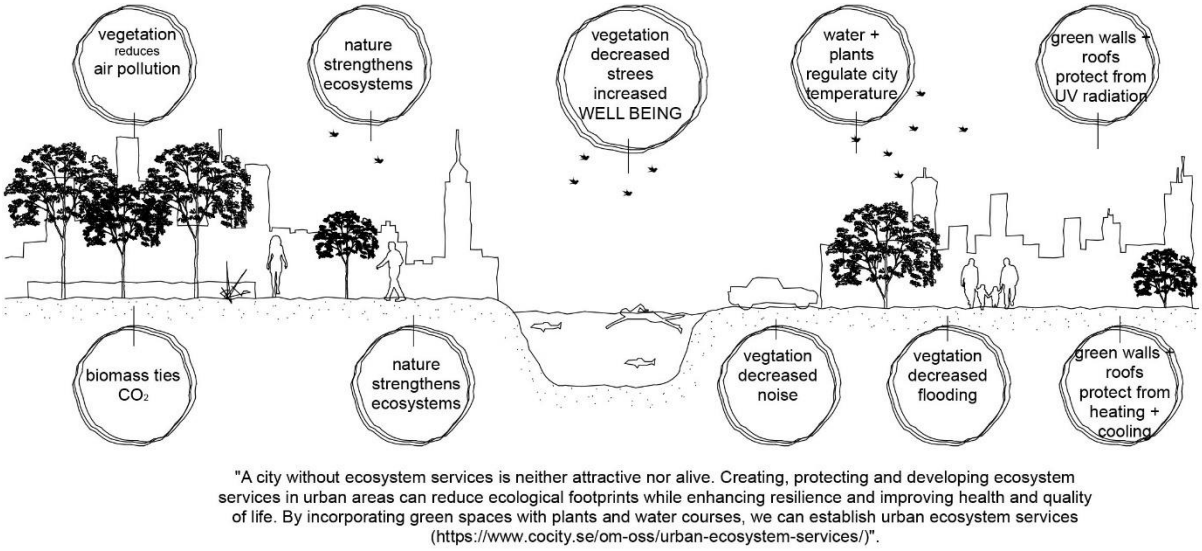


Figure 34Figure 2 Diagram illustrating the benefits nature has for the urban environment. Source: Author

The proposed building typology will incorporate the Urban ecology theory. It will introduce new ecosystems within its surrounding. The design will incorporate vegetables within its building interior spaces and exterior facades. The use of vegetation will be beneficial to urban dwellers as demonstrated in figure 6.

2.2 Urban regeneration

Couch *et al.* (2003) described the role of regeneration as being concerned with the re-growth of economic activity where such economic activity has been lost. Regeneration further occurs where the environmental and ecological quality and balance has ceased (Couch *et al*. 2003). In order to enhance the quality of life of a community, the shaping of attractive and unattractive urban buildings and spaces through renovation that is centred on sustainable urban regeneration is crucial.

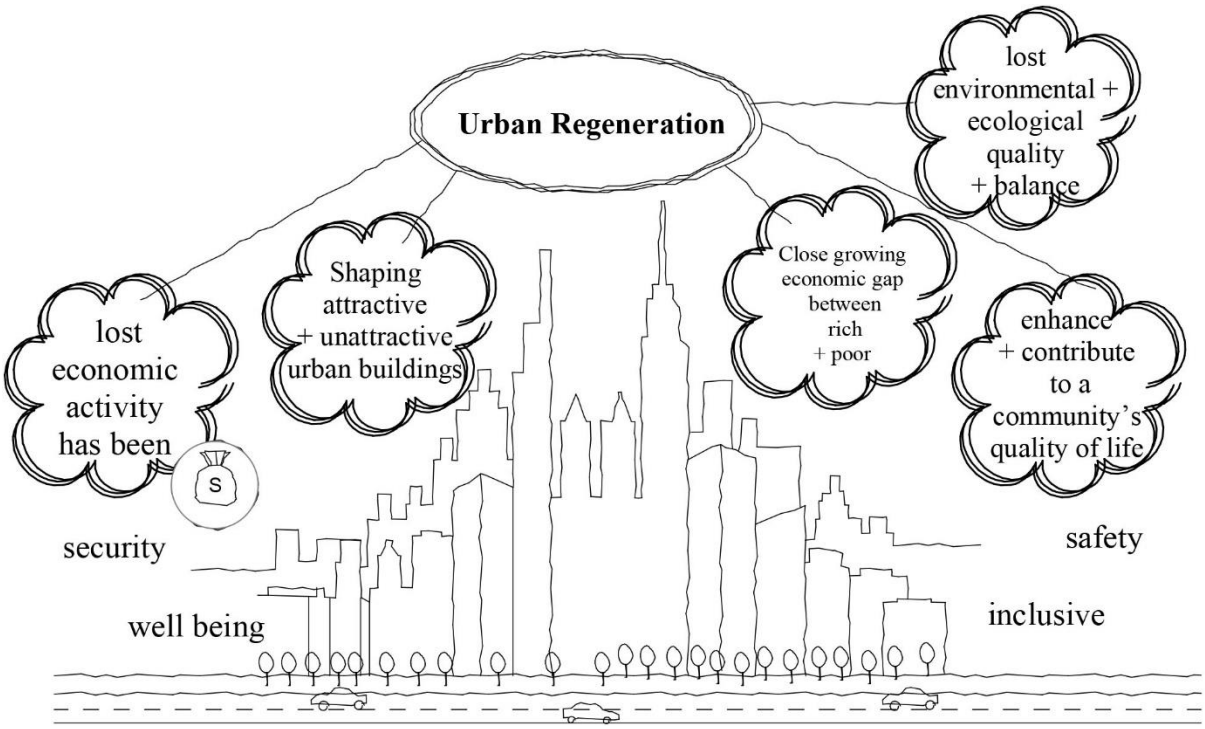


Figure 35 Diagram illustrating some of the urban problems that urban regeneration focuses on, to create better urban communities. Source: Author' interpretation

The proposed building aims to be a catalyse for change. Adaptively reusing the delapidated builing the aim of the proposed design will be to shape the cities image. Alleviate some of the urban problems illustrated in Figure….

2.4 Concepts

2.5 Well-being

According to Atkinson, Fuller and Painter (eds. 2012 existing research for human wellbeing has been attributed to various factors such as: 1) employment, wealth and income; 2) health, social belong and education, and; 3) social order, leisure and recreation.

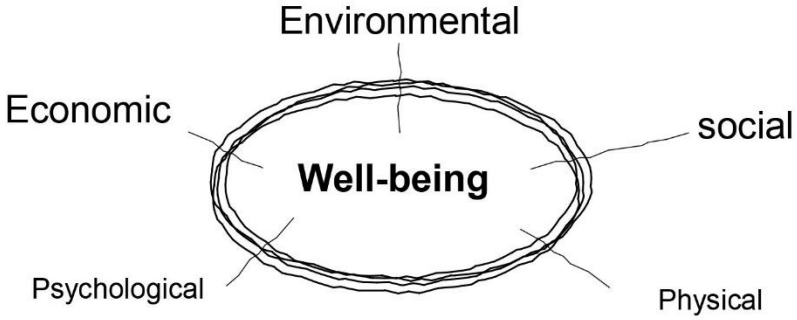


Figure 36 Factors that could influence wellbeing. Source: Authors interpretation

The concept of wellbeing has various influences as demonstrated in figure 8. The use of materials and spatial planning will ensure that the building gets natural lighting within high pedestrian areas for

visitors and staff. Economically the building will be a space where potential urban farms come to learn about farming technologies in order to provide an income for themselves and their families. Street traders will use the vegetables within from the greenhouse to sell. The proposed green house will have social spaces so visitors can engage and learn about faming.

2.6 Resilience

Due to the way this design is proposing to grow vegetables, the concept of resilience is relevant due to the uncertainties of climate change and how the city will adapt. The uncertainties that come with farming in large open spaces in rural land means urban areas need to grow vegetables too. When pertaining to food security resilience, Bullock (2017) stated that the concept can be used in several contexts, making an example of an international contextual development that considers social structures as well as capacity building. Also linking the population growth to food supply and maintaining agricultural production under climate change Bullock (2017). The design aims to cater for a growing population as well as become a catalyst for other buildings, to incorporate growing vegetables within their spaces.

2.7 Rights to Food

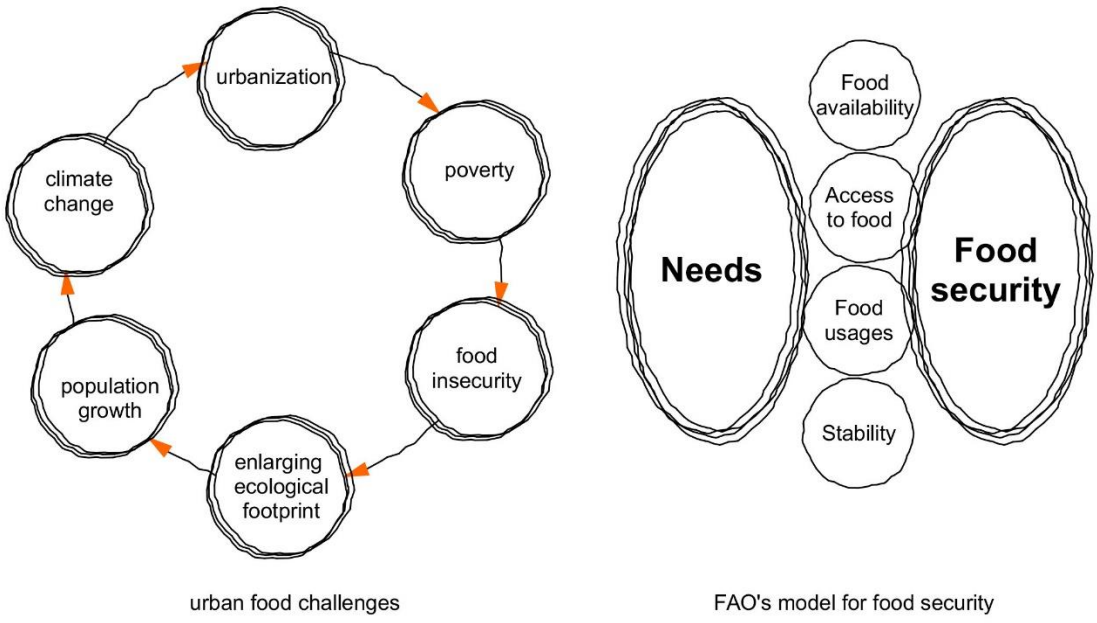


Figure 37Diagram illustrating the Urban Food Challenges and the Food and Agriculture Organisation's model for food security. Source: Authors interpretation

The rapid population growth means there will be a need for rapid increases in food productivity Giménez (2010). These predicted increases in food production will have to be achieved sustainably and will require rethinking on how this will be achieved effectively. This is one of the studies main focus and through this initiative the design aims to provide solutions for urban dweller faced with food insecurity.

3. Building Typology

3.1 Greenhouses typology

According to the Food and Agriculture Organization of the United Nations (2013), greenhouse production transpired in northern Europe, later prompting development in the Mediterranean, Oceania, North America, Africa and Asia. In the 1990s, Mediterranean countries were known as the global competitors of greenhouse vegetables. Evolutions in greenhouse technology have since been improved, from fertigation, material covering, pruning techniques, plant training, soil solarisation and climate control systems. This form of farming is set to play an important role in sustainability, optimising efficient water-use and better control of product quality. Technological advancements of greenhouses mean all horticultural species can be cultivated in any region worldwide. For sustainability, strict selections are still required for each region for better cultivation based on the region's climatic conditions.

Greenhouse Materials

The cover materials and structures used for greenhouses are regarded as vital for its construction (Teitel, Montero, & Baeza 2012. The location requires the material to be suitable to the country's climatic conditions while also ensuring the materials for construction is readily available in order for the greenhouse to be sustainable (Teitel, Montero, & Baeza 2012. In order to improve the efficiency for these greenhouses they have to be consistently evolving, as growers, designers and researchers try to find better and more sustainable means of growing in greenhouses as well as minimising undesired environmental effects (Teitel, Montero, & Baeza 2012).

Figure 38 Example of a glass greenhouse in Spain. Source Teitel, Montero, & Baeza (2012).

Depending on the climatic conditions for particular regions, various methods have been proposed by researchers to control the humidity, temperature and radiation in the internal spaces that affect the plant growth and production for photosynthesis to occur. This is when the material used has significant effects to allow sufficient solar radiation into the greenhouse. The translucent cover used

determines the microclimate internally. For some growers the use of glass rather than plastics is preferable due to its thermal properties (Souliotis, Tripanagnostopoulos, and Kavga 2006). Although plastics may be cheaper, their thermal and illumination properties can be much lower (Souliotis *et al*. 2006). Maximising natural daylight is an essential principle to achieving sustainable buildings and design (Boye & Arcand 2012). According to Teitel *et al*. (2012), photovoltaic cells have been incorporated in some greenhouses to generate power for when there is insufficient light, in these cases additional electric light energy is used for the plant growth.

In warmer climates the use of screenhouses and other innovative insect proof screens have been incorporated to prevent pests from entering operable greenhouses. For ventilation Teitel *et al*. (2012) suggested the use of natural vents, which can be incorporated on both the sides and the roof of the greenhouse depending on the vent arrangement, as well as the incorporation of insect screens, depending on the design. These insect screens were first used in Mediterranean regions and later gained popularity worldwide (Teitel, Montero, & Baeza 2012)..

Natural ventilation is the most sustainable and cheapest form of ventilation irrespective of location. In order to control the circulation and air exchange, a mixture is required to control the temperature. A study by Bournet and Boulard (2010) indicated that in warmer climates a combination of air exchange is required. Stevens (1994) added that this circulation prevents hot and cold spots within the internal space to minimise diseases that arise from humid pockets in the plant canopies.

A completely enclosed greenhouse is said to have its advantages, such as reducing the need for pest control, yet it requires complete mechanical ventilation. Therefore, researchers have found that a combination between a semi-enclosed solution is the most sustainable and attractive option (Teitel *et al*. 2012). Other factors such as orientation and site, according to Teitel, Montero, & Baeza (2012). can be of great importance to maximise the natural environment, yet emphasis that each design must be engineered specifically for its location.

Ventilation rate for greenhouse ($m^3 m^{-2} min^{-1}$)								
Wind speed ($m s^{-1}$)	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8
0.5	1.54	0.59	1.91	0.84	1.47	1.49	1.63	1.46
1.0	3.16	1.21	3.95	1.77	3.16	3.15	3.49	3.00
1.5	4.78	1.84	6.03	2.72	4.86	4.83	5.38	4.56
2.0	6.40	2.46	8.11	3.68	6.59	6.53	7.29	6.12
2.5	8.02	3.09	10.20	4.64	8.32	8.23	9.20	7.68
Ventilation rate for plant canopy zone ($m^3 m^{-2} min^{-1}$)								
0.5	0.69	0.43	1.84	0.99	1.41	1.43	1.56	2.11
1.0	1.50	0.98	4.25	2.50	3.43	3.43	3.74	4.74
1.5	2.29	1.55	6.64	4.09	5.45	5.44	5.93	7.35
2.0	3.07	2.17	9.02	5.68	7.47	7.45	8.11	9.95
2.5	3.86	2.80	11.38	7.27	9.49	9.44	10.29	12.55

Figure 39 Effects of external wind speed and vent configuration on ventilation rates of green houses and plant canopy. Source: Tietel *et al*. (2012:54)

In line with sustainability, the production of certain crops that are not suitable for those climatic conditions are continuously being questioned due to artificial climatic control being required. Despite this greenhouse site selection, it is still regarded as vital, factors such as site, weather conditions, irrigation and availability of water, infrastructure and proximity to transport networks, access to communication systems, and energy have to be considered. Including orientation to avoid shadows from adjacent buildings and maintaining the objective of maximum light in the greenhouse.

3.2 Urban adaptive reuse

'Humankind has spent many hours and resources to create the built environment around us. These built environments define and symbolizes our communities. They become part of the community. When a structure is vacated, it impacts the community as a whole. It is important for the community to see these spaces as opportunities rather than blight or problems. They can be the breeding ground for a new and exciting developments, rather than social ills'
http://adaptivereuse.info/about-ar-info/

Various problems are associated with abandoned sites and buildings which are well recognised around the world, from social conflict, poor living conditions, inefficient use of property as well as economic depression. In Durban, the eThekwini Municipality released a press release announcement in 2015 that a new bylaw would be implemented towards derelict buildings in the city in order to tackle, as well as rehabilitate problem buildings within the city (http://www.durban.gov.za :2005). This law would tackle buildings that are showing signs of becoming unhealthy, buildings that are derelict in appearance as well as buildings that are over crowed or are illegally occupied. These buildings would form part of a regeneration process for the city of Durban and create a holistic living environment that is healthy and safe for all its occupants.

Douglas (2006:4) defined building adaptation as ''any intervention to adjust, reuse, or upgrade a building to suit new conditions or requirements''. While Bullen (2007:21) describes it as ''A process that retains as much as possible of the original building while upgrading the performance to suit modern standards and changing user requirements''. According to Wilkinson, Remoy and Langston (2014:18), the reasons for adaptation can be compared to a life cycle like those of an organism, which have a beginning, middle and end. The authors describe these organisms as experiencing life cycles with differing lengths, stating that buildings are same (Wilkinson *et al*. 2007). Buildings can experience obsolescence at varying stages of its life cycle, which can bring about opportunities for adaptation (Wilkinson *et al.,* 2014:6).

In the perspective of sustainability, the problems associated with disused buildings have mainly been recognised in countries with strong economies where significant actions have been taken. In these developed countries various initiatives have been implemented and documented in order to provide sustainable planning and redevelopment. These include a significant amount of environmental considerations and the concept of ecology on sustainable development more than human aspects or social issues threatening peoples safely, causing social tension as well as causing material waste, derelict buildings are also unsightly (Antuchevičienė 2008:332). Derelict buildings pose great potential for adaptive reuse or for the adaptive recycling of materials if the building is inadaptable, making these buildings great subjects of sustainability while creating regeneration to house mix uses.

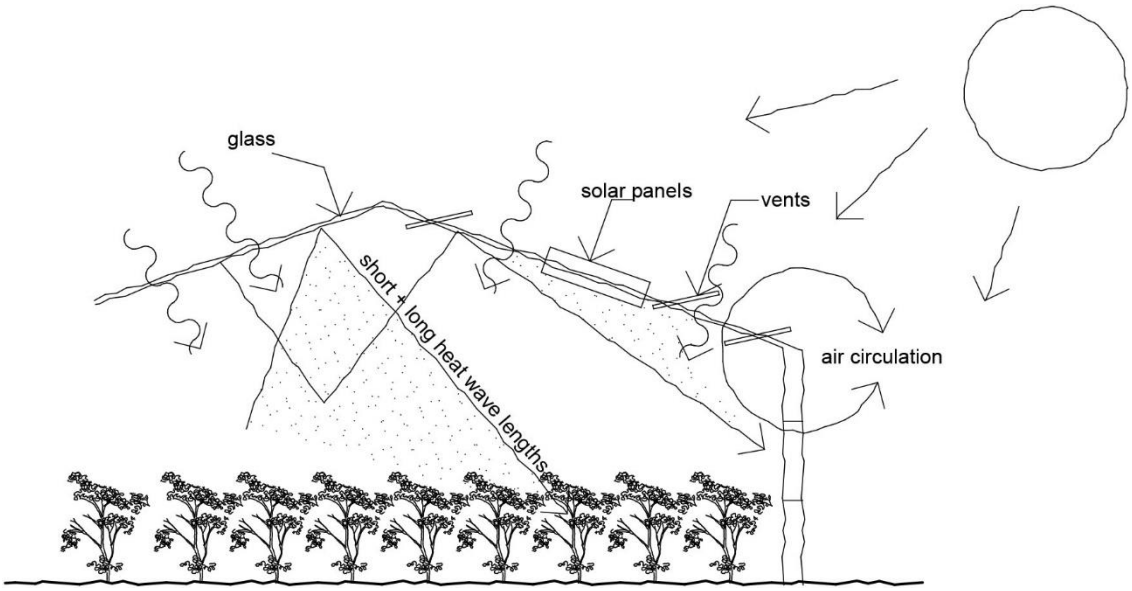


Figure 40 Greenhouse design diagram. Source Author

Wilkinson *et al.* (2014:4) asserted that the built environment has a role to play in reducing adverse effects on the environment and greenhouse gas emissions. According to Carroon (2010:5), buildings are primary contributors to environmental degradation during their construction, demolition, reconstruction, and operation stages. The author thus posited that reducing carbon emissions can be achieved by adopting the concept of adaptive reuse, specifically because embodied energy expenditure has already occurred (Carroon 2010:5). This is supported by an analysis done by the United Nations Energy Programme, which estimates that the embodied energy of a building is reduced to 20 % if a building is operational for 100 years (Carroon, 2010:7).

In order for adaptability to be effective and holistic the adaptability and conversion must be justifiable. According to Antuchevičienė (2008) a building needs to be structurally sound in order for it to withstand alterations and extension. For alteration to be suitable for its proposed use, design and

form of the building needs to be in harmony with its local building surroundings and architectural style. Surrounding needs and materiality must be considered in order for the building to sustainable.

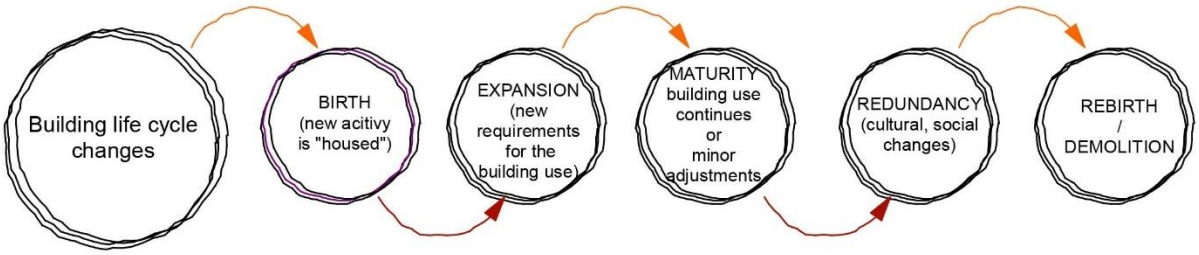
According to Melaver and Mueller (2009) adaptive reuse is the ultimate form of sustainability if it is done in the right way. Adaptive reuse is a method that centres itself mainly on preserving a building's historic legacy. The method does this by firstly, attempting to use existing structural materials, and secondly, limiting and reducing demolition waste. Its sustainability lies in that it conserves already used energy and reduces carbon emissions. When a building is demolished it loses its embodied energy, which can be the sum total energy cost of a building. Thus, new materials need to be brought to the site, adding to the environmental carbon emissions that come with assembling a new building. According to Boschmann and Gabriel (2013), it may take 25 to 42 years to reach the carbon equivalency of an adaptively used building.

Abimbola *et al* (2012) stated that sustainable development must have basic principles which can be differentiated. The authors described the design of a life cycle as consisting of the prebuilding phase and the post-building phase (Abimbola *et al*. 2012). These phases are aimed at balancing the traditional concerns that go into the design phase. The phases are namely the resources it will take to build the existing building. The natural systems that it will take to develop the project while caring for the human needs for health, safety, physiological satisfaction, physiological and comfort. While balancing the cultural and natural environment, advocating for sustainable construction (Abimbola *et al*. 2012). Between the construction industry and sustainable development, a lucid environment has been created due to construction having a strong economic significance and impact on the holistic environment.

In a world that has created a society where it is usually easier or less expensive to replace an object; whether it be a cell phone or a building, Carroon (2010) asserted that in order for a society to become regenerative, there needs to be a culture of repair and renewal. In this way it is possible to reduce environmental impact, especially in buildings (Carron 2010). With sustainability as a topic of global discussion, the concept of reuse is a relevant one, encompassing other such as the reduced transport requirements during construction, material use and energy consumption (Bullen 2007). Carroon (2010:9) argued that new buildings cannot always solve the environmental dilemmas that have been created, and that a culture of renewal, reuse and repair is needed.

Due to the demand for space in urban areas, Douglas (2006) expressed that the built environment needs to respond to the changing urban landscape to avoid becoming redundant. Douglas (2006) outlines that the process of adaptation has various factors and its renewal is dependent upon its suitability, location as well as its overall condition for alteration. Abandoned buildings are wasted

resources, which are then prone to vandalism, premature deterioration, occupation by squatters, and are susceptible to damages from intruders. In a housing area, these abandoned buildings are commonly the symptoms of social depravation as well as poverty. In non-residential areas, abandoned buildings could be indicative of economic recession, taking up valuable land which can be redeveloped for various uses that can be beneficial to the city's economy as well as its community.



According to Wilkinson, (2014) the above diagram illustrates the changes that occur within building life cycles.

Diagram illustrates Wilkinson *et al.'s* (2014:4) considerations when adapting building to new environments. Source: Author interpretation

Carroon (2010:9) emphasised that preservation in buildings and communities is a gesture and a physical manifestation of a particular culture and time for which future generations can enjoy and see. Boschmann and Gabriel (2013:221) noted that the built environment not only creates a space for daily occupation in order for activities to occur, but also defines the spatial form of a city. The built environment's presence may have cultural symbolism or it can portray local history that creates a sense of place. Creating iconic symbols of global economy while others embody a city's identity. A building having historical significance can be beneficial in that it provides an opportunity to create a sense of place. When done adequately, adapted buildings developed in existing neighbourhoods pose the potential of creating a live/work situation, eliminating the need for commuting (Chung 2004), inciting renewal in neighbourhoods located in derelict areas. While some researchers, such as Wilkinson *et al*. (2014), have argued that creativity in adaptation is lost as opposed to a new builds. They also argue that creativity lies in fitting contemporary needs in existing buildings. Being selective when choosing buildings is key in order to retain buildings that still have benefits for their society and culture.

Chapter 4

4.1 Precedent studies

4.1.1 Introduction

The selected precedent studies were chosen from international examples to see how designers outside of the South African context have dealt with the concepts and theories in the literature, as well as the other literature in the previous chapters. The precedents demonstrate similarities, as well as differences, in their environmental and architectural approach. They were chosen to show how different contexts have dealt with the research problem and how they have adapted it to their context to further add to the literature in order to generate helpful guidelines that can be used in the architectural design research.

4.1.2 Lufa Farms in Montreal Quebec, Canada

Architect	:GKC Architects
Client	:Fermes Lufa Farms
Location	:Montreal Quebec, Canada
Construction Period	:2010
Cost	: USD2 million

4.1.2.1 Introduction / Background

In 2009, clients Mohamed Hage and Lauren Rathmell rented a greenhouse space at McGill University to learn about sustainable hydroponic farming and to do various tests on the system. These tests helped the duo develop sustainable farming and responsible agriculture methods. The husband and wife team along with Yahya Badran and Kurt Lynn then co-founded Lufa Farms in 2009 with a vision of revolutionising urban agriculture (Magder 2018). In 2010 Lufa Farms started construction on their first rooftop greenhouse. It was the world's first commercial rooftop greenhouse on an industrial building, located in Montreal, Quebec. The rooftop greenhouse would provide high-yield and year-round farming in a smarter, more sustainable and commercially viable way. The building required minor adaptation to hold the greenhouse, which included structural reinforcements, separate stair accesses, a freight elevator, and a 140 000 litre reservoir. The planning would take up to four years (Carrot city 2014)

4.1.2.2 Urban regeneration

The site is situated in the Montreal, Quebec metropolis which is part of a large city situated in Canada. Montreal was the economic capital of Quebec, with a population of 1.6 million. The city had a cultural diversity with the influx various immigrants, but remained as a hallmark for its French civilization and British influence (Burnet *et al.* 2016).

The building was located in an industrial area in Ahuntsic, within 8kms of down town Montreal. The site, two storey building, had been recently renovated with a well-constructed flat roof, which was constructed to take an additional third storey. However, it was never built. Later GKC Architects was appointed on the project. The planning phase tackled technical challenges more than the design (Montreal Lufa n.d). Within this dynamic and culturally diverse city, the design of the urban greenhouse introduced a different type of regeneration. It successfully localised the growing of vegetables minimising food miles, maximising access and taking what is described by the architect and clients as lost space on urban roof tops. The architects believe that these spaces within the urban environments should be utilised to create a sustainable environment and future through urban agriculture for local communities.

Figure 41 rooftop greenhouse

4.1.2.3 Resilience and rights to food

> ‘We would only need to convert the rooftops of 19 average-sized shopping centres to grow enough veggies for all of Montreal. Every new greenhouse we build gets bigger, better, lighter, and cheaper, so that urban rooftop farms can become a must when building new structures’ *(*Montreal Lufa n.d.).

The concept of the rooftop farms was not to replace local farms or food makers, as this was not practically viable. The clients’ aim was to build a healthier, more sustainable local food system in order to develop a community of hundreds of neighbourhood pick-up points to get food from their rooftops to the community as directly as possible. The vision was efficiency, convenience, and community-building. This also included a fleet of electric cars to supply eco home delivery. Opening doors for community visits and open houses, for people to know their farmer, know their food, and know where and how their vegetables are grown (Montreal Lufa n.d). With the urban agricultural farm situated in close proximity to home and local markets, the cost to purchase decreases resulting in affordability, especially for disadvantaged local community members. Food proximity and production benefits all communities in various ways. Firstly, with access to local greenhouses, communities are educated on the growing process. Secondly, local greenhouses can provide access to practical examples and growing knowing, particularly for individuals interested in growing their own vegetable gardens. The enclosed greenhouse also means all year-round food production, regardless of weather, ensuring communities have consistent access to local produce.

4.1.2.4 Permaculture

Landfills are one of the largest producers of methane, a powerful greenhouse gas. The Lufavores famers believed that organic waste should be composted, instead of it adding to the problem. In an urban agricultural setting, the challenge of space for the compost arises.

To meet this challenge, the Lufavores farmers composted their green waste on site where they or worked with municipal partners to ferry green waste to composting sites. By harvesting to order for each day’s baskets, they ensured their vegetables were as fresh as possible and that they eliminated waste from farm to table.

The design principles used to achieve an ecological outcome while saving energy was the primary focus for the greenhouse design. By building on top of an existing building it reduces the effects of heat islands. This resulted in a fully automated and operable glass structure for summers with automated thermal screens to ensure heat is not lost in the night and in winter. Based on a five circuit heating system, different mechanisms were designed to enable a microclimate to be adapted to each

plant. Prime consideration also included rain water retention as well as filtration of the green house water in order for it to be reusable (Carrot city 2014).

4.1.2.5 Urban Ecology

The construction of the greenhouse on an existing building is in line with Spirn's (2011) theory that stated that in order to achieve a sustainable ecology within the urban environment, human needs need to be met. This design approach achieved this while also reducing the building's ecological footprint by constructing the greenhouse on an already existing building foot print. The design encompassed synergies between the existing building and the new greenhouse in order to optimise the energy performance in order for it to compete with other regular farms (GKC n.d). The greenhouse also used half of the heating required for ground level greenhouses due to the following factors: Firstly heat from the building below is used to save on the greenhouse above, while also serving as a protective buffer from the climatic environment above to lower the existing buildings heating needs. Secondly heat is only applied and artificially generated on cold winter nights by using gas heaters. In the city the night-time temperatures are higher than in the country side due to thermal mass heating from the adjacent as well as other city buildings. Fourth point is that energy curtains are used which are automatically utilised during cold nights which help insulate the space to prevent heat loss. Lastly the plant transpiration is utilised in summer to cool the air to reduce heat islands which are created by the tar roof which lowers the energy used to cool the building below the greenhouse (Montreal Lufa n.d).

Figure 42 indoor vertical farming

Figure 43 racks of vegetation ready for packing

A sustainable ecological approach to design and functionality drove this urban agricultural farm. The architects and technical team ensured that the greenhouse would function sustainably, minimising harmful effects on the environment and local communities. An ecological way of design is followed. According to the researcher the cost to ensure such an adaptive design and the feasibility in developing countries such as South Africa requires a close study in terms of the returns such a roof top green house buildings would have over a long period of time .

4.1.3 Pasona Urban Farm, Tokyo Japan

Architect	:Kono Design
Client	:Pasona
Location	:Tokyo, Japan
Construction Period	:2010

4.1.3.1 Introduction / Background

As young people migrate to cities, the concern for future agriculture also grows (Allen 2013). Through the years, various concepts and building prototypes have been designed and forecasted for the distant future. For a Tokyo based office, Pasona, this concept and idea became a reality (Allen 2013). The design of the Pasona recruitment firm was part of a renovation of a 50 year old building. The renovation for the nine-storey office building required the superstructure and the building's envelope to be kept, although part of the client's brief required a total redesign and relook at the building's façades, auditorium, offices, and cafeterias. It further required the provision of roof garden, as well as urban agricultural facilities. The design resulted in a 3995 square meter building, dedicating parts of it to green vegetation and urban agricultural spaces.

Figure 44 External view of Pasona Urban Farm. Source: (Andrews, 2013)

Urban ecology

According to Spirn (2011), urban ecology is critical to the future of a city and its design. Japan relies highly on imported food due to their limited arable land, with only 12% of it being suitable for cultivation (Allen 2013). Because of the scarce availability of land, coupled with the decline in agriculture, the client understood that opportunities for jobs in agricultural farming had become scarce, therefore the client's aim was to cultivate and educate a new generation of farmers. This would be achieved by offering lectures, public seminars and internship programmes to empower students. On top of this, the programme offered financial advice in order to promote traditional and lucrative business professionals in the sector for business opportunities. All of this was done to reverse the decline in farming and to ensure a sustainable future for food production.

Permaculture design.

> 'It is no longer sensible to ignore the possibility of sudden and prolonged changes in the biosphere due to the unknown effects of modern activities. Design of support systems with maximum flexibility and diversity is the best response to a potentially unstable environment (Holmgren1996:7).'

Practically, permaculture encompasses various sustainable design strategies, in order to create a harmonious integration between design and ecology. According to the researcher the use of this concept is evident in the architect's design approach, which integrated nature in its spatial planning. The architect took the problem which was the lack on arable land in Japan and solved it by incorporating it into the design using the principals found in permaculture.
This ecological integration is also practical in that the food harvested within the office spaces was served in the office cafeterias, making it the biggest farm to table project in Japan. The staff, who worked within the building, maintained and harvested the with the support of agricultural specialists (Andrews 2013). This ecological approach to design minimised wastage and transportation costs. The project made a reality the concept of a full circle ecosystem, where the production and consumption of food was done in the same space.

Figure 45 vegetation integrated within the office's circulation spaces.

Adapting to an urban environment's demands and using the lack of arable land to grow vegetables within the city to solve a problem that confronts humans and the earth as a whole, can be seen in the internal garden view captured in Figure 6. The principles obtained from the concept of permaculture is well represented in this design. The use of the concept is evident in both the client's vision and the architect's design approach. The environmental constraints of the city, as well as the geographical location for agriculture, has led to the incorporation of vegetables within this built environment. The design took advantage of this problem and solved it through integrating vegetables with the building's interior and exterior envelope, while simultaneously creating good working conditions for its employees. The gardening aspect of permaculture has not been used traditionally. Instead, the use of artificial lighting to generate the photosynthesis process was implemented. Further, hydroponics were used instead of soil in some of the internal spaces With these technological advancements and methods, nature's lessons have been taken into account and adapted according to the new conditions.

3.1.3.2 Well-being

The literature researched on well-being under the literature review stated that the biological need for food and shelter for an adequate livelihood is an important aspect of achieving well-being. This includes protection from the earth's harsh elements, as well as social needs required by humans. The

literature further added that environmentally, well-being includes minimising the globe's ecological footprint, caused by the effects of climate change. The adaptation of green spaces to support biodiversity has become a mitigating factor to this global issue.

The incorporation of vegetables within the building's offices was in line with the client's vision, which was to create new farmers in the urban areas of Japan. The client wanted to bring about a new interest within the agricultural lifestyle and space, while also bringing about change in the way local people thought and spoke about agriculture. Further, the client's vision was to create a community of people who had a rooted understanding and interest in the environment (Andrew 2013), which would in turn benefit them environmentally. According to Gallaher (2017), abundant green spaces bring about better health among humans especially among the elderly and lower socio-economic classes. The clients need to have a visual intervention e.g. seeing the vegetable growing process, encourages urban communities to grow their own plants and vegetables. Farming by actively engaging people in a visual manner within their busy day to day lifestyle, also brings the effect of biophilia into the office environment therefore achieving better working environments. Andrews (2013) stated that the maintenance and harvesting of the indoor crops encouraged the employees to become more socially active, which has led to better teamwork in the workplace. When it came to the rentable office space, a significant part of it was lost but the client was more concerned about the benefits of urban agriculture as well as the green spaces for the betterment of the employees and their work environment and engagement (Kono Design n.d).

Figure 46 Lighting details and how light is strategically paced for the vegetation as well as internal spaces,. Source: (Allen 2013)

The architect's focus was not to impose the standards of what 'green' should be, but rather focused on encouraging a change in the way people thought about their environment in their everyday lives. The importance of not merely thinking about natural resources from afar but rather actively engaging with

nature was also part of the architect's focus. Therefore, the project aimed at striving to inspire other offices to embrace this type of design to encourage young urban dwellers to rethink about agriculture in order to reinvigorate it in rural areas (Allen 2013).

3.1.3.3 Rights to food

'To be self-sufficient is to have the ability to produce all requirements and needs; food, tools, clothing and shelter' (Holmgren1996:12). '

The office headquarters dedicated 20% of their 215,00 square meter office space to planting and growing fresh vegetables, making it one of the largest indoor urban agricultural farms in Japan. It incorporated the use of hydroponic mixtures as well as soil-based farming (Allen 2013). The incorporation of vegetables into the architecture consists of a double skin green façade, which created a balcony where oranges as well as flowers grew. Externally, the building appeared as if it was wrapped with green foliage. Internally, fruit trees were used as partitions. In the office's seminar rooms, bean sprouts were grown on the underside of the benches. Inside the offices and conference rooms, tomatoe vines could be found suspended above the table.
The design required ducting and piping to be rerouted to the buildings perimeter in order to achieve a maximum ceiling height. The height enabled the building to achieve climate control. Observation and tracking of the humidity and temperature for adequate airflow into the building was required. For the safety of the employees to achieve a conducive working space as well a suitable space for the growing of vegetables.

Hidden between beams on the bottom vertical edges were lighting fixtures which the internal space between the beams a light cove. These light coves were used throughout the office spaces from the second to the ninth floor, which resulted in a 30% reduction in energy (Andrews 2013). The indoor spaces required a warm environment for plant growth, which resulted in the working spaces becoming uncomfortable, which the architect regarded as the building's greatest downfall (Allen 2013).

3.5 Conclusion to Precedent studies

The chosen precedent studies demonstrated how the concepts and theories in the literature review can be incorporated into practical building environments in a manner that is sustainable, using existing buildings and adaptively reusing them to grow vegetation that provides fresh produce for local communities. These spaces not only provide food security by feeding their local communities, they

are also ecologically beneficial to the urban environment in that they create biophilic spaces for locals to experience and be a part of. The localisation of food production in these controlled buildings means communities are less likely to be affected by natural disasters and the harsh realities of climate change. This ties into the Walker and Salt's (2006) definition of resilience thinking, which advocates for adaptable solutions that reduces humans' carbon footprint in an ever changing environment The architectural responses from the architects and clients that incorporate vegetation into the built environment illustrates how vegetation serves multiple purposes that go beyond simply providing food. These responses demonstrate how the growing of vegetation brings communities together in a social manner while also locating people closer to their food source. Although some of the conceptual permaculture design ideas, principles and ecological thinking has previously been seen as an idea for the distant future, these examples establish that they can be implemented currently. Despite the fact that the indoor growing technology is still being constantly improved, such case studies show how the built environment can be utilised effectively in the urban environment. In these urban building typologies, the regeneration is evident in the forward thinking by both clients and architects who have redefined urban spaces and taken control of them, illustrating forward thinking that can improve the lives of urban dwellers and their environment.

Chapter 5

5.1 Case Studies

The chosen case study reviewed an organisation initiative that was not lead by professional architects but individuals who found opportunities in unattended abandoned buildings in urban and peri-urban areas. These individuals started to make a difference in their communities by utilising the physical structures of the built environment as opportunities for alternative use. Innovative forms of urban agriculture began to take place as a means of securing food in the urban environment. Even though the approaches are varied, their overall objectives were similar. An urban precinct/building was chosen in South Africa. Instead of focusing on the final product, the case study also analyses on how the built infrastructure was re-adapted into its context, as this is one of the many means in which alternative urban agriculture can be adapted usefully.

5.1.1 Green camp Gallery: Umbilo, Durban South Africa

Organization : Green Camp Galley

Founder : Xolani Hlongwa

Construction : 2013- ongoing

Location : 246 Umbilo Rd, Bulwer.

Introduction

'consider a dilapidated building with few broken windows. If windows are not repaired, the tendency for vandals is to break a few more windows. Eventually, they may even break into the building, and if its unoccupied, squatters move in and light fires inside. This attracts more crime, drug and prostitution destabilizing the neighbourhood' Xolani Hlongwa Green Camp Gallery Founder

The green camp gallery was located within the Durban suburb of Umbilo, which was both an industrial and residential suburb that housed offices, shops, stand-alone homes, and flats. Among these spaces were abandoned and derelict buildings which had been left unattended. This resulted in homeless people taking occupation of the buildings. In 2013 Xolani Hlongwa, a 43-year-old former ballet dancer turned social activist, found one of these abandoned corner buildings at the industrial end of Umbilo, Berea in Durban. The concept of starting the green camp gallery came about from his travels, as well as the difficulties he had witnessed from traveling across Europe for 16 years. Due to various circumstances, he felt these experiences were designed to bring negative impacts into his life, which resulted in him being homeless. Through his journey he stumbled upon an abandoned building

in the Durban suburb of Umbilo which he occupied for years before starting the urban regeneration project through the Green Camp Gallery.

Urban regeneration

Located within downtown Durban the Green Camp Gallery is surrounded by a mix of middle- and upper-class communities, uneducated labourers, students as well as petty criminals. The site was occupied by a group of male squatters and was a hot spot for drug related activities. It would become catalyst for change and regeneration with a long-term vision, aimed at broadening people's thinking as well as educating them on how to live within their communities and environments sustainably. Hlongwa described the concept of the Green Camp Gallery as an ''urban farming, urban renewal project that entails applying indigenous knowledge systems that are based on Hlongwas ideas which mostly include renewing the inner environment'' (Sosibo 2018). The work done by Hlongwa on 246 Umbilo Road was far more than what met the eye. His concept and implementation demonstrated regeneration within an environment faced with urban decay and where ecological balance had been lost. It redefined its position through its adaptative reuse, reshaping what was once seen as unattractive into a space where people could gather and learn. The model aimed to create an interaction with the local environment and create reverse gentrification. Unlike gentrification, the vision was to create a space for people who come from broken environments like the founder himself; which would resulting in a sustainable balance that improves people's livelihoods and communities.

Figure 47 site location plan source: South Africa-V n.d.

Urban ecology

This project, according to the founder, consisted of a ten-year plan that was grouped into three stages: recycle, rehabilitate, and stimulate. These stages were further broken down into years**.** The first three years fell under the recycling stage, which entailed recycling and reusing the existing building both internally and externally. Their definition of recycling was further redefined to have a new meaning; by recycling they aimed to bring back the dignity of space, while also reclaiming it. The fourth to sixth years fell under rehabilitation. t=The individuals involved wanted the recycling process to give birth to rehabilitation., Once this was achieved it would lead to the stimulation process which took indicated the final six to ten years. Through this ecological approach, the vision, implementation, and design hoped to bring about other similar projects to create sustainable communities.

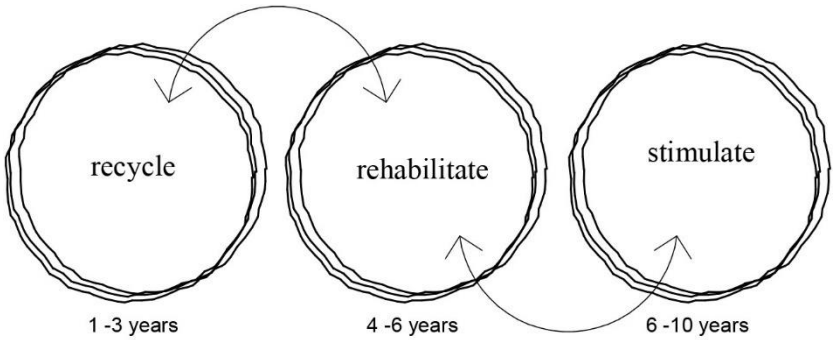


Figure 48 Diagram illustrating the Green Camp Gallery's 10 year cycle plan. Source: Author

Figure 49 Views of the adaptively used building using materials that were left over from the abandoned house as well as materials that were donated to the Green Camp Gallery by various organisation and people in order to create artistic pieces to plant in. Source: Author

Rights to Food + Resilience

The Green Camp Gallery addressed issues of food security and caring for the environment. This was done by approaching the problem at the grassroots level. Through the restructuring and cleaning of the abandoned property, the Green Camp Gallery illustrated how urban farming, creativity and social responsibility could positively transform neighbourhoods previously plagued by urban decay, crime,

and social disintegration. Resilience was demonstrated through the capacity to adapt to new conditions, which further educated people on how to grow their own food through recycling and community support.

Integration of Permaculture Design and Urban Agriculture to Achieve Well-being

Hlongwa was an advocated for recycling and observing nature. The activist asserted that he had learnt many lessons from his observations of nature. The concept of permaculture design aims to integrate components that have been learnt from existing ecosystems in order to provide guidelines for the creation of a sustainable design method. This was evident in the Green Camp Gallery. The space was a hub for urban agriculture or urban farming, as the founder referred to it. It further served as a space for rehabilitated art. The gallery space utilised used materials that were left over from the abandoned building, as well as material that was donated to them by various organisations and people, to create artistic pieces to plant in, such as old shoes. Both the internal and external spaces intertwined as one moved from office spaces to the gardens, to the shops, and finally, to the private spaces. Old materials were rehabilitated and recycled in order to show people and the community how to do so in a creative manner. What was once a derelict, crime ridden site housed art exhibitions, movie screenings and gardening workshops. It became a place where neighbourhood children could play in. Food grown within Green Camp Gallery was bought by local restaurants, informal traders and markets.

Figure 50 Vegetation grown in recycled tyres

Figure 51 Outdoor courtyard space created as a hub for urban agriculture which they refer to as urban farming as well as a space for rehabilitated art in a form of a stage for outdoor performances. Source: Author

Figure 52External close up view of the Green Camp Gallery entrance. Source: Author

Figure 53external street view of the Green Camp Gallery. Source: Author

Figure 54 Vegetation grown in recycled pot plants Source: Author

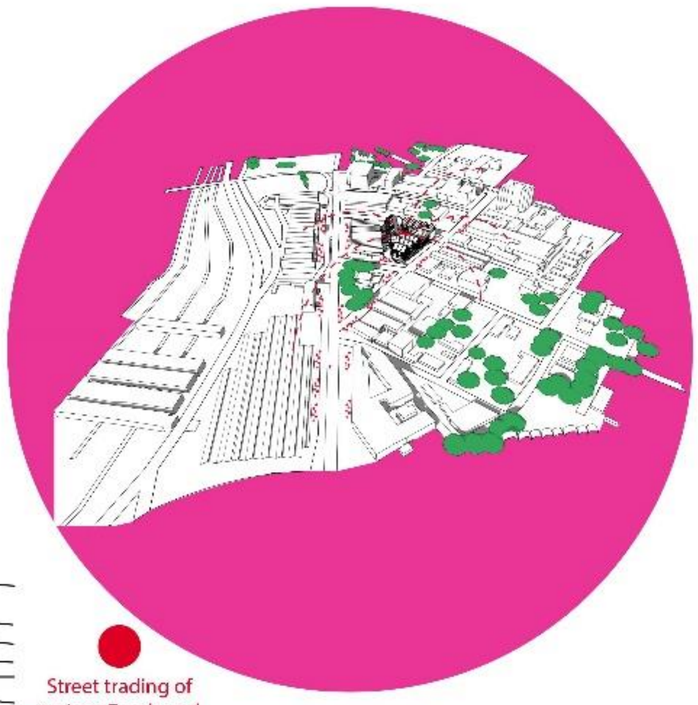
Figure 55 Fresh vegetation grown from the green camp gallery packed and ready to be sold to surrounding restaurants and informal traders. Source: Author

Conclusion to Case study

In a country faced with many challenges, this case study has raised critical issues that affect individuals and communities. The case study exhibited how individual can take ownership of these problems, and thus putting responsibility in the hands of all global citizens. Further, the case not only demonstrated ways in which humans can use their environment to better suit them, but also illustrated one can manipulate one's built environment in a more ecological manner. The approach to design was holistic, taking into account the human need to exist in an environment that caters to all needs

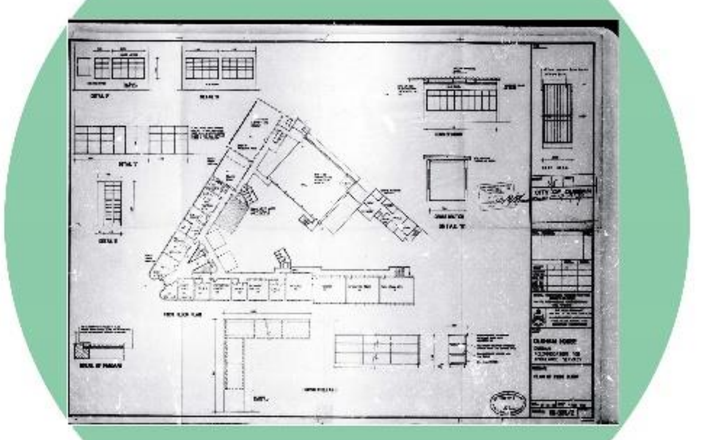
required for a better livelihood. The use of vegetables and recycled materials to define spaces, as well as a combination of roofed and unroofed spaces, demonstrated allowing surrender to nature, allowing new ecosystems to form yet providing shelter for its cofounder activist and the visitors who used the space. The theories and concepts used to analyse this case study reveal great lessons which can be taken to better the future of South Africa. Through the analysis it is evident that no space is left undefined, and in its current form it is subject to change in which lies the freedom of adaptation and the beauty of the space.

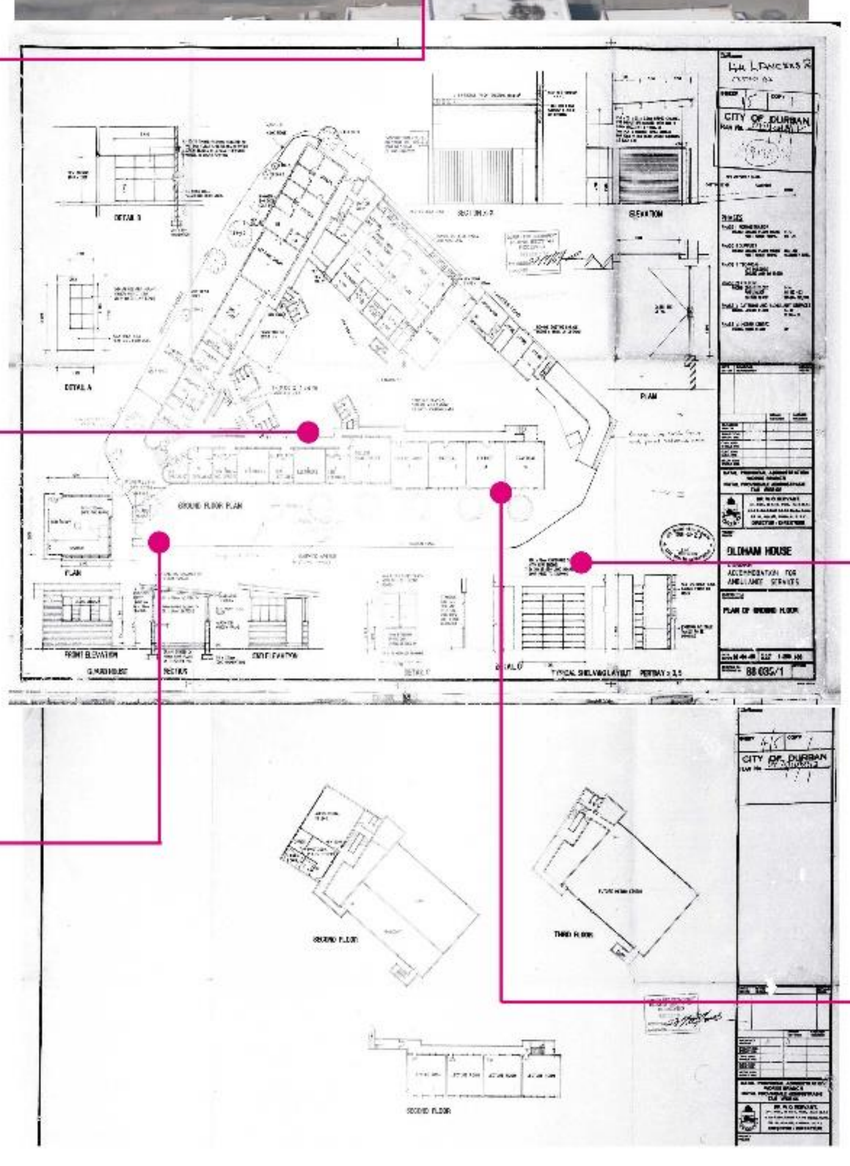
List of Figure

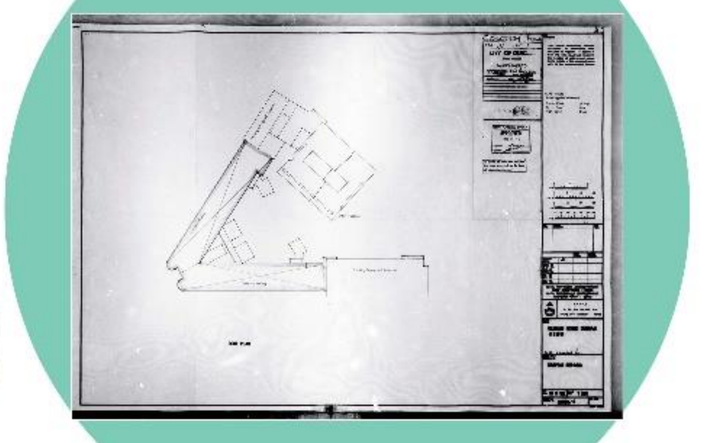


Street trading of various Foods and goods

SITE PLAN / LOCAITY
SCALE:1:200







SINEGUGU MAPHANGA
205515252

agriculture, forestry & fisheries
Department: Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

our future through science

To use the built environment within the city to create a social atmosphere that attracts, provides and educates people on natural plant-based agriculture and food production.

What lessons can be learned on successful urban agricultural projects and how have new technologies within the built environment as well as in agriculture aid in achieving the growing of crops in limited urban spaces?

Precedent Studies

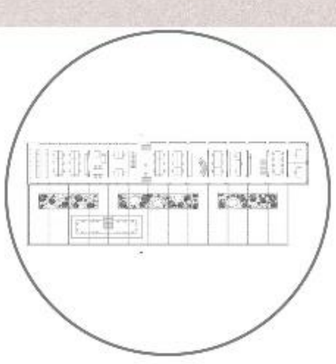
Pasona Urban Farm by Kono Designs Tokyo Japan

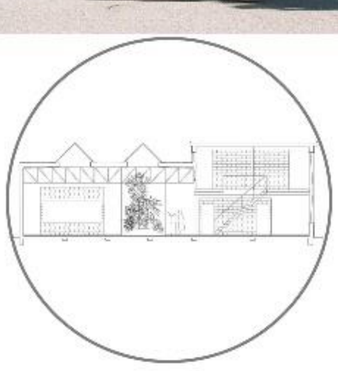
Interior spacial quality
incorporation indoor growing
(agriculture)

Lufa Farm by GKC Architects Quebec Canada

Interior spacial quality
incorporation indoor growing
images illustrate different growing
methods using natural and artificial

Joolz headquaters Amerdam





Interior spacial quality
incorporation indoor growing
(agriculture)

Case study - Green Camp

Case study showing vegeation being grown in a dilapidated building

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Towards an architecture that facilitates an alternative urban agriculture within the city of Durban

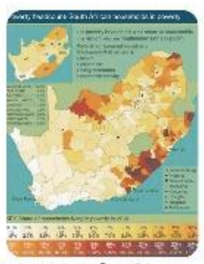
A proposed mix use urban agricultural food production and research centre

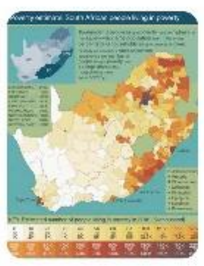
Where ?

Who ?

Why ?

What ?



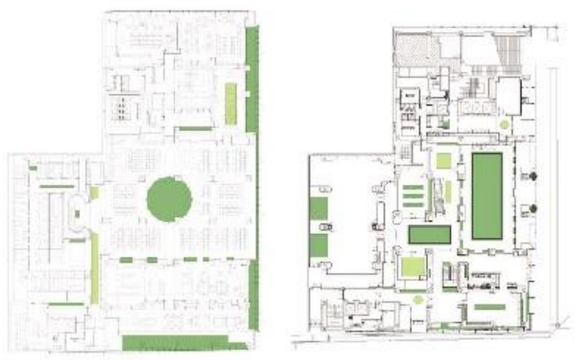


Accomodation

- **Food Production**
  Urban Greenhouse + PFAL "Plant Factory with Artificial Lighting "
- **Research**
  Food testing + Labs
- **Teaching**
  Practical teaching + lectures + talks+ Tourist information centre
- **Operations**
  Offices
- **Selling**
  Food trading stalls + Restaurants + Soup kitchens
- **Residential**
  Visitng scientiest + researchers

Design Principals

Adaptive Reuse
Expressing Old and New
Use of Glass, Timber, steel, concrete
Environmental Ecology
Incorporating the Natural environment into the city going **"GREEN"**
Sustainability
Off the grid



Organoponic systems

Organoponic systems farming

Greenhouse indoor farming

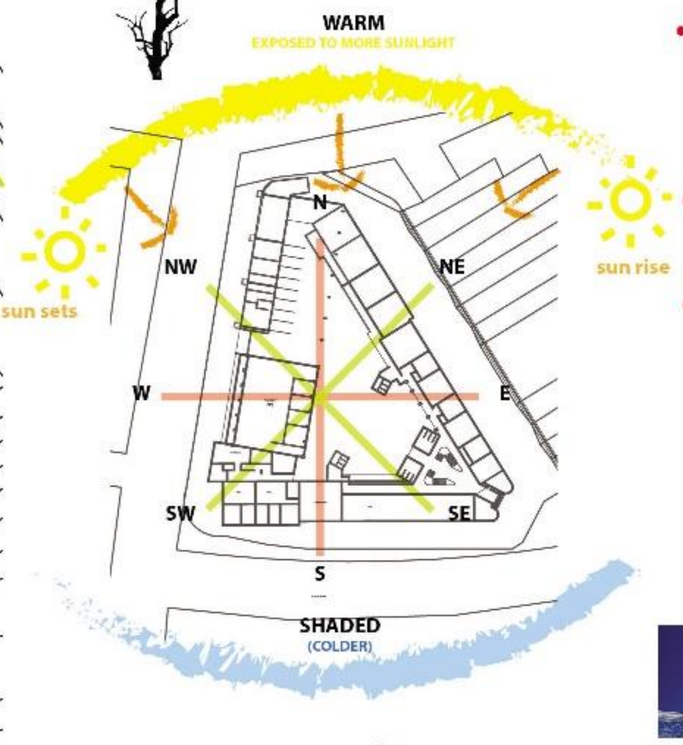
Hydroponic

Vertical Farming with LED lights

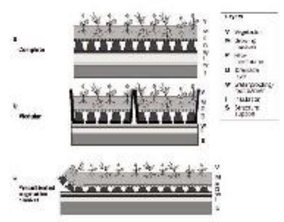
Greenhouse insect insect proof screens

Drip irrigation system

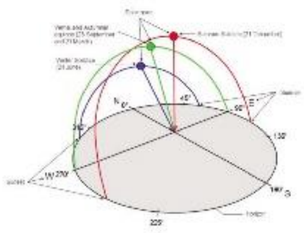
Types of vegetation grown through indoor farming



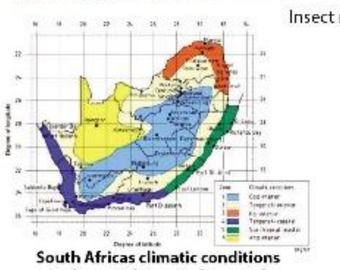
- Natural sunlight is the cheapest source of light available, translucency of the greenhouses and greenhouse shading are important factors
- Insect netting is a straightforward solution to a globally recognized problem. As the name indicates, it is designed to keep harmful insects out of your greenhouse and keeping useful insects inside by applying a netting system in the ventilation windows.
- Vertical Screening System
  screens are controlled by motors and may open all simultaneously or individually depending on the
- Evaporative cooling which uses the heat in the air to evaporate the water from the leaf and other wetted surfaces can be used to cool the greenhouse



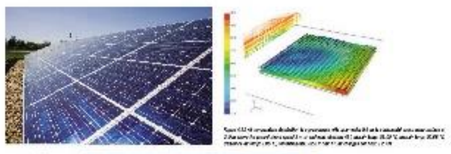
Insect netting

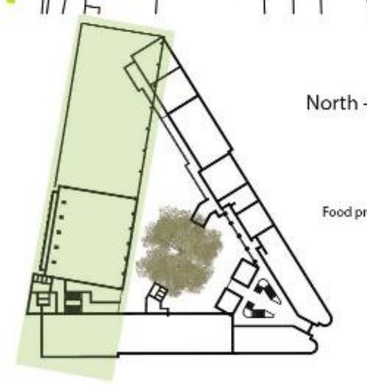


Suns path in the sky during different seasons

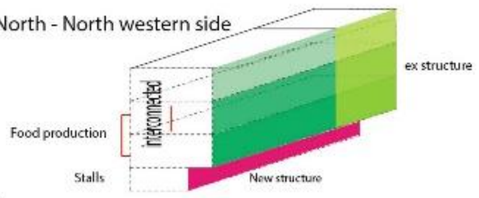


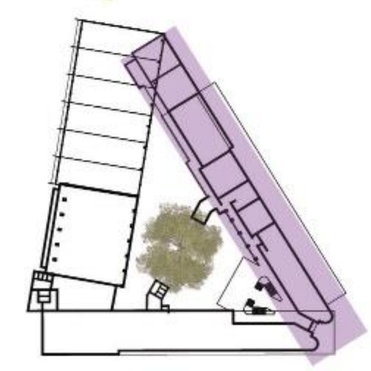
South Africas climatic conditions
Durban - Sub tropical (coastal)



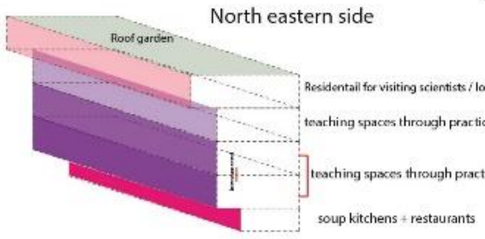


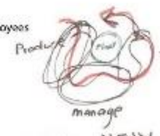
North - North western side

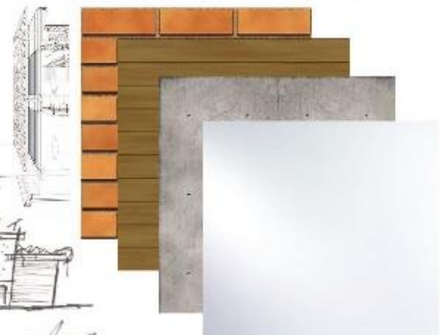


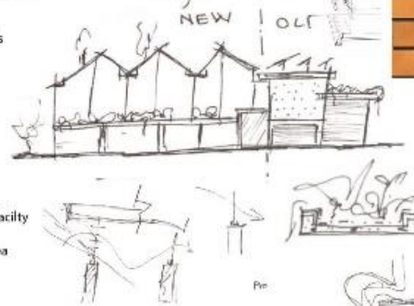


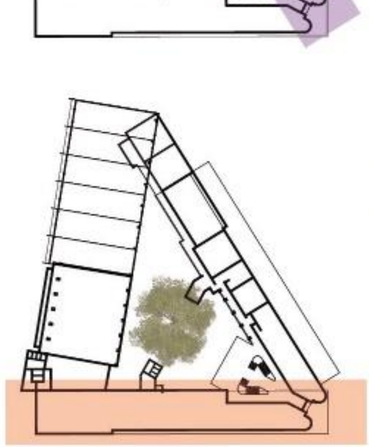
North eastern side

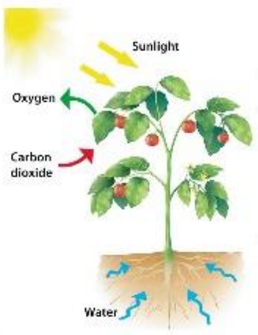




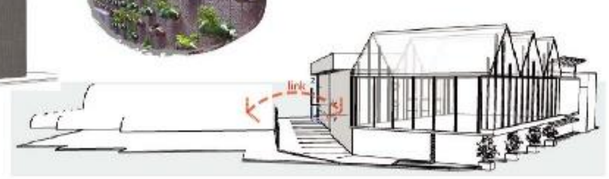


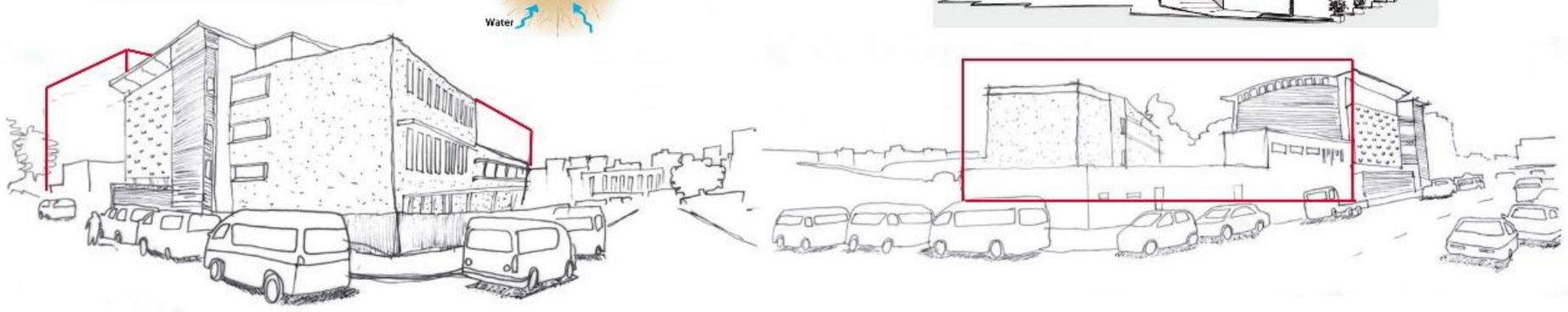


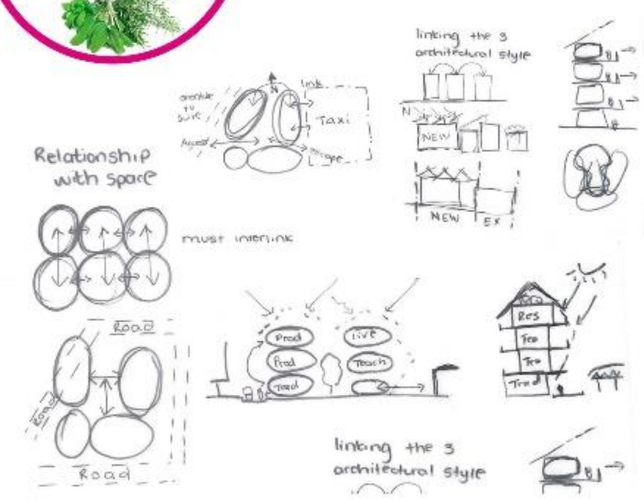




h Western Fascade







SINEGUGU MAPHANGA
205515252

Lancers Road

Julius Nyerere Street

Wills Road

Lancers Road

Existing taxi Rank entrance

Existing taxi Rank

Trading Shop

Trading Shop

Trading Shop

Trading Shop

Water storage
Delivery Area

Trading Shop

Delivery yard

Water room

Trading Shop

Office room

Trading Shop

Store room

Trading Shop

Trading Shop

Trading Shop

Trading Shop

Trading Shop

Trading Shop

Trading Shop

Waiting Area

Store room

Reception / welcome centre / information centre 240sqm

Fire escape

Entrance Reception

LOBBY

Reception / information

File room

Switch Room / IT room

Kitchen

Kitchen

court yard

Restaurant

Female Public ablutions

Store room

Switch Room / IT room

Existing taxi Rank

GROUND STOREY PLAN
scale 1:200

University Road

FIRST STOREY PLAN
scale 1:200

SECOND STOREY PLAN
scale 1:200

Extra layer of DPC to be applied over the underlay at roof ridges, hips and at the roof's apex

1957 x 987 x 40 mm 21.5 kg 72 Polycrystalline cell Bundu Power, 330 Watt, 37.62 Solar Panel fixed to roof sheeting,installtion to specialist detail

Klip-Tite colorplus AZ150 sheeting profile, roll-formed in continuous lengths. Sheeting be laid by an approved contractor in strict accordance with the manufacturer's specification. Stop endings must be formed at the apex and the pan turned down at the eaves to form a drip. The roof sheeting shall be closed as necessary with purpose-made flashings of a design approved by the supplier

Exisitng roof trusses to be demoloshed and replaced with new Galvanised mild steel truss to engineers detail

175 x 75 x 25 mm purlind galvanised mild steel to Engineers detail

1200x600mm OWAcoustic sinfonia premium biologically absorbable mineral wool ceiling tiles. System S3 (Square-edge to suit 24mm grid) colour: white

200 x 200mm square aluminium gutter powder coated charcoal grey as per Architects specification

17 500
First Storey

2mm thick lazer cut aluminium screen. Powder oated pale pastel green colour ANP9089. Holes cut 10mm diameter at 20mm intervals. screen to be mounted on aluminium frame o specialist detail and specification, shop drawings subject to architects approval

Precast conctrete lintel as per Engineers specification

Window to be as per window schedule

SW - 006

40 x 40 x 2m square pofile steel balustrade with maximum 100mm gaps inbetween to comply with sans 10400. balustrade to be fixed to steel beam.

203 x 133 x 25mm galvanised steel rafter to Engineers detail. powder coated charcoal grey

12 800
First Storey

240 x 120 x 25mm galvanised steel beam fized to wall and steel frame to Engineers detail. powder coated charcoal grey

114mm x 38mm C.C.A treated V.5 Structural pine, layed out with centres of 400mm. Wood sealer to be Rystix Exterior wood sealer. Colour stain to be teak, subject to Architects approval.

9 600
First Storey

Window to be as per window schedule

240 x 120 x 25mm galvanised steel beam fized to wall and steel frame to Engineers detail. powder coated charcoal grey

2mm thick lazer cut aluminium screen. Powder oated pale pastel green colour ANP9089. Holes cut 10mm diameter at 20mm intervals. screen to be mounted on aluminium frame o specialist detail and specification, shop drawings subject to architects approval

1200x600mm OWAcoustic sinfonia premium biologically absorbable mineral wool ceiling tiles. System S3 (Square-edge to suit 24mm grid) colour: white

6 400
First Storey

1200x600mm OWAcoustic sinfonia premium biologically absorbable mineral wool ceiling tiles. System S3 (Square-edge to suit 24mm grid) colour: white

2mm thick lazer cut aluminium screen. Powder oated pale pastel green colour ANP9089. Holes cut 10mm diameter at 20mm intervals. screen to be mounted on aluminium frame o specialist detail and specification, shop drawings subject to architects approval

3 200
First Storey

Exisiting wall plaster to be removed and new smooth plaster to be applied and made good. walls to be pained with plascon wall and all colour country musgroom

1200x600mm OWAcoustic sinfonia premium biologically absorbable mineral wool ceiling tiles. System S3 (Square-edge to suit 24mm grid) colour: white

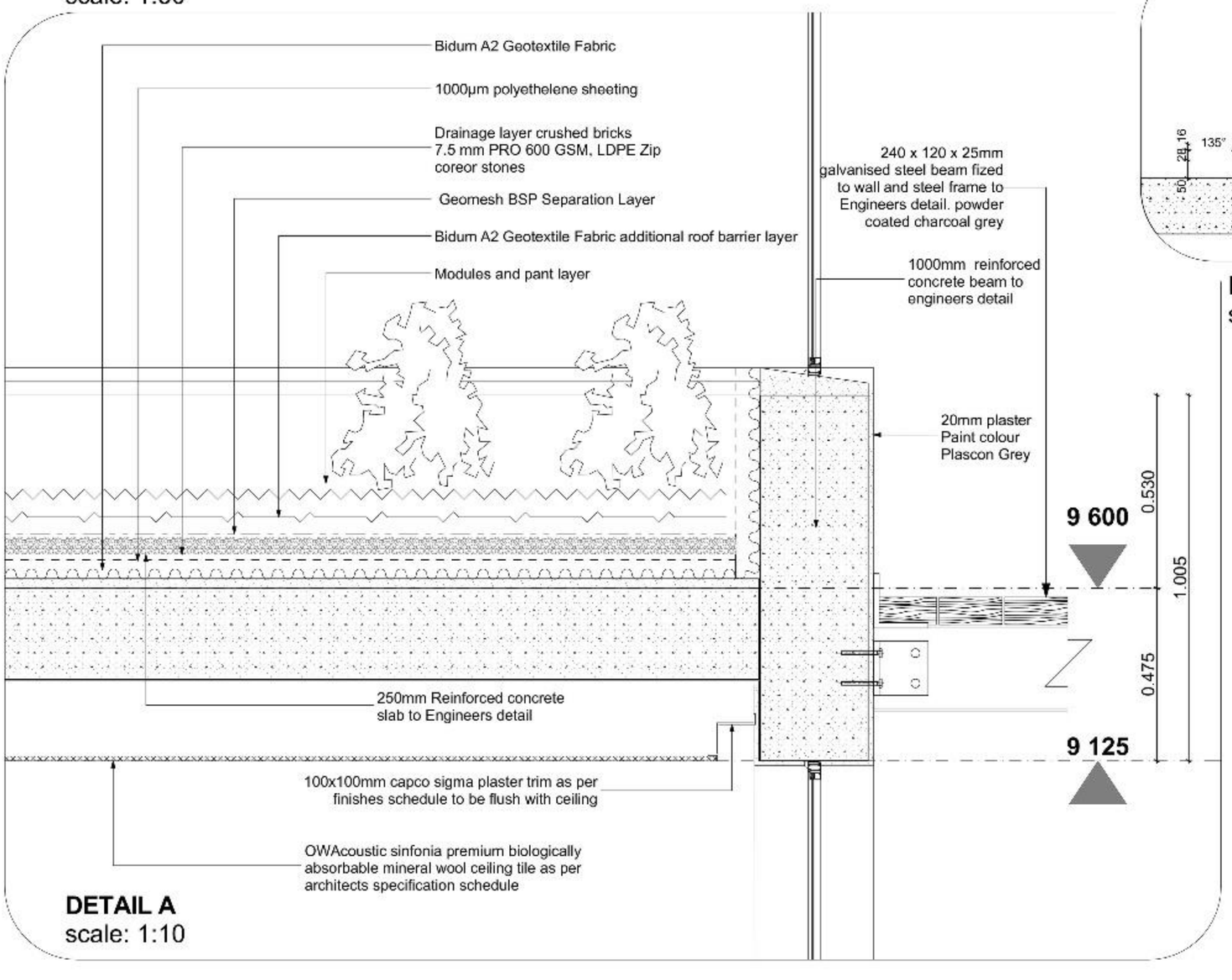
Exisiting wall plaster to be removed and new smooth plaster to be applied and made good. walls to be pained with plascon wall and all colour country musgroom

0 000
Ground Storey

sg sg sg sg sg
sg sg sg sg sg
sg sg sg sg
plaster and paint
A
plaster and paint
B
plaster and paint

STRIP SECTION
scale: 1:50

DETAIL B
scale: 1:10



DETAIL A
scale: 1:10

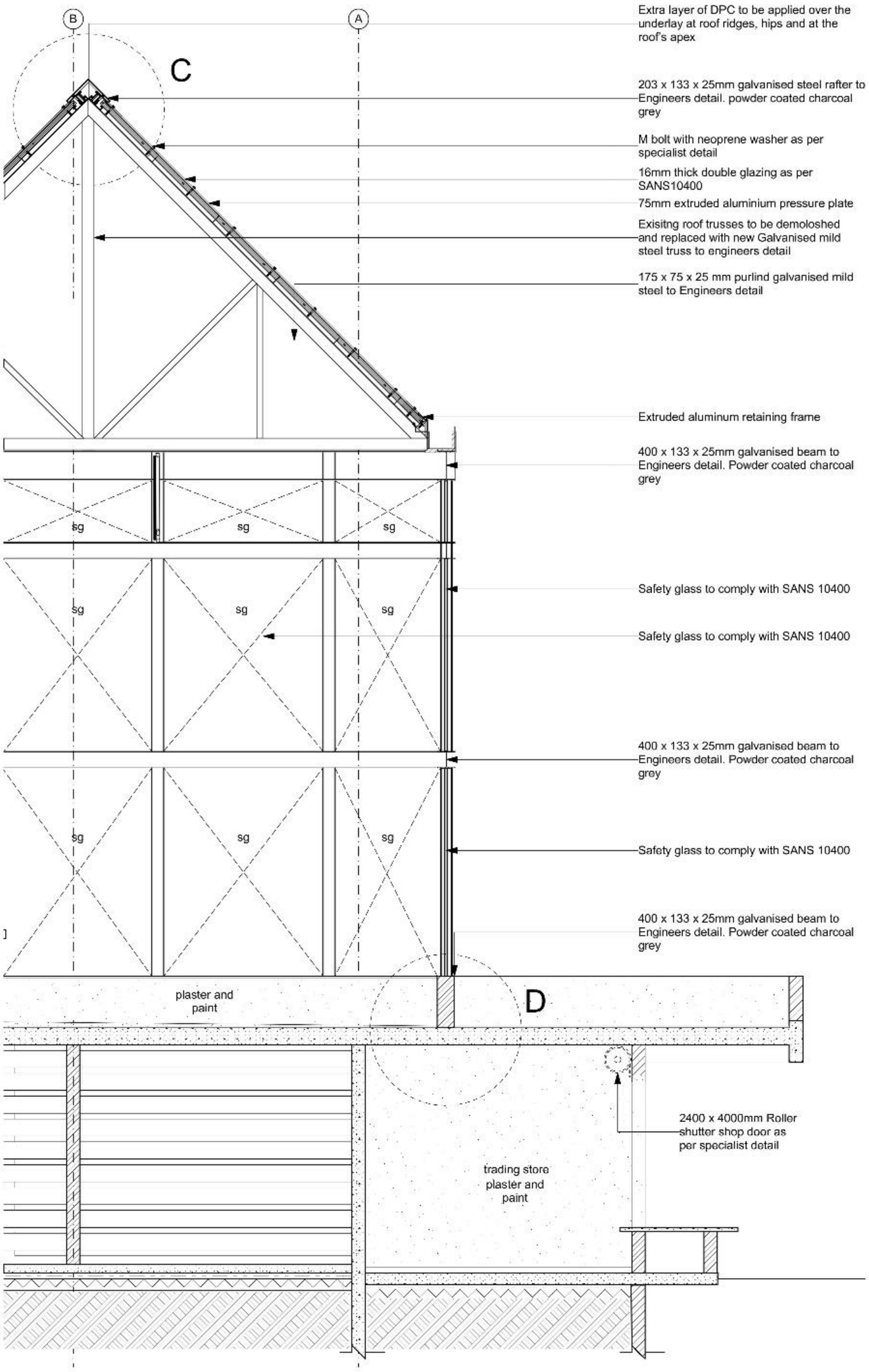
drawing:
stip section + detail 01

Physical address
44 Lancers Road Berea
Durban
4009

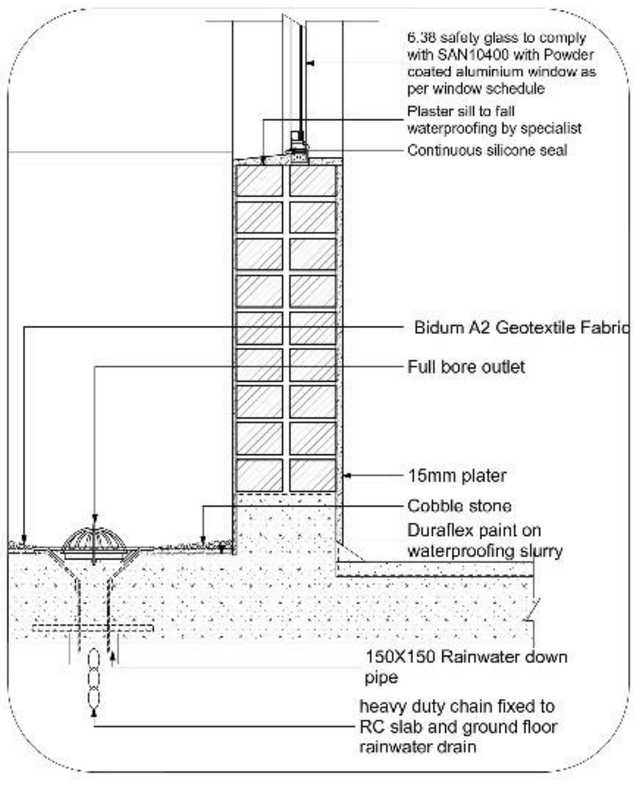
Building classifaction:
Research centre

contract number:	date:
205515252	2019|11|20

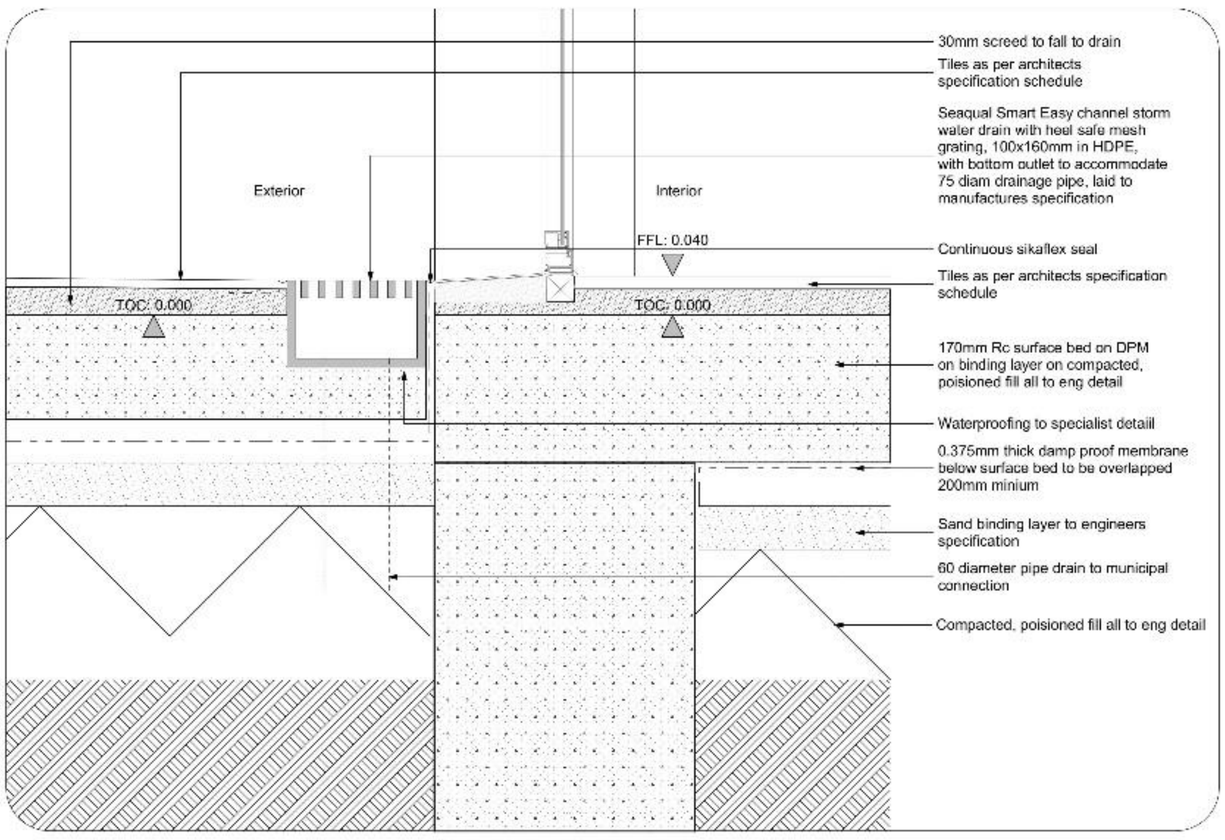
drawn:	scale:
S. Maphanga:	1:50, 1:10
checked: S. Maphanga	SACAP Reg 205515252
clients signature:	



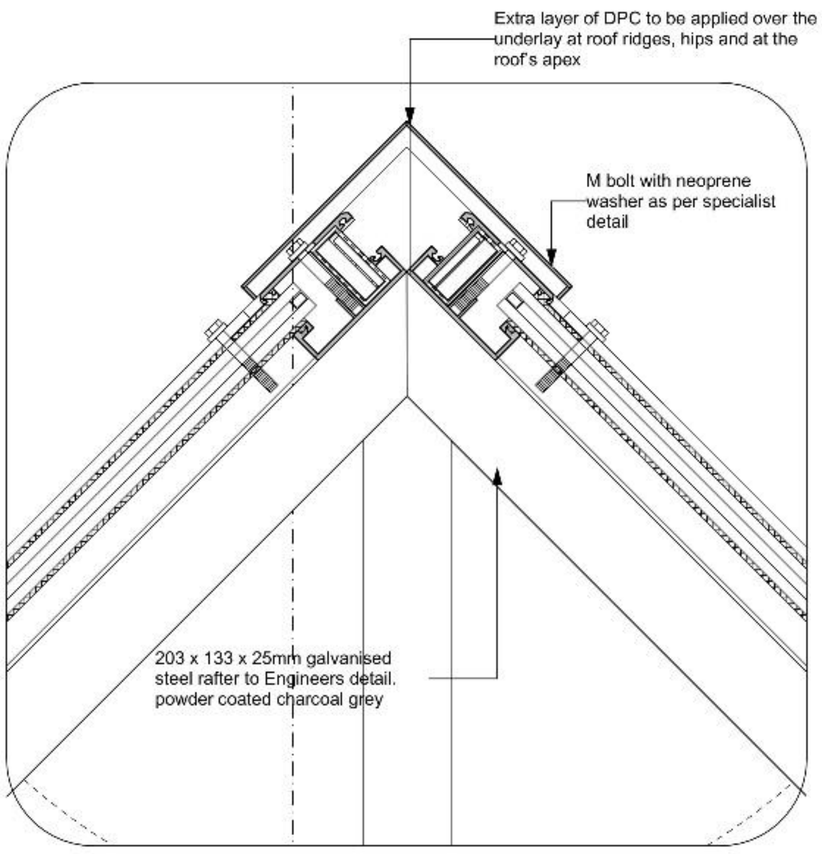
STRIP SECTION
scale: 1:50



DETAIL D
scale: 1:10



DETAIL E -
Threshold detail
scale: 1:5



DETAIL C
scale: 1:10

drawing:
stip section + detail 01

Physical address
44 Lancers Road Berea
Durban
4009

Building classifaction:
Research centre

contract number:	date:
205515252	2019|11|20

drawn:	scale:
S. Maphanga:	1:50, 1:10
checked: S. Maphanga	
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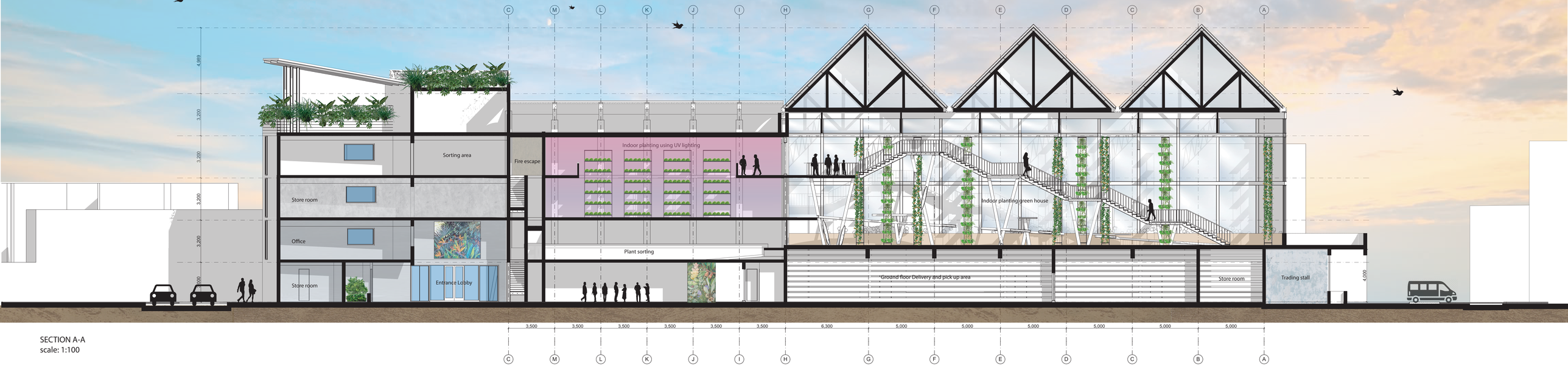
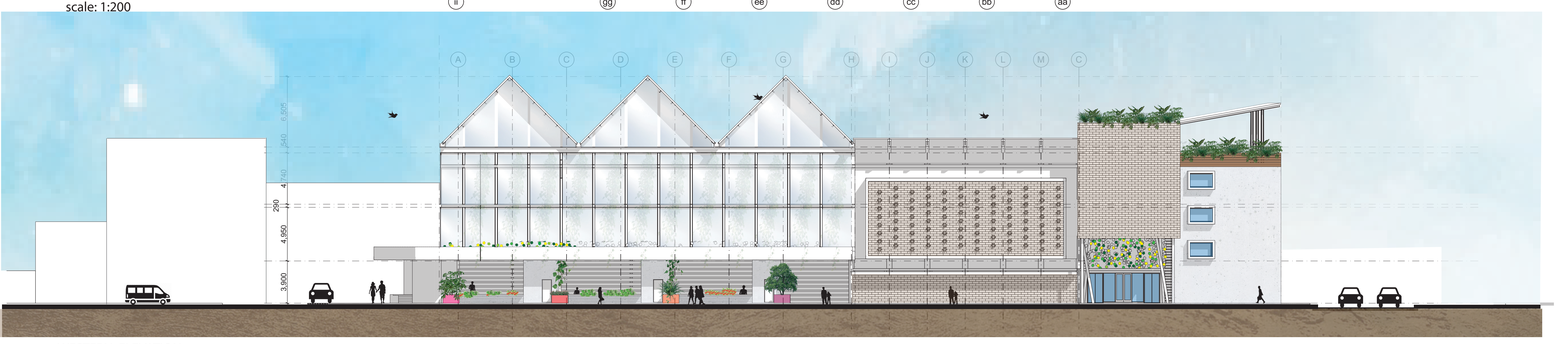


SECTION A-A
scale: 1:100

EASTERN ELEVATION
scale: 1:200



WESTERN ELEVATION
scale: 1:200

SECTION B-B
scale: 1:100